NCBDS30:IIT

30th National Conference on the Beginning Design Student, April 3-5, 2014
Illinois Institute of Technology College of Architecture, Chicago, IL

Proceedings

MATERIALITY

Essence + Substance

Leslie Johnson — Conference Chair
Catherine Wetzel — Conference Chair
Kathleen Nagle — Editor

Cover
S.R. Crown Hall
Lukasz Kowalczyk, Photographer

ISBN 978 -0-615-99335-5
Adams Press, Chicago, Illinois

NCBDS30:IIT

April 3 – 5, 2014

30th National Conference on the Beginning Design Student
Illinois Institute of Technology, College of Architecture, Chicago, IL

Proceedings

MATERIALITY

Essence + Substance

Leslie Johnson, Chair
Catherine Wetzel, Chair
Kathleen Nagle, Proceedings Editor
Paul Pettigrew
Kevin Todd

The Proceedings were published in conjunction with the 30th National Conference on the Beginning Design Student, held at Illinois Institute of Technology, April 3 – 5, 2014. Full papers, abstracts and tinyTEDs were triple-blind peer reviewed and selected authors were invited to present full papers or tinyTED presentations at the conference. Papers submitted by the publication deadline appear in the Proceedings document.

Acknowledgements

NCBDS30:IIT provided an opportunity for beginning design faculty to gather in S.R. Crown Hall, home of the College at Architecture at Illinois Institute of Technology to consider the topic of materiality. The legacy of Mies van der Rohe, the distinguishing nature of his 1938 curriculum for IIT and the beauty of a space rooted in ideas of material practice offered a background to the ongoing conference dialogue regarding the pedagogy and practices of beginning design teaching. In recognition of the conference's 30-year commitment to collegiality, discourse and dissemination, this year we honored Jim McGinty for his foresight and initiative in 1972 that laid the foundation for NCBDS. NCBDS remains a self-organizing colloquium of educators who identify with the particularity of beginning design education.

NCBDS30:IIT launched two initiatives in the making of this year's conference. The first initiative was to provide blind peer review to authors that chose to submit full papers in the call process. The full papers received feedback prior to the conference in support of authors seeking additional publication opportunities. The second initiative was a curated selection of 3-minute image-based presentations, tinyTEDs, in place of poster sessions, as a way of encouraging dissemination of emerging ideas. The conference committee was impressed with the breadth, depth and quantity of submittals in each category: abstracts, full papers and tinyTEDs. The committee appreciates the insight and generous support of the readers and moderators.

Thank you to the College of Architecture, Dean Wiel Arets and Associate Dean Vedran Mimica for their support of NCBDS30:IIT. For administrative and operational assistance, special thanks go to Faith Kancauski, Richard Nelson, John Kriegshauser, Richard Harkin and Stuart Macrae. Thank you to Lukasz Kowalczyk for all images for the conference materials. Thank you to all of our student assistants who helped with conference events from staffing tables to technology management. Kevin Todd deserves a special thank you for his constant management of conference priorities.

Thank you to Bolle Tham and Martin Videgård for delivering a thoughtful keynote lecture. Don Gatzke and James Sullivan were especially helpful in the organizing the presentation of the McGinty Award. James Sullivan, Jeff Balmer, Eric Oskey, Peter Hind and Brian Kelly, past conference chairs, helped immensely with timely answers to our conferencing queries. Best of luck to Meg Jackson, Greg Marinic and Cord Bowen, co-chairs of NCBDS31 at the University of Houston.

Readers and Moderators

The NCBDS30:IIT committee would like to thank all the peer reviewers and readers that donated their time and insight to reviewing the many abstracts, papers, and tinyTED proposals submitted to the conference. Thank you to the moderators, drawn from the group of readers, for their willingness to lead thought-provoking discussions in each of the conference paper sessions.

Jim Agutter | University of Utah
Lorena Alvarez | Temple University
Nicholas Ault | Clemson University
Jeff Balmer | UNC Charlotte
Jasmine Beyamin | UW Milwaukee
Matt Burgermaster | New Jersey Institute of Technology
Erin Carraher | University of Utah
Thomas Cline | University of Oklahoma
Ben Corotis | California College of Art & Design
Jill Danly | Illinois Institute of Technology
Judith DeJong | University of Illinois at Chicago
Brian Dougan | American University of Sharjah
Firat Erdim | IE University, Segovia
Clifton Fordham | Temple University
Phil Gallegoa | University of Colorado, Denver
Grant Gibson | University of Illinois at Chicago
Ellen Grimes | School of the Art Institute of Chicago
Sallie Hambright-Belue | Clemson University
Peter Hind | University of Nebraska-Lincoln
Colleen Humer | Illinois Institute of Technology
Meg Jackson | University of Houston
Bruce Johnson | University of Kansas
Leslie Johnson | Illinois Institute of Technology
Thomas Kearns | Illinois Institute of Technology
Brian Kelly | University of Nebraska-Lincoln
Lukasz Kowalczyk | Illinois Institute of Technology
Eva Kultermann | Illinois Institute of Technology
Jodi Lynn La Coe | Penn State University
Steve Lagrassa | University of Detroit Mercy
David Leary | School of the Art Institute of Chicago
Dave Lee | Clemson University
Michael Lucas | Cal Poly San Luis Obispo
Greg Marinic | University of Houston
Jonathan Miller | Illinois Institute of Technology
Kindon Mills | Illinois Institute of Technology
Taiji Miyasaka, | Washington State University
Patricia Morgado | North Carolina State University
Kathleen Nagle | Illinois Institute of Technology
Clare Olsen | Cal Poly San Luis Obispo
Peter Olshavsky | University of Nebraska-Lincoln
Eric Oskey | Temple University
Carlo Parente | Illinois Institute of Technology
Maria Perbellini | Texas Tech University
Paul Pettigrew | Illinois Institute of Technology
Jeff Ponitz | Cal Poly San Luis Obispo
Noah Resnick | University of Detroit Mercy
Kyle Reynolds | UW Milwaukee
Joyce Rosner | UT Austin
Andrew Schachman | Illinois Institute of Technology
Homa Shojaie
Karla Sierralta | Illinois Institute of Technology
Robert Silance | Clemson University
Thomas Sofranko | Louisiana State University
James Sullivan | Louisiana State University
Michael Swisher | UNC Charlotte
Aron Temkin | Norwich University
Stephen Temple | UT San Antonio
Andy Tinucci | Illinois Institute of Technology
Anca Trandafirescu | University of Michigan
Carmen Trudell | Cal Poly San Luis Obispo
Elpitha Tsoutsounakis | University of Utah
Jesse Volger | Washington University in St. Louis
Karl Wallick | UW Milwaukee
Catherine Wetzel | Illinois Institute of Technology
Amanda Williams | Illinois Institute of Technology
Betsy Williams | Illinois Institute of Technology
Kristina Yu | University of New Mexico
Mo Zell | UW Milwaukee

Lukasz Kowalczyk, Photographer

Table of Contents

Materiality: Essence and Substance

From the master/apprentice paradigm of learning building craft to the hallowed halls of formalized education, the historical trajectory of architectural study presents a challenge to integrating materiality within the conception and delineation of the built environment. Today representational tools and techniques are often compromised substitutes for the physicality of architectural works. Consequently, architecture's pedagogical structures struggle to infuse tactility, material assembly, and making into the representational methodology of design education today.

After generations of architectural work being decoupled from the pressure of local resources, contemporary concerns for sustainability and material sourcing have shed new light on the need for architects, and thus architecture students, to comprehend the materiality of building in new ways. While design/build studios and material investigations embedded into the educational process attempt to bridge this divide, digital fabrication tools and highly engineered materials further challenge traditional means and methods.

With this history and these challenges, how might the materiality of representational artifacts align with both the design intent and the physical manifestation of buildings? How do foundational studies in design thoughtfully and effectively incorporate materiality and its inherent challenges and opportunities?

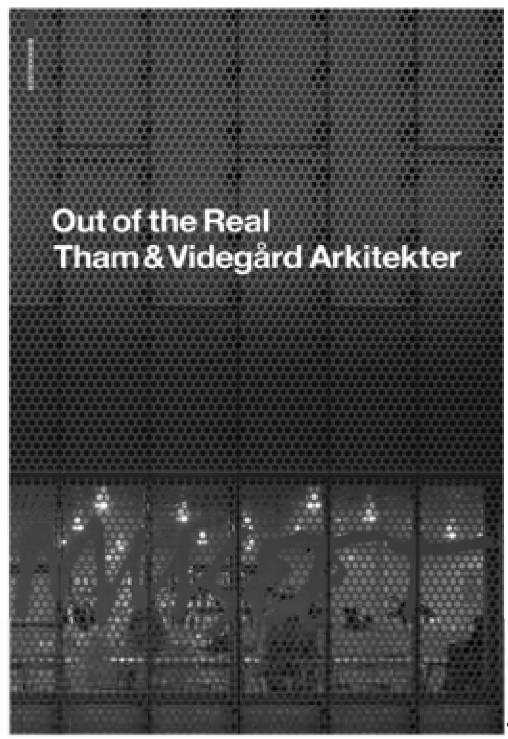
Material | Immaterial: What do we teach and why do we teach it? What is the material of foundational studies and how does it promote the immaterial objectives of design education?

Essence | Substance: How do we employ material practices in curricula to promote understanding of the essence and substance of architecture? What are the roles of physical material, craft and making in beginning design?

Tools | Techniques: How do the evolving tools and techniques of investigation and representation intersect with the understanding of materiality? How have they changed or influenced beginning design education?

Assembly | Tectonics: How does the teaching of architecture as a set of systems promote understanding of the poetics of assembly and material practice? What is the ethos of material economy, efficiency, and ecology in foundational studies?

Mikael Olsson



Åke E:son Lindman

Out of the Real

Bolle Tham & Martin Videgård

Tham & Videgård Arkitekter is a progressive and contemporary practice that focuses on architecture and design – from large scale urban planning to buildings, interiors and objects. The practice objective is to create distinct and relevant architecture with the starting point resting within the unique context and specific conditions of the individual project. Commissions include public, commercial and private clients in Sweden and abroad.

The practice's approach to architecture is inclusive, with practical, theoretical, social and environmental issues analyzed and integrated within the process. The method of work encourages innovative thinking to drive the development of the project, which in turn facilitates the subsequent realization within the logics of efficient contemporary production. This represents an important direction of the practice, based on the view that architecture is the physical realization of ideas. In response, Tham & Videgård have become even more interested in the importance of the original craft that drives the profession and the potential that the process, from idea (concept) to construction, represents.

Tham & Videgård Arkitekter designed the Tree Hotel project in Harads, Sweden, recently awarded the Barbara Cappochin International Architecture Prize. House Lagnö won the international House of the Year Award 2013 given by *World Architecture News* and was Highly Commended at the *Architectural Review* House Awards 2013 London. Other major works include the Moderna Museet Malmö, the first branch of the Swedish Museum of Modern Art, and the Kalmar Museum of Art, awarded the Kasper Salin Prize 2008 and shortlisted for the Mies van der Rohe Award 2009. Their work has been exhibited in Stockholm, Venice, Seoul, Prague, London, Lisbon, Helsinki and at the Louisiana Museum in Denmark. A monographic exhibition on the practice of Tham & Videgård will open in Paris in April 2014.

Tham & Videgård recently won the invited competition for a new school building at the Krabbesholm School of Art, Architecture and Design in Skive, Denmark. Their design for the new School of Architecture and Campus Entrance for the Royal Institute of Technology, Stockholm, is now under construction. Their work has been published extensively and is the subject of three monographs, the most recent, *Luoghi dell'Abitare (Places of Living),* presents a selection of buildings from twelve years of practice. As an integrated part of the architectural practice, Bolle Tham and Martin Videgård also teach and lecture at schools of architecture in Sweden and abroad.

Associate Professor Tim McGinty taking research notes in Central Park circa 1980

The award was introduced by James Sullivan, Associate Professor of Architecture and Chair of the Department of Interior Design at Louisiana State University, and presented to Tim McGinty by his former student Donald Gatzke, Professor and Dean of the School of Architecture at the University of Texas, Arlington.

The Inaugural McGinty Award

James Sullivan, Louisiana State University

This year the National Conference on the Beginning Design Student (NCBDS) met for the 30th time to provide a forum for design educators to present papers and projects and hold discussions related to the study and practice of beginning design education.

The conference's origins reside in a small gathering entitled *Beginnings*, held in 1972 at the University of Wisconsin, Milwaukee. Organized by Tim McGinty and Gerry Gast, young faculty at UW-Milwaukee and the University of Illinois at Urbana-Champaign respectively, this meeting brought together design educators to discuss introductory design education. Just over a decade later, after a second gathering held in 1983 at Cranbrook Academy, the first Beginning Design Conference was held in 1984 at Arizona State University. Since that conference in Arizona, the National Conference on the Beginning Design Student has been and continues to be the primary venue for discussion about the practice of and research into beginning design.

Perhaps the most remarkable aspect of the NCBDS's longevity is that the conference has no formal organizational structure. It has no president, no treasurer, and no dues. Instead, the conference has a dedicated community of beginning design scholars and educators whose interest in the educational challenges and attendant pedagogies, projects, and curricular strategies associated with beginning design propel the conference.

This year, our community initiated a new tradition. We recognized a member in the beginning design community for significant contributions to beginning design. This recognition came in the form a new award named *The McGinty*. *The McGinty* is not an annual or bi-annual award, but rather it is an award that will be given as needed to recognize important and significant contributions to NCBDS or beginning design generally.

This award is an important step in NCBDS's efforts to bring forward its past and know itself as a discipline. To do this, we who work in the discipline must be aware of the area of knowledge we claim, the salient questions asked in that area, and its important figures. Additionally, this effort is important to the conference itself, given its loose and informal 'organization.' Such an organization can easily lose track of itself, where it has been, what it has offered and accomplished, and who was involved. Yet if we consider our work at the conference as a contribution to a community, then surely we should preserve those contributions, and occasionally recognize them, particularly the important ones.

The inaugural recipient of *The McGinty* is the person after whom the award is named, **Tim McGinty**. As a founder of NCBDS, and chair and participant in many conferences, Tim is naturally the first person to receive this award. Tim holds his Bachelor of Architecture from the University of Kansas and his Masters of Architecture degree from the University of Pennsylvania. His teaching career started at the University of Nebraska but then moved to the University of Wisconsin, Milwaukee, where he was one of the founding faculty members of the program. After thirteen years at UW-M, Tim moved to Arizona State University where he taught until 1996. He then stepped down from his tenured appointment to join his wife in practice until they retired together recently. Still, every now and then, Tim is pressed into service by the University of Colorado, Boulder, to teach studio, if his family (including grandkids) allow it.

Conference History

1972	Beginnings, University of Wisconsin, Milwaukee
1983	Cranbrook Meeting, Cranbrook Academy
1984	Drawing and Environmental Design, Arizona State University *Tim McGinty, Chair*
1985	2nd Annual Basic Design Conference, Arizona State University *Tim McGinty, Chair*
1986	3rd Annual Basic Design Conference, Arizona State University *Tim McGinty, Chair*
1987	4th Annual Conference on the Beginning Design Student, Arizona State University *Tim McGinty, Chair*
1988	5th National Conference on the Beginning Design Student, University of New Mexico *Nicholas Markovich, Tim McGinty, Chairs*
1989	6th Conference on the Beginning Design Student, Tulane University *Michael Crosby, Donald Gatzke, Nicholas Markovich, Chairs*
1990	7th National Conference on the Beginning Design Student, Louisiana State University. *Nicholas Markovich, Chair*
1991	8th Annual Conference on the Beginning Design Student, Arizona State University *Mary Hardin, Tim McGinty, Chairs*
1992	9th National Conference on the Beginning Design Student
1993	10th National Conference on the Beginning Design Student, Tulane University *Donald Gatzke, Scott Wall, Chairs*
1994	11th National Conference on the Beginning Design Student, University of Arkansas *Jeff Hartnett, Greg Herman, Murray Smart, Chairs*
1995	12th National Conference on the Beginning Design Student, Virginia Tech *Marie Wall, Chair*
1996	13th NCBDS: Into the Abyss, Louisiana State University. *Tom Sofranko, Nicholas Markovich, Chairs.*
1997	14th NCBDS: Not Only But Also, Carnegie Mellon University *Bruce Lindsey, Laura Lee, Chairs*
1998	15th NCBDS, University of California, Los Angeles *Jose Gamez, Chair*
1999	16th NCBDS: Quality, Origins, and Foundations, University of Nevada, Las Vegas *Jeff Hartnett, Chairs*
2000	17th NCBDS, University of Puerto Rico *Jorge Rigua, Chair*
2001	18th NCBDS. Portland State University *Rudy Burton, Clive Knights, Chairs*
2003	19th NCBDS: Unstaked Territory, Oklahoma State University *Eric Connell, Chair*
2004	20th NCBDS: Not White, Diversity in Beginning Design, Hampton University *Shannon Chance, Theodore Sawruk, Chairs*
2005	21th NCBDS: The Beginner's Mind, University of Texas, San Antonio *Steve Temple, Chair*
2006	22nd NCBDS: Intersections, Iowa State University *Igor Marjanovic, Clare Robinson, Chairs*
2007	23rd NCBDS: Translation, Savannah College of Art and Design *Conrad Rathman, Chair*
2008	24th NCBDS: We Have Never Been Pre-Disciplinary, Georgia Institute of Technology *Sabir Khan, Chair*
2009	25th NCBDS: But Also, We are a Discipline, Louisiana State University *Jim Sullivan, Matt Dunn, Chairs*
2010	26th NCBDS: Made: Design Education & The Art of Making, UNC - Charlotte *Jeffrey Balmer and Chris Beorkrem, Chairs*
2011	27th NCBDS: Beginning of/in the End - Sustainable (re)Started, University of Nebraska-Lincoln *Lindsey Bahe, Peter Hind, Brian Kelly, Chairs*
2012	28th NCBDS: End of/in the Beginning – Realizing the Sustainable Imagination, Penn State University *Jodi La Coe, Chair*
2013	29th NCBDS: Actions: the Making of Place, Temple University *Eric Oskey, Dennis Playdon, Lorena Alvarez, Chairs*
2014	30th NCBDS: Materiality – Essence + Substance, Illinois Institute of Technology *Leslie Johnson, Catherine Wetzel, Chairs*

Design Process | Design Thinking:
Alternative Methods in the Classroom

James Agutter, Elpitha Tsoutsounakis

University of Utah

This paper will investigate the process of re-thinking the way we teach a design thinking curriculum in order to accommodate many more students in a seminar that is simultaneously broad and focused and goes beyond the typical lecture/exam classroom model.

Background

In the modern world, the boundaries that exist between different disciplines often aren't as easily defined. The adherence to siloed solutions is breaking down. Bridges are being built between specialties in order to cultivate a shared understanding, synergistic collaboration and a common vocabulary – all of which are essential to solving complex problems. At this juncture in time, design and design thinking have evolved into a dominant framework for bridging these divides and for facilitating creative and interdisciplinary problem solving. Those versed in the language of design and critical thinking will be essential voices in such dialogues. Therefore, it is absolutely critical that we not only educate our future designers with a strong foundation in the fundamentals of design and design thinking, but to begin cultivating collaborative environments that reflect contemporary paradigms.

This idea of cross-fertilization is not new. It has, perhaps, just been inadvertently forgotten due to the complexities of the university structure. The Bauhaus which operated in Germany from 1919–1933 (and subsequent new Bauhaus at the Illinois Institute of Technology) was/is a model of interdisciplinary study that purposefully ignored arbitrary and artificial boundaries and provided a common approach to design and art-making across divergent disciplines. This union of art, craft and technology led to innovations in architecture, graphic design, product design, furniture design and materials that continue to reverberate.

In the last number of years many private institutions and design practices have taken up this theme of the linkage between different disciplines through the common language of design. The d.school at Stanford, the New School at Parsons, IIT Institute of Design and MIT Media labs are examples that bring together a diverse set of specialties across the common framework of design while addressing complex, community based problems at their core.

Approach

To address these issues and trends, we at the University of Utah, teach "Introduction to Design Thinking" which is a freshman level course offered by the Multi-disciplinary Design program. Rather than teaching the course as a series of methods that can be applied to different situations, we are interested in the value of Design Thinking as a way to introduce students at the beginning level to a way of approaching the world through questioning and iterative testing in a rhizomatic process that doesn't always follow an expected trajectory, but becomes a powerful tool for solving problems with innovative solutions. We believe it is critical that the beginning design student understands that initially the product of their studies is less critical than developing a process that is refined through direct and immediate feedback of what they produce. We are also interested in a continued study of Design Thinking as a methodology; how it has evolved from a long standing search for articulating the design process that transcends the last decade of popularization and branding and how it can further develop as a robust dexterity for students, designers and non-designers alike.

We have established these main objectives for the course.

- design principle understanding and application
- importance of craft

- visual literacy
- abstract to concrete dexterity
- abundance mindset
- human centered design principles
- inquiry and project-based learning
- critical thinking skills
- identifying authentic real-world tasks and challenges
- experimentation with multiple ways of problem solving
- team building and collaboration

In the past the course was taught in two separate sections. The first portion of the semester was based on the development of specific design skills through design problems that illustrated basic principles such as hierarchy, figure ground and layout. These are grounded in a process that moves through Observation, Analysis, Ideation, Prototyping and finally Dissemination. In the second portion of the semester, students utilize those concepts and process in the context of a real world problem where they work with community partners to come up with solutions.

The approach was based on the stance that students must be knowledgeable about the fundamentals of design practice and principles prior to engaging the application of design thinking methods and strategies to solve complex problems.

During the first portion of the course the concepts were taught separately through individual and focused design projects. These projects challenged the students to observe the world around them while also composing presentations dealing with layout and general design principles. Students were introduced to the studio pedagogy through the practice of critiques and engaged in dialog about the work on review days.

These individual projects were followed with the group project spanning the second half of the semester. Each course works with a community partner that gives the students the opportunity to work in a real, applied situation. The students work in groups of 3-4 and are challenged to come up with a team identity. The traditional 5 phases of the design thinking model are organized in three activity designations with deliverables as well as additional exercises at key points. The first set is the Observation & Research activities. The students are given a topic to investigate through a variety of observation methods from first, second and third person perspectives. Once their observations are compiled the groups work through an in-class charette to identify insights and opportunities that interest them and develop a problem statement to direct their project. We find that most students, prior to taking the course, don't have the skills to identify opportunities and articulate their own problem statements. The ability to define the problem is critical not only for students that continue to study design, but important also for students in any degree of study.

Once they have agreed upon and refined their problem, the groups begin the second set of activities for the project, Ideation. The students are introduced to a variety of brainstorming techniques. Each group is required to generate 20 possible solutions for each student in the group and then given a matrix to evaluate and score the solutions on a variety of factors including cost, feasibility, energy, desirability, aesthetics, etc. Each group presents their top possible solutions to the rest of the class describing what criteria they valued most in selecting the final direction. The Ideation activities concludes with a 'solution statement' that requires the students to define in writing what the objective and methods of their solution will be. This allows them to reconsider the problem statement and gives them parameters to refer back to during iterative refinement of their solutions.

The third and final set of activities of the project is in the area of Implementation. Again, the concept of an iterative design process is reinforced in class discussion. Each group is required to meet with the instructor and TA for desk crits to discuss their progress. In this set of activities they materialize their proposed solutions through sketches, diagrams, renderings and initial prototypes. Each group assembles a concise presentation that summarizes their entire process and presents their work in a final review with a jury of stakeholders from the community partner organization as well as design faculty and relevant experts. Each presentation allows time for feedback, questions and critique. The students are able to reflect on this feedback in generating a process book at the end of the project that includes their process from each phase and their final solution. These process books also provide a document to hand off to the community partner.

	STRUCTURE	SCALE	SEQUENCE	PARTNERS
FIRST ITERATION [F_09 - S_13]	STUDIO / SEMINAR HYBRID	30 STUDENTS I PROFESSOR	COORDINATED DEADLINES FORMAL REVIEW	CHILDREN'S MUSEUM COMMUNITY GARDEN
SECOND ITERATION [F_13]	STUDIO / SEMINAR HYBRID	90 STUDENTS 1 PROFESSOR 4 TAs	COORDINATED DEADLINES FORMAL REVIEW	UNIVERSITY OF UTAH COLLEGE OF SCIENCE
THIRD ITERATION [S_14]	STUDIO / SEMINAR HYBRID	70 STUDENTS 1 PROFESSOR 1 TA	DISTRIBUTED DEADLINES DAILY REVIEWS	NATURAL HISTORY MUSEUM OF UTAH JADE THERAPEUTICS

Course comparison chart.

Evolution

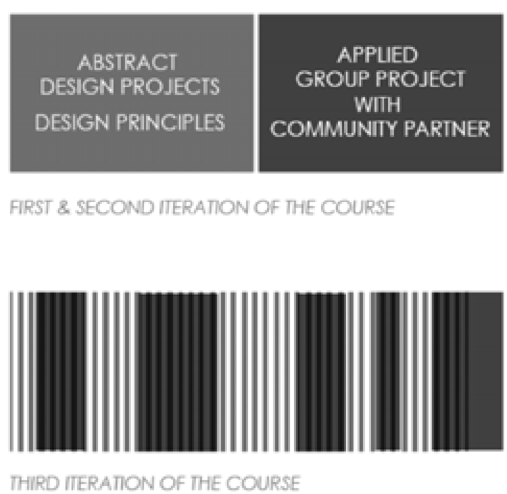
First and Second Iteration

Due to the popularity of the course and in attempt to maximize the impact across the entire University community, we scaled the course from a class of 30 students to a class of almost 100 students during the Fall 2013 semester. We have found that simply multiplying the current content and methods as well is not adequate. Our strategy in the second iteration of the course was to split the students up into 4 cohorts led by graduate student teaching assistants. The entire class would meet once a week in lecture, and once a week in lab for more intimate discussion and feedback. In this model the project pacing and structure was the same, but the issue of scale was dealt with by distributing students across separate classrooms. This allowed for easier management of the students, but created new problems. The 4 cohorts were essentially different sections and no longer learning from each other and the teaching assistants were not comparable in critique and grading.

Third Iteration

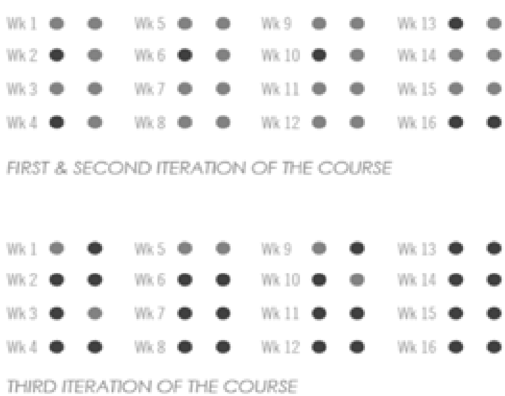
In an attempt to address the issues that were discovered during the first and second iterations of the course, we have modified the structure of the course again. This new approach focuses on distributing assignments across the length of the semester instead of distribution of students into separate cohorts.

The original 3 individual design projects were reinvented as one individual design challenge that can be completed through out the semester. Students have been presented with 5 possible design projects that are simple enough for a beginning student with no design experience, but also give the students the opportunity to understand basic design principles, process and craft. Students have the option to sign up for one of six design crits per class, during which to present their work to the rest of the students. This requires the student to select the project and due date. Students then have the option of turning in their project if they are satisfied with their work, or they have up to one week to make refinements based on the feedback.



Project structure across different iterations

This approach has many advantages. The students are learning from the critique of each other's work every class period, instead of the original 3 review days. This dramatically increases the practice of critique and design language for the students. The students also have the choice of which project they want to pursue, this allows for greater variety in work and multiple examples reinforcing design principles in different ways. An extra advantage for the instructor is that grading is distributed across the entire semester, so more time can be spent giving meaningful feedback on projects. Conceivably, as the semester progresses, the students' work will collectively improve as they are seeing solutions to the problems and learning from class discussion of work.



Distribution of design critiques across the semester.

Group Project

In the first and second iterations of the course the semester was essentially split in two, and the group project was carried out in one continuous block spanning approximately 7 weeks. This felt like it was too long, despite needing the time for the work. This semester, in the third iteration of the course, the group project is assigned early on and the remaining course content is distributed through out. The risk is that working in groups in some capacity for the entire semester will become onerous for the students, but our hope is that they will prefer the variety of focus in the course.

Community Partners

A major success through out all of the course iterations has been the opportunity for the students to work with a community partner. This allows them to apply the concepts and design thinking methodology to real-world problems and find innovative solutions that have the potential of really making an impact. In past semesters, students have worked on a variety of projects. They designed new exhibits and experiences at the Children's Discovery Museum in Salt Lake City, facilities and storage solutions for the Wasatch Community gardens and solutions for improving the proposed Crocker Science Center on the University campus looking at issues of advising, tutoring, learning spaces and common areas.

This semester, the students have begun work on exhibits for the Natural History Museum of Utah. We partnered with the museum and Jade Therapeutics, a local research company, and received funding from the University for this interdisciplinary project. The grant will provide funding to implement the students proposals in the museum in a special exhibit about the eye, disease and treatment in order to educate the public and raise awareness. The students will work through the phases described before, Observation & Research, Ideation and Implementation to arrive at novel solutions for museum exhibits or programs on this topic.

The opportunity to have their work eventually built and displayed in the museum is an exciting outcome for a beginning level undergraduate course. It is particularly valuable for the student to understand so early on in their careers how to take an insight from the very beginning in articulating the problem all the way through the process of designing, refining, prototyping and building a solution.

Conclusion

Through 3 iterations of the design thinking course we have gone through a number of transitions. We moved from a small course that valued one on one critiques with a linear sequence of projects, to a large class that favors a rhizomatic or non-linear structure of projects to facilitate one on one critiques with minimal staff. On the positive side we have learned that this course can serve as a large-scale demonstration of interdisciplinary collaboration. It has educated a diverse group of students in design literacy, demonstrated the value of design and provided unique collaborations and opportunities with community partners. In addition, it has been a tremendous promotion and recruitment tool for the Multi-Disciplinary Design program. On the negative side we learned that there is a challenge of critique pedagogy with large numbers of students. We also struggled with the issue of depth vs. breadth, diminished feedback opportunities and difficulties with dealing with such a diverse student population with vastly different backgrounds.

We are excited about the continuing evolution of the course and the goal to continue to raise design awareness across the entire University.

Materials as Collections

Michael Leighton Beaman, Zaneta Hong

Rhode Island School of Design, Harvard University Graduate School of Design

Materials as Collected Information Sets

To understand a material is to understand the collections of information, which define them. From chemical properties to application history, materials are the manifestations of manifold information sets. In creating a pedagogical approach to how one utilizes materials in the design process, the ability to access, analyze, organize, and manipulate information is paramount.

The use of materials in design education has taken on many pedagogical frameworks - courses that examine materials in their ecological and technological context in the form of natural systems; courses that examine a specific material and study with its use in a focused but detached context, such as detail examination of built work; and courses that examine material selection, representation and rendering to communicate why specific selections are made and the phenomenological effects they produced.

While all of these frameworks provide useful and varied inquiries into the question of materials in the design and production process, they share a common understanding of materials research as being adjacent to the design processes itself. Here, materials are to be studied in as much as they are selections to be made. This becomes increasingly apparent when looking at the growth of both commercial and academic materials collections associated with the design disciplines. These resources are typically organized using the CSI *MasterFormat*[1] cataloging system, the goal of which is to facilitate the specification of materials and products for the purposes of standardizing construction notation.

In an academic setting, where research and innovation are on equal footing with practical know-how, the question of a materials-based pedagogy for design education is one we were interested in developing alternative answers to. By re-contextualizing materials as information sets, we sought to embed materials research into the core of the design process. With combined backgrounds in three different design disciplines (architecture, landscape architecture, and industrial design), we also were invested in developing materials-based pedagogies within the larger question of interdisciplinary design education. To do this, we began by examining the role of information in structuring how we work with materials.

Information

Within our current digital infrastructure, information is what moves between media, platforms, and disciplines. This quality has rendered design practice increasingly dependent on the ability to effectively work with information - access, analysis, manipulation, and formulation. Though this has arguably always been a tacit function of design, the emergence of digitally based design methodologies has made it an explicit one for designers. This realization in the general public, and what has become an expectation among both students and clients alike, is a product of our evolving relationship with computational media and a cultural dependence on information-based production.

Information theory emerged in the late 1940s through the works of Claude Shannon, Norbert Wiener, and others.[2] Built from applied mathematics, computer science, and electrical engineering, information theory laid the foundation for systems of information quantification allowing us to transfer, transform, store, organize, communicate, and utilize information via digital means. Information theory effectively decontextualizes information in ways that allows it to exist outside of its original form. This presents us with flexible relationships between collections of information, which allow for the re-composition of data sets into new hybrids and juxtapositions, revealing latent qualities and possibilities. For us, information sets are conceptually rigorous, explorable frameworks for designers. Information in this way establishes a basic building block for rethinking materials-based design education, and affords designers the possibility of engaging materiality across domains. Though this approach departs somewhat from the current trajectory of material-based pedagogies in architecture and design, it is one that is already present in the history of materials research and technology. By the eighteenth century, the study of materials incorporated information gained from three primary modes of inquiry: practice, experimentation, and philosophy.[3] The study and application of materials was an act of understanding, manipulating, and deploying materials knowledge to achieve a desired effect, and was part of the repertoire of artists, chemists, doctors, engineers, and entrepreneurs.

It is with this historical precedent that we began to think of materials as the collection of information sets that define its properties, capacities, and possibilities.

For the purpose of our pedagogical approach, refined materials are assemblies of three types of information sets: *operations, effects,* and *performances.* Our approach is built upon an unfolding of the concept of a materials collection from a repository of artifacts to an assemblage of information sets. We use this description as a method to reveal and redefine the engagement of materials within the design process. Through a greater understanding of material and their informational basis, students are able to reassess concepts of material selection, application, craft, and fabrication, thus steering then towards design explorations that are expressed in innovative forms and utilized with transformative means.

Operations

Operations *are the processes and modes of manipulation in which a material yield change.* Operations – natural or artificial, biological or manufactured – are comprised of information (what) and methods (how).[4] These encompass a material's intrinsic and extrinsic qualities. Intrinsic qualities are those that are essential to a material's composition. They are instructive in that they describe the capacity of a material to produce specific phenomena. Extrinsic qualities are those that are imbued, and are limited to the capacities of the intrinsic qualities.

Effects

Effects are observable transformations in an environment. A state is the information of a system at a determined point in time. Difference in state can be thought of as information that is not the same at two distinct times. Effect, then is the combination of difference in a system, and its measurement as a change in state. This encompasses changes at the macroscopic scale - the scale in which objects and/or processes are of a size that is both measurable and observable with the naked eye[5] - and the microscopic scale - the scale in which objects and/or processes are of a size that is measurable, but only observable through augmented senses or correlated events.[6]

Performances

Performances *are the measurable transformation of an environment.* Performances by their definition are comparative and thus quantifiable. Performances are evaluated by a material's fitness to address specific conditions.[7] Performance requires the definition of an environment be based on a set of parameters, where their measurement can be directly or partially correlated to changes in a parameter's variability.

Case Study 1: Databases for Materials Information

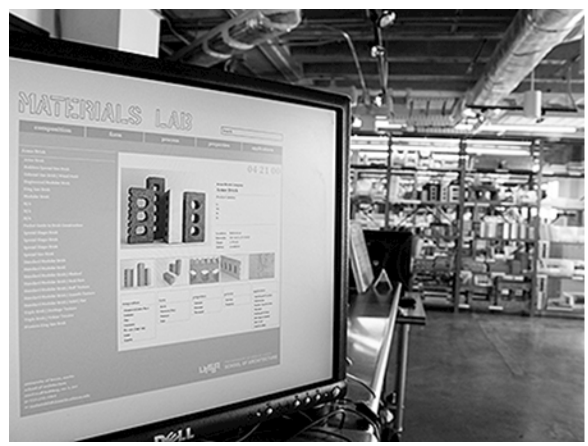


Fig. 1. The Materials Lab's collection database is an online means to connecting the physical materials collection housed at the University of Texas in Austin to the greater design community.

A database is a collection of information, which has multiple modes of access via its attributes or metadata. Databases can be expressed in multiple forms, states, and conditions; and are available simultaneously, unlike serially formatted systems, where information is revealed in a specific order.[8] Catalogues have a set organizational structure and fixed affinities. Databases on the other hand, offer a democratic, user-centric system of organization that can be prompted into new collections of information with new structures, affinities, and relationships. The metric for information in a database is without graduation or calibration, rendering inherent values explicitly. Every bit of data is equal to any other, which means every manifestation is as valid as any other. Accessing information is not a construction or a composition; instead it is a culling that when layered, reveals patterns or dissonances. In terms of design agency, databases offer directness to information, and a malleability of communication.

Academic material collections, much like their professional and commercial counterparts are tasked with acquiring, cataloging, and storing specimens (fig. 1). In doing so, they provide a valuable resource for students, faculty, designers, and researchers. More than just a resource defined as a controlled and static environment, a materials collection can also become a laboratory for experimentation, and discourse. It begins with a 'hands-on materials' understanding at the basic and most immediate one-to-one scale, where the opportunities to see, touch, and smell are part of the education for a beginning designer. But beyond these organizational and practical considerations, an academic materials collection can also provide a pedagogical framework that critically and fundamentally engages design pedagogy.

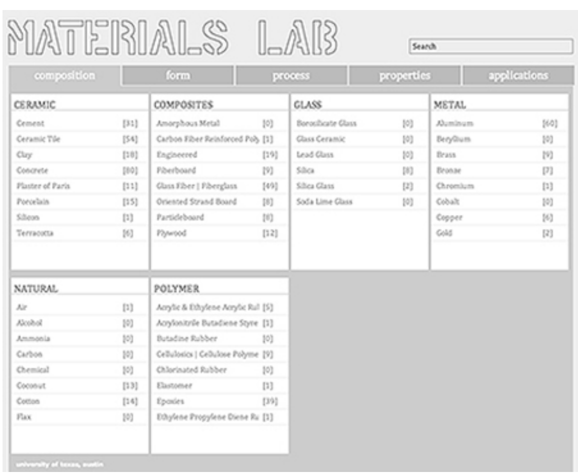


Fig. 2. The Materials Lab's collection online database.

The overall design of the Materials Lab collection database[9] provides a classification system that is based on five material information sets: *composition, form, processes, properties,* and *application* (fig. 2). The five sets allow users to have an option to search for materials at both a specific, intensive scale to a general, extensive scale. The database was designed to organize materials with three distinct tiers of metadata – manufacturers, products, and items. As part of collecting manufacturer data, this included the identification of basic contact information, as well the manufacturers' subsidiaries, and year of material acquisition. The collection of materials/products included a range of essential information that was, and is currently being researched by the Materials Lab staff. Product data included name; primary, secondary, and tertiary CSI *MasterFormat* numbers, and the physical location in the collection (fig. 3).

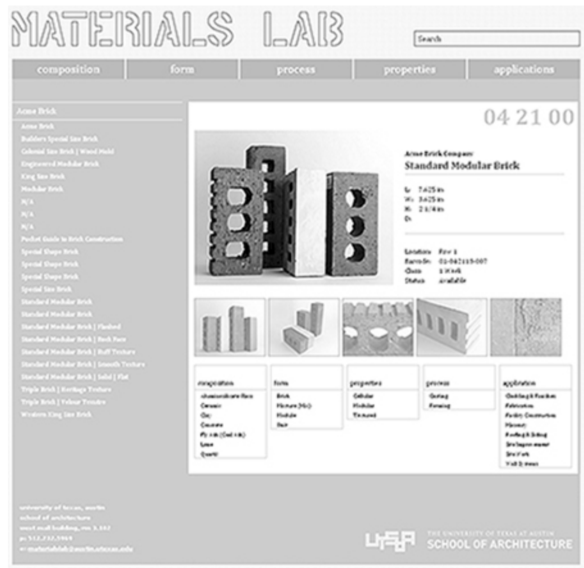


Fig. 3. Catalogued materials information for a product.

Most important to the documentation of a product was the ability to upload photographs of the product, including construction details and onsite documentation of any built precedent. All of the materials information is open source content for the public.

Case Study 2: Computational Models for Materials Information

Computational practices are not inherently digital in nature; they are the simple process of following a well-formed procedure. However, developing a rigorous procedure in which each step is followed precisely can be more easily automated and insured when "computerized."[10] Materials information when quantified can be distributed through a digital, computational model. For designers invested in digital modes of design practice, the ability to integrate material operations, effects, and performances afforded through an information-based understanding of materials is invaluable. Accessing material properties directly into their formative processes opens new avenues to design thinking, production, and manufacturing.

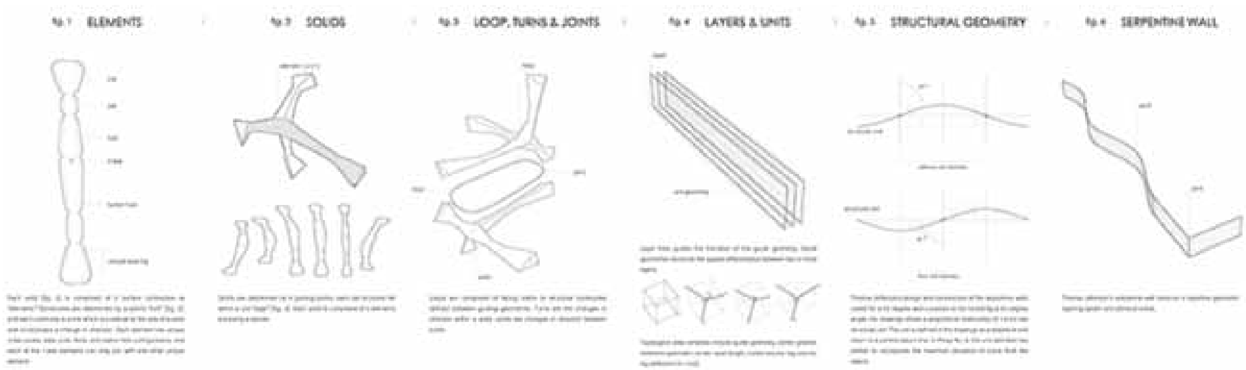


Fig. 5. The 1,998 polypropylene elements were assembled in sets of six, forming 333 solids composed of 1,998 turns and loops in one, two, or three layers of units.

This integration was one of the goals for the *Proxy Series'* design investigations. The *Proxy Series* began in 2007 as a set of process-based projects focused on the exploration of emerging technologies, and materials. Proxies are constructions that examine the nature of architectural design, production, and theory within the design subsets of programming, processes, procedures, manufacturing, and assembly. Proxy No. 8, a 34.0' x 10.0' x 4.5' installation was created through a rigorous research, design, manufacturing and construction process. This project was a collaboration between Beta-field, a design research office, and students at the University of Virginia School of Architecture. Although the students involved ranged in backgrounds and graduate levels, each was new to using digital computational design and manufacturing processes.

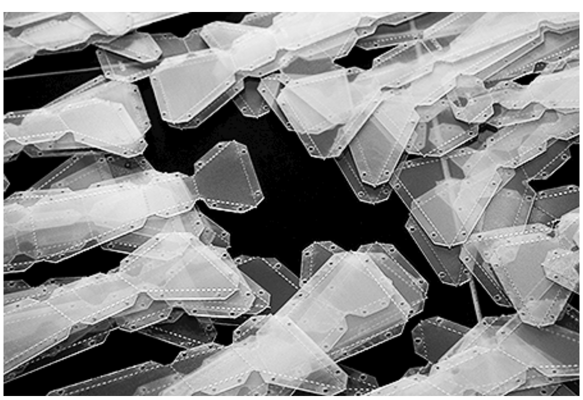


Fig. 4. The Proxy No. 8 installation is constructed of 1,998 individually cut polypropylene elements pieces.

Because we were leveraging information and the computational means to integrate it at different points in the design process, we began with a parallel investigative approach. This was useful in that it forced a deconstruction of the more familiar and linear processes students were more accustom to. It also meant that we could begin with materials research before ever knowing what we would be building as a final installation; and then this would feed into our computational model throughout the project lifespan.

By conducting investigations with cardstock paper, a construction material readily available and easily used in design and manufacturing workflows, we extracted properties and examined modes of manufacturing that took these properties into account. Paper became a surrogate to experiment, and it provided us with cheap, quick responses and feedback. The next step was to investigate materials that would allow our initial studies to move to an architectural scale. Paper worked well during our testing phase, however failed at the large scalar increase. After researching a number of materials, we determined polypropylene sheets - a durable, flexible, relatively inexpensive, and inert plastic, which has a long history of industrial use and a variety of manufacturing techniques - was our best option (fig. 4). As polypropylene can be manipulated in similar ways as paper, we had an analogous, consistent, and scalable material to work with. Using a hybrid of analogue and digital materials research techniques, this became an effective way to experiment (fig. 5).

As we were constructing a freestanding, three-dimensional installation, the challenge was finding a way to translate computational models into physical material constructions. This meant creating a process of modulation and disassembly that was both virtual and computational. Using a number of approaches, we devised a set of parametric procedures that performed this function for us. These steps systematically broke-down complex geometries into an initial set of simplified solids, which in turn, were reconstructed using a series of 2D to 3D structuring strategies. This material processing technique reestablished the geometric complexity defined through rationalized planes, rather than compound curvilinear surfaces. These strategies allowed us to approximate NURBS polysurfaces into a sheet material construction (first paper then to polypropylene). The deconstruction to reconstruction process required automation and precise execution in order to be successful. We used parametric software augmented by custom coding to achieve this goal.

Proxy No. 8 was a response to the rationalized, geometric and programmatic content of Thomas Jefferson's sinusoidal single brick width garden wall (fig. 6). The installation's analysis examined the manufacturing and construction methods in central Virginia of that era. In addition, Jefferson's own drawings and notes extracted the geometric and material information that went into Proxy No. 8's final formation. This investigation yielded data on both the modular assembly logic and global performance of the wall's geometry and material make-up. From this, we developed a modulated construction taking Jefferson's built form as a conceptual starting point to draw three defining strategies, which informed the global responsiveness, the complex form approximation process, and the 2D to 3D construction (fig. 7).

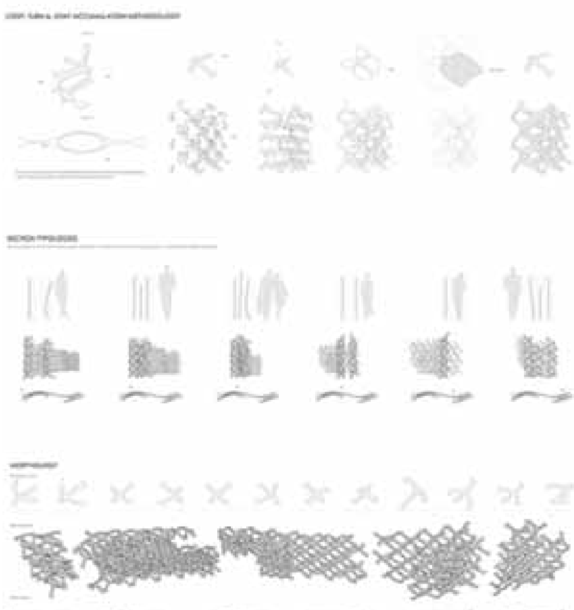


Fig. 6. The installation's geometric whole and performative elements rely on an analysis of the original structural geometry evident in Thomas Jefferson's serpentine walls constructed from 1817 to 1820. These walls define the exterior, layered border within the academic village of the University of Virginia.

Fig. 7. The installation was designed and all parts detailed and manufactured using a set of parametric procedures carried out in succession. Each element has a unique index code and configuration of tabs, cuts, folds, and buttonholes, making each of the 1,998 elements a unique element that could join with only one other unique element image.

Managing the layers of information that went into the design, manufacturing, and construction of the project was challenging. However, by utilizing the input data, along with the new data that the computational model and material prototypes generated, we were able to construct a management system that made the assembly intuitive. It also allowed us to insert new information developed within the process with a specific degree of freedom. Information from the assembly procedure; material and machining tolerances; and material failure typologies became parameters we could test and update throughout the process. This established a feedback loop in which digital processes simulated material processes, and where errors could be corrected, and future steps more rigorously calibrated.

Conclusions + Simulations

Design education can be a powerful generator for materials research and development – an epicenter of emerging discoveries and technological accomplishments. This is a setting where central issues in ecological sustainability are taken into account in balance with cultural aesthetics, social needs and desires, and economics. The common language of materials can foster a larger discourse towards advancing design research within its own design disciplines as much its adjoining fields. Beyond these two examples our approach to material as collections of information has found its way into may courses focused on early career students in architecture, landscape architecture, interior architecture, and sustainable design. Recently, this information-based materials pedagogy was used to develop an understanding of ground as a diverse set of political, cultural, infrastructural, ecological, and material networks during a one-week intensive workshop at the Harvard Graduate School of Design.

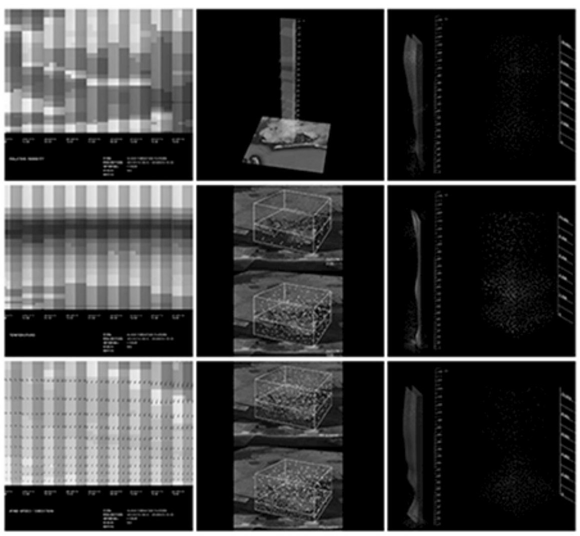


Fig. 8. Material simulation of natural phenomena.

Through materials-based simulations, which utilized parameterized material properties to define the context for design intervention as an assembly of processes, boundaries, and materials, students were asked to investigate two material performances - *behavior* and *formation*. Students were then asked to communicate their simulations using familiar and disciplinary specific modes of visualization (fig. 8). The resulting animations, diagrams, and drawings, allow students to gain insight into how computational models of dynamic systems could yielded instrumental material behaviors and formations, that are both descriptive and generative (fig. 9).

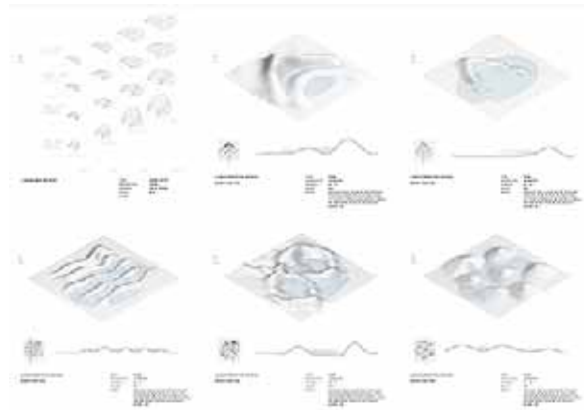


Fig. 9. Material simulations of landform typologies.

This design methodology examined how assemblages of processes, materials, and technologies simulated through computational media, revealed conditions of ground, which could be aligned by information type rather than appearance.

Information-based definitions of materials have helped us shape pedagogies that position materials research as a subset of design research, in which discovery and innovation, hybrids and composites, misuses and reuses are all components to complex and critical design solutions.

Notes

[1] CSI is an abbreviation for The Construction Specifications Institute, and their publication of the CSI *MasterFormat* 2004 system has been implemented as an integral part in the cataloging of products in the Materials Lab catalogue database, as well its location within the physical space. It should be noted that the CSI *MasterFormat* system is an educational means for students – to have them be exposed to the design profession's standards and its utilization in construction documentation. The Materials Lab represents 15 of the 48 divisions represented in the CSI *MasterFormat*, including those categorized in the *Facility Construction Subgroup, Facility Services Subgroup, Site and Infrastructure Subgroup,* and *Process Equipment Subgroup.* The CSI *MasterFormat,* however has its limitations for an academic materials collection, especially when designating a single CSI number to a particular product. Each CSI number and corresponding category classifies a particular material composition and/or material application; and it can be very detailed or very broad in its classification. In order to resolve this issue, the Materials Lab collection database was designed to record multiple sets of CSI numbers for the accounting of multiple material categories. In effect, users possessed the freedom to elicit creativity within a flexible database application.

[2] Gleick, James, *The Information: A History, A Theory, A Flood* (New York: Knopf Doubleday Publishing Group, 2011).

[3] Klein, Ursula and Wolfgang Lefevre, *Materials in Eighteenth-Century Science: A Historical Ontology* (Cambridge: MIT Press, 2007), 16.

[4] Beaman, Michael and Zaneta Hong, "Material Identities: Materi-ontology" in *International Journal of Interior Architecture and Spatial Design: Autonomous Identities,* ed. Meg Jackson and Jonathan Anderson (Houston: Atrium Press, University of Houston, 2013), 138-145.

[5] Reif, Frederick, *Fundamentals of Statistical and Thermal Physics* (Boston: McGraw-Hill, 1965).

[6] Reif, Frederick, *Fundamentals of Statistical and Thermal Physics* (Boston: McGraw-Hill, 1965).

[7] Kaufman, Stuart, *At Home in the Universe (*Oxford: Oxford University Press, 1995), 245.

[8] Manovich, Lev, "Database as Symbolic Form," *Convergence: The International Journal of Research Into New Media Technologies* 5 (2) (June 1999): 80-99, accessed February 5, 2009, doi: 10.1177/135485659900500206.

[9] The custom design and development of the collection database was a collaborative effort between the Materials Lab, the University of Texas in Austin Information Technology Services, and the School of Architecture Information Technology Services. Initiated in spring 2009, the collection database is ongoing in its updates and improvements.

[10] Terzidis, Kostas, *Algorithmic Architecture* (Oxford: Elsevier Press, 2006), xi.

Making Architecture “Thinkable”:

A Drawing Course in Beginning Design

Mike Christenson

North Dakota State University

Introduction

This paper describes a set of exercises assigned in a foundations-level architectural drawing course. The primary curricular goal of the course is to instruct students in traditional architectural drawing techniques. However, the “take-away” from the course is not centered on technical knowledge; rather, the course seeks to introduce students to a set of critical issues expected to remain at the core of their design thinking as they proceed into the professional degree program.

The course, ARCH 231 (Architectural Drawing), is required in the second year of the five-year M. Arch. professional degree program at North Dakota State University (NDSU). It typically enrolls between 48 and 72 students.

The core assumption of ARCH 231 is that architectural drawing is done to see something that is *unseeable* – to make the invisible visible. this assumption seeks to differentiate specifically architectural drawing from illustration (i. e., the production of images which attempt to simulate the visual appearance of objects, spaces, or buildings). This in turn supports the idea that every architectural drawing is capable of opening a new way of seeing – for example, by foregrounding what is in the background, or by placing things into relationships which they may not otherwise be understood to have. In this way, architectural drawings operate to make architecture “thinkable.”

The pedagogical approach pursued in this course relies in part on the work of Daniel Herbert, particularly his well-known *Architectural Study Drawings*.[1] Herbert’s argument that study drawings are not acts of “passive recording” but rather “active participants” in a design process is directly relevant to the structure and content of many of the assignments in ARCH 231. Fraser and Henmi’s *Envisioning Architecture* has also proved to be an important resource for the development of the course pedagogy over time, as it seeks to explore the “distance” between drawings as representation and what they seek to represent.[2]

Technique

Critically, the goal of heightening students’ awareness of architectural “thinkability” does not preclude rigorous attention to technique. In certain assignments, for example, careful attention to precision, accuracy, and scale is necessary to establish common ground for critique. In other assignments, differences between media and tools are highlighted through technique. Accident also becomes an important technical factor, as students should emerge from the course with the confidence that they can productively address mistakes, mismatches, and results that don’t go according to plan.

The value to architecture of pencil on paper, collage, and other drawing tools exists in their ability to promote specific ways of seeing. For example, because of its translucency, tracing paper is an indispensable tool for testing ideas, for layering new questions on top of old ideas. By contrast, a sketchbook does not facilitate iteration in the same way as tracing paper; its value is stronger as a means of recording field investigations. These tools and systems are not neutral with respect to architectural epistemology (i. e., the construction and dissemination of architectural knowledge) because each of them tends to foreground and obscure forms, ideas, information, and phenomena in different ways.

Techniques of transfer, such as tracing, chemical transfer, and impression transfer, become means of shifting assumptions into the territory of the unfamiliar. Techniques of assemblage become a means of juxtaposing the belonging with the non-belonging, occasioning accident. These techniques each possess a unique ability to highlight or obscure attributes of memory as well as experienced phenomena, and as such, they are each essential to the thinking of architecture.

An early assignment in the course deliberately focuses students' attention on the importance of technique. The assignment requires students to create a set of perspective drawings of a transitional space, in any location near the NDSU Architecture Building in downtown Fargo – where "transitional space" is defined as the environment perceived while moving between the interior and the not-interior. The set of drawings is required to consist of two *illuminated-volume drawings,* one *chemical transfer drawing,* and one *copy collage drawing*. Each of the drawings must register a foreground, middle ground, and background, and each drawing in the set must measure approximately 6" x 24".

The *illuminated-volume drawings* are of two types: black-pencil-on-white-paper and white-pencil-on-black-paper. These drawings are done from direct observation, and are meant to depict observable effects of light defining volume. In the assignment, it is essential for students to complete a *pair* of illuminated volume drawings, as this forcefully highlights the differences in character and quality of pencil-on-paper depending on whether a student is effectively drawing shade and shadow or is drawing light.

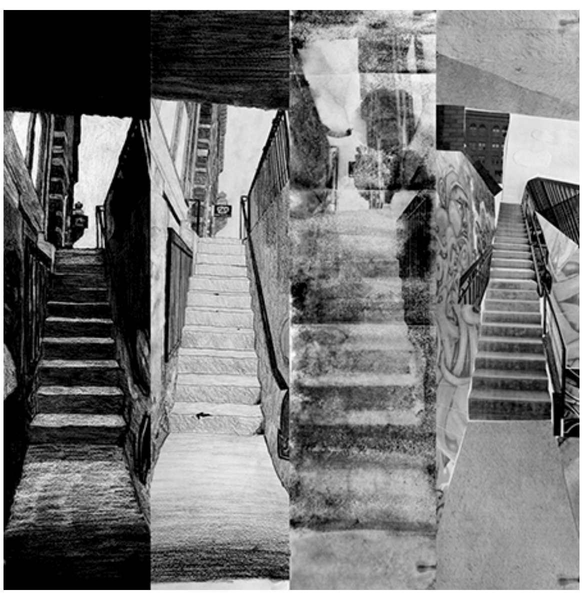


Fig. 1. From left: Illuminated-volume drawings (white-on-black and black-on-white); chemical transfer drawing; copy collage drawing.

The *chemical transfer drawings* are prepared by applying a solvent such as acetone (or a blender pen) to the reverse side of a photocopy or laser print, in order to transfer the image to a receiving surface such as paper, wood, chipboard, or cardboard. Here, because the production technique is akin to painting, while the results are visually similar to charcoal drawing, this component of the assignment questions the degree to which "drawing" is properly concerned with placing marks on paper.

Finally, the *copy collage drawings* are produced by assembling scraps of copied material produced by either a photocopier or a printer. The copied material may include textures from items such as paper bags or fabric. While here, too, the technique arguably departs from what is traditionally understood as "drawing," the copy collage drawings have the important effect of preparing students to understand and work with digital image manipulation (which they do in a course the following semester).

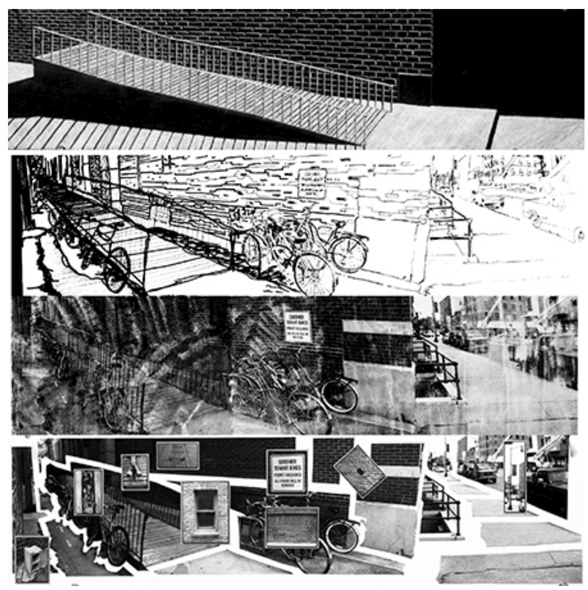


Fig. 2. From top: Illuminated-volume drawings (white-on-black and black-on-white); chemical transfer drawing; copy collage drawing.

The requirement of the drawings in this assignment to register f*oreground, middle ground, and background* (or, alternatively, *the touchable, the seeable,* and *the hearable*) is not intended to establish sharp boundaries between zones but rather to highlight the connections between the perceived and the drawn.

In general, this assignment works to foreground the significant differences between drawing techniques by having students repeatedly draw the same environment using different tools; in this way, it serves as an important introduction to exercises which follow.

When the completed student drawings are critiqued, the group continually returns to the question: *what new thinking does this drawing make possible?* This line of questioning allows for the possibility that ideas change while drawings are being done, and specifically, that individual drawings or sets of drawings are often begun without knowing the end result in advance: in testing the various techniques introduced here, students often find themselves pleasantly surprised by what their own drawings reveal. In particular, the "thinkability" of architecture is revealed to be strongly dependent on the specific choices students make about media and technique.

The Eisenman Exercise

Consistency is important to a set of architectural construction documents for obvious reasons: a set of drawings which are internally consistent, i. e., in which the plans match the sections, the sections match the elevations, etc., facilitates (though it does not guarantee) the error-free construction of buildings. But while consistency is clearly important to a final set of construction documents, it tends to be overemphasized as a goal in the production of architectural drawings generally. Even as ARCH 231 acknowledges that in certain highly specific situations (e. g., the production of a final set of construction documents), consistency is paramount, it also emphasizes that an insistence on consistency can be counterproductive at other times. In particular, mismatches and gaps between domains (for example, between the domain of the plan and the domain of the section) can be a potent area for the disclosure of things otherwise unseen, during most phases of design, from the beginning throughout a project to its conclusion. This course insists that students develop the ability to mine these mismatches and gaps for the disclosures they inevitably contain.

An assignment designed to develop and test these abilities begins by providing two precise section drawings to students. The sections are of House VI, designed by Peter Eisenman, although this fact is not disclosed to the students. Using the two sections as a base, students are asked to construct an oblique drawing at a scale of 1/4" = 1'-0" depicting an imagined work of architecture meeting certain programmatic conditions (e. g., providing an entry from a public street and a sequence of increasingly private spaces). The sections as given need to remain "true," i. e., they need to accurately describe the project as drawn in oblique.

By introducing techniques of precision and orthography not present in the first perspective-based assignment, this assignment serves an important technical function. In-class discussions address the use of hand-drawing tools to produce precise plan- and elevation-oblique drawings.

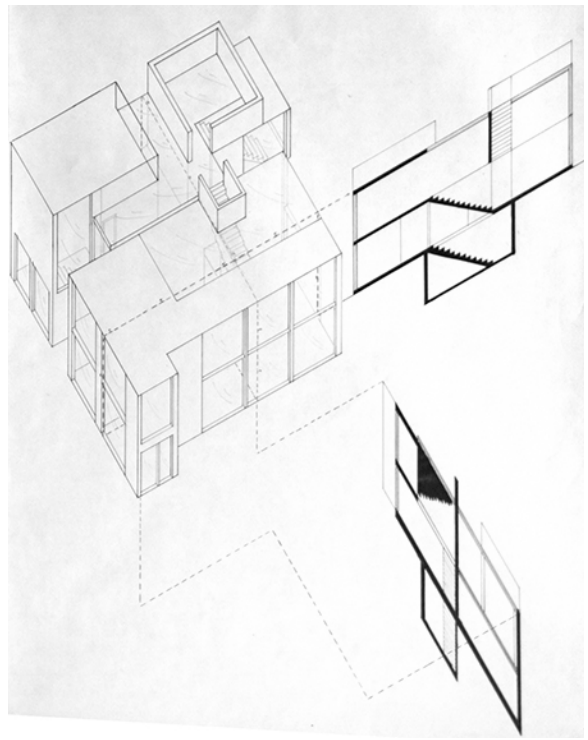


Fig. 3. Plan oblique projection of imagined house based on Eisenman sections.

However, the most important pedagogical function of this exercise is to introduce the idea of drawing's generative role – that the spaces between drawings provide for the possibility of invention and discovery. Critically, the architectural sections that initiate this assignment provide a structure for architecture's "thinkability" – a basis against which subsequent decisions can be judged. While Herbert argues that study drawings are always "incomplete and contingent,"[3] this assignment explores the extent to which apparently authoritative drawings can be productively seen in the same way.

Distant and Local / Sticks and Wall

Architectural drawings possess a strange property of scale, which is that they are capable of being interpreted at 1:1 ("as they are") and also "at scale." But because scale is an arbitrary construct, the product of an imposed relationship, drawing may find within its scale-shifting a generative mode. Students in this course are expected to develop comfort both in working at scale and in shifting scale as they work.

In the course, students are specifically encouraged to think about scale as a way of relating themselves (as producers of artifacts) to their tools of production, methods of measurement, and the artifacts they produce. For example, in a pencil drawing produced "at scale," even the pencil lines themselves – in their visible, measurable thickness – can be said to represent partition walls of a specific thicknesses. The observable and measurable nature of these pencil lines is conditioned by the sharpness and hardness of the pencil and the receptivity of the paper to the graphite; their precision is determined by the steadiness of the hand as well as by the scale at which students work.

Drawing a plan of the same building at a different scale does not change the measurable relationship between the pencil and paper. in other words, the pencil does not automatically become half as thick, nor the paper twice as sensitive, simply because we have decided to draw at a different scale. Hands and fingers work this way too: students can't scale their fingers to half their size if they need to draw more precisely.

An assignment titled *Distant and Local* examines relationships between the physical act of measuring and the intellectual exercise of scaling. In this assignment, students are asked to investigate the range of everyday position, reach, and motion of their bodies in space. Two spaces are designated as subject matter: a local space which can be easily visited, observed, and measured, and an imagined space, selected from their oblique drawing in the first assignment of the course.

Students produce several hand-drafted drawings, each on 17" x 22" paper, including (1) a detail of their hand in the local space (e. g., touching a wall or holding a handrail) at full scale; (2) a combined section/plan of critical junctures within the local space, superimposed on the imagined space, at a scale of 1/4" = 1'-0"; and (3) a combined section/plan of a specific transition (e. g., a stair or doorway) within the local space, superimposed on the imagined space, at a scale of 1" = 1'-0". The final two drawings must include at least two figure drawings of the student, illustrating a full range of bodily position, reach, and motion.

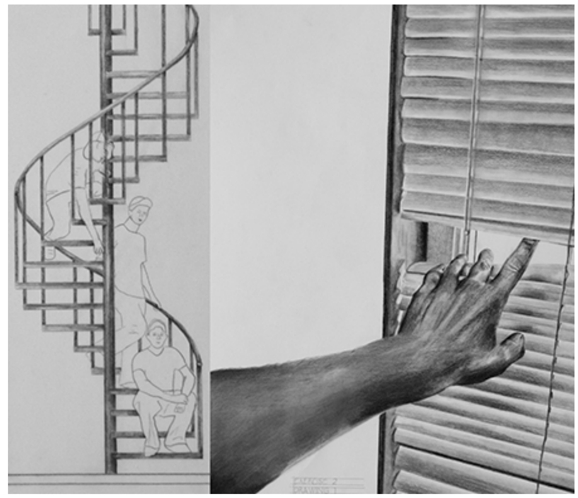


Fig. 4. 1" = 1'-0" drawing of stair within a local space; full-scale drawing of hand in a local space.

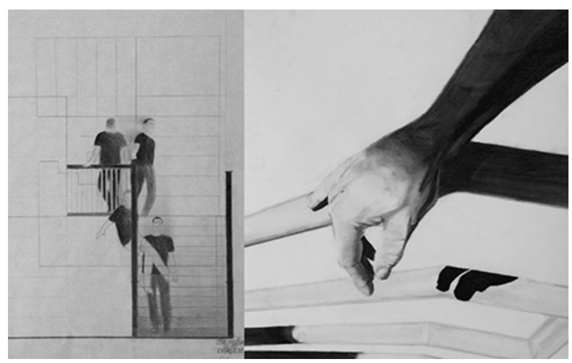


Fig. 5. 1/4" = 1'-0" drawing combining section and plan; full-scale drawing of hand in a local space.

When subjected to critique, the drawings that students complete for the *Distant and Local* assignment raise the question of the ever-present gap between memory and imagination, a gap which architectural drawings attempt to bridge. In particular, the local spaces are generally known to the students, while the imagined spaces exist to the extent that they are drawn. Students find that while they can acknowledge differing memories of the local spaces, and different projections of imagined spaces (ultimately deriving from the same two section drawings), they rely on the specific conditions of the drawing as a structure for conversation. In this way, the drawings don't answer questions so much as they make questions possible. Architecture is made to be "thinkable" in terms simultaneously tangible and intangible.

Another assignment, *Sticks and Wall,* examines relationships between the physical act of measuring and the physical act of representing. Sticks and Wall begins by providing student teams with paper, pens, and straightedges, e. g., unmarked scraps of wood of no particular length. The task of each student team is to produce elevation drawings of an existing interior wall at a specific scale, say 1:100.

Because the measuring units are not prescribed with predefined units, students must devise their own system for recording measurements and producing a scaled drawing. For example, students may calibrate their measuring units into parts. Calibration not only makes it possible to measure features of the wall which don't correspond to whole-unit distances, but it also makes it possible to produce a proportionally scaled drawing of the measured wall. At the conclusion of the exercise, all of the drawings should all be the same size, i. e., superimposable on each other, demonstrating to the students that "scale" is always a ratio, i. e., a relationship between something measured and something drawn, but that "scale" doesn't depend on particular units.

Accident

Accident is an important attribute of the course. As students make choices about media, they should be ready for accidents to happen. What kinds of accidents can we expect to occur? How do we make ourselves aware of accidents, when they happen? How do we go about recognizing value in the unintended, the peripheral, the shifted, the suddenly revealed, the accidentally-juxtaposed? What are the implications for architecture?

An assignment titled *Structured Photography* asks students to position themselves in an urban site and take a series of photographs described by a 360-degree panorama. Students then place the photographs into a rectangular matrix, i. e., so the photographs are placed adjacent to each other. Finally, students are asked to respond to the matrix with the production of a figure-ground image tracing the visible contours of elements in the natural and built environment. This format necessarily leads to unintended relationships: the figure-grounds result both from deliberate intent (attempting to categorize solid separately from void) as well as the accidental relationships that emerged from the specifics of the matrix. The apparently random yet internally consistent figure-ground diagrams trigger reflection on the ways in which urban environments evolve over time.[4]

Fig. 6. Photographic matrix and figure-ground response drawing of an urban environment.

Another assignment, titled *Material Fragments,* begins by asking the students to find a material fragment meeting the following criteria: (1) It is an incomplete or broken machine part or tool part or architectural fragment, including at least two distinct materials (e. g., metal and wood, or metal and plastic); (2) It is small enough to fit within a 6" cube. Students are asked to produce two hand-made drawings, each on 17" x 22" paper: first, a set of precisely measured drawings, completed at full scale (1:1) using black ink on white paper or vellum, including a plan, a section, and a plan or elevation oblique projection; and second, a set of drawings prepared by direct transference from the fragment to the paper. In the context of the exercise, *direct transference* could mean stamping, rubbing, tracing, tearing or scraping the paper with the fragment, etc.; there are meant to be no obvious limits on how students carry out the act of directly transferring the fragment to the paper. However, the final product must be a flat drawing.

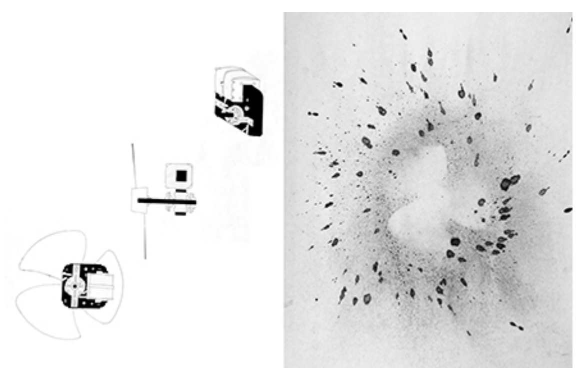


Fig. 7. Drawings from the *Material Fragments* exercise (broken electric fan).

In the example shown here (Fig. 7), the student completed her first drawing of a broken fan precisely as an exploded elevation oblique projection. For her second drawing, she applied black ink directly to the fan blades, and then spun the fan to apply the ink to the paper.

In both of the examples discussed here, students draw not simply to illustrate or represent found content, but instead use drawing as a means of exploring and testing the possibility of "accident" to reveal specific understandings of cities, spaces, and objects. Pedagogically, the acceptance and encouragement of accident within the course is simply another dimension of architecture's "thinkability" as made possible by drawing. Selections from the wide literature on accident in design processes are discussed in class to support this approach.[5]

Discussion

After teaching this course and modifying the exercises over a period of three years, I've observed trends in the discussions and critiques suggesting that beginning design students benefit from the core assumptions in the course.

For example, in course critiques, students come to confront the notion that architectural drawings do not communicate in the same way that words do. Nevertheless, every drawing facilitates conversation. Students find that the person who creates a drawing is not the singular authority of its meaning: instead, what is essential is that the drawing opens, or makes possible, architectural conversation. After completing this course, students find that they are able to discuss how their drawings operate to open conversation. Moreover, they are ready to engage in conversation about their drawings. Critically, if a conversation about a drawing takes an unanticipated direction, the drawing is not considered a failure.

Critiques also address the idea that the value of an architectural drawing is best measured by the value of the drawing that follows. This implies that no drawing is really "final," that revisions and rethinking could continue without end. (Even a finished building can be remodeled to suit a new purpose.) Obviously, the limitation of this idea is that decisions need to be finalized in order for things to be built and paid for (and graded) - which is true, but this in itself doesn't really answer the assertion that a drawing is never really "final."

Most importantly, the course raises the question of the degree to which the choices students make about representational media and technologies are influenced by a desire to emerge with predictable results – and how can those choices be productively called into question?

Notes

[1] Herbert, Daniel M. *Architectural Study Drawings.* John Wiley & Sons: New York. 1993.

[2] Fraser, Iain, and Rod Henmi. *Envisioning Architecture: An Analysis of Drawing*. John Wiley & Sons: New York. 1993.

[3] Herbert, 2.

[4] Christenson, Mike. "Productive Accident in Student Analysis of Urban Form and Space" in *Proceedings, The Reach of Research: Proceedings of the Architectural Research Centers Consortium National Conference on Architectural Research, Jackson, Mississippi, April 6-9, 2005*.

[5] Selections from the literature include McLachlan F., Coyne R., The accidental move: Accident and authority in design discourse, in "Design Studies", v. 22, 2001; Hayles N., Mulder A., How does it feel to be posthuman? An email interview with N. Katherine Hayles, in The art of the accident, NAI Publishers, Rotterdam, 1998; and Lynch K., What time is this place, MIT Press, Cambridge (USA), 1972.

Student work in this paper was completed by Joseph Conway (Fig. 1), Dustin Froese (Fig. 2), Danielle Jermyn (Fig. 3), Tyler Brandriet (Fig. 4), Jeffrey Mellgren and Nicholas Lippert (Fig. 5), David Wilson (Fig. 6), and Casey Tabert (Fig. 7).

Space: Abstraction and Real Experience
A Spatial Tradition In Beginning Design Over 30 Years

Marleen Kay Davis, FAIA

University of Tennessee College of Architecture and Design

Abstract

Ideas distinguish architecture from mere building. Architecture is three-dimensional and is experienced by individuals moving through space. Thus, architectural ideas are manifest as three-dimensional and spatial. In teaching the beginning student, an important goal is to recognize, generate, and communicate three-dimensional spatial ideas in architecture.

Ideas are abstractions, although a beginning architecture student tends to think of architecture as building, with a physical reality and function. As a result, abstraction for the sake of abstraction can be mystifying for the beginning student. Thus, a careful exploration of the interrelationship of abstraction and the reality of space creates meaningful insight for beginning students. Recognizing that an abstract concept such as space is an experiential reality is the core of what I will term a "spatial tradition" in design education. Further, this is a legacy of the pedagogical approach of Bernard Hoesli at the University of Texas at Austin.

In a conference entitled "Materiality," a paper entitled "Space" is perhaps intentionally anti-material. However, in a Special Session focusing on 30 years of Beginning Design, a spatial approach to beginning design is indeed an important "topical presentation," as this is a critical perspective representing a distinctive pedagogical tradition.

This paper will present different pedagogical strategies from a spatial tradition, developed over decades of involvement in the first year design curriculum at two different institutions. A key goal is the development of students' ability to think abstractly and spatially, in a meaningful way that links abstraction with real experience.

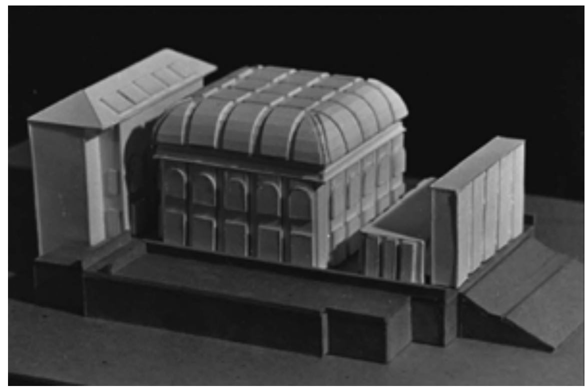


Fig. 1. Study of space on campus.

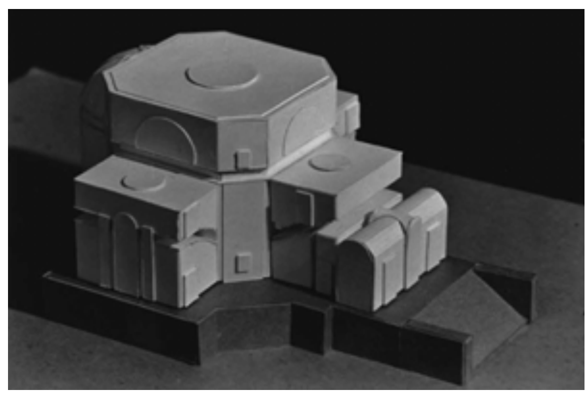


Fig. 2. Study of space on campus.

The Spatial Tradition of Bernard Hoesli: University of Texas at Austin and Cornell University

Alexander Caragonne's 1995 book, entitled *The Texas Rangers: Notes from the Architectural Underground,* describes the genesis of a pedagogical tradition spanning over 40 years and influencing dozens of schools and educators in the United States. (1)

Swiss architect Bernard Hoesli arrived at the University of Texas in Austin in 1951. He soon established himself as the leader of a core teaching team, which redefined the design curriculum, with a focus on the first two years. A key goal was to promote the students' understanding of space and the design process. Hoesli's very reflective diary reveals his thought process in developing a goal-oriented design education and pedagogy.

Hoesli's time at Texas was intense, but short: 1951-1956. Internal faculty dissension within the program prompted the core faculty that Hoesli worked with to disband. As they relocated to other architecture schools, they took with them Hoesli's rigorous and reflective approach to design pedagogy. They did not take a formulaic set of assignments, but rather the technique of identifying pedagogical goals related to space and process, and then crafting assignments to meet those goals.

This spatial tradition in architectural education is not formulaic and has developed in different ways at different schools. Bernard Hoesli himself returned to Switzerland, where he had a long career at the ETH in Zürich. John Hejduk left Texas for Cooper Union. His forty year intellectual legacy there is well documented.

The largest group eventually made their way north to Cornell University, where they were referred to informally as the "Texas Rangers": John Shaw, Lee Hodgden, Colin Rowe, Werner Seligmann, to name a few. The 1960's and most of the 1970's is the time period when this group defined and experimented with the educational pedagogy at Cornell. A conceptual, spatial approach to understanding architecture, history, and urban design was a primary goal.

Dating from the very reflective approach to teaching developed by Bernard Hoesli, this spatial tradition is pedagogical in the very best sense: assignments are developed based on clear objectives and strategies discussed at length in advance by the faculty involved. These strategies are explicitly spatial in nature.

Students who experienced this modality of teaching at Cornell during the 1960's and 1970's understood the pedagogical goals that underlaid each assignment. As these students have become teachers, their approach is similarly spatial, disciplined, and conceptual. Thirty years later, the 1970's graduates of the Cornell architecture program include no fewer than ten deans of architecture, along with a dozen program chairs and numerous faculty.

Syracuse University / The University of Tennessee

The genealogical imprint of many great teachers from Cornell has influenced me, in my thirty years of experience in teaching at two institutions. As a faculty member who coordinated first year at Syracuse University for many years, I initially worked closely with Syracuse Dean Werner Seligmann, one of the "Texas Rangers." Seligmann was passionate about the importance of the first year program as the intellectual foundation of the School. An immediate exposure to spatial thinking in architecture was a primary goal.

From Syracuse, I moved to the University of Tennessee as dean. The beginning studios were six individual experiments, with no clear common denominator. We convened as faculty, identified goals, and developed a framework for the course that developed students' understandings of abstraction, space, and design.

Spatial Tradition in Teaching Beginning Design Studio: Five Strategies

Based on the work I've done over the years, I have identified five different strategies for a spatial approach to teaching beginning design. These strategies combine an understanding of space as both an abstraction and as an experienced reality. These strategies are not formulaic, and lend themselves to very flexible interpretations by different faculty members. While a spatial approach to design in first year is not a "fundamental design and composition" approach, nor an experiential emphasis on "making," issues of composition and tectonics are included.

These strategies are designed to make the abstract real, or to make the real abstract, promoting a conceptual understanding of space, so crucial for the beginning student.

1. Analysis: the basis for design (Figures 1 - 5)

A key first year learning experience includes the documentation--and analysis--of existing spaces on the campus that the student can visit.

Documentation of three-dimensional space in a two-dimensional medium is an abstraction itself. Students learn basic conventions of representation and understand the experience of scale.

Analysis is imaginative: by looking intently at the existing buildings and campus around them, students can see space, represent space, and conceptually diagram architectural ideas. The documentation and analysis of a local space helps the students to see an experienced reality in a conceptual and abstracted way, through drawings and diagrams.

Figures 1 through 5 demonstrate imaginative techniques to represent space, structure, circulation, context, light, proportion, and other conceptual aspects of the building design.

2. Respect for history: precedents and painting (Figures 6 - 8)

The influence of Colin Rowe at Texas and Cornell insured a deep respect for architectural history, including the history of painting. At Cornell, the analysis of architectural precedents continued throughout all levels of the curriculum, in virtually all courses. The imaginative, and provocative, comparisons of Colin Rowe (e.g. "Mathematics of an Ideal Villa" or his observations in the article "Transparency") evolved from the German dialectical tradition of comparisons in art history.

In my experience, the analysis of an architectural precedent is an essential component of first year design. Not only does this introduce research skills to the students, but each student becomes familiar with a single architect and building design. Such an analysis builds on the prior analysis of a campus space. Variations of painting analysis, including spatial speculation and compositional transformation, are also effective first year exercises.

Analysis is a creative process: It inevitably involves an imaginative interpretation, or abstraction, of past precedents. This insistence on analysis remains present in an educator such as Peter Eisenman, who typically leads an entire semester design studio in an analytical endeavor. Results have been published in his recent, *Ten Canonical Buildings: 1950 - 2000.* (2)

The abstraction of reality in analysis is the inverse of the design process, when an abstract concept is developed into a built reality. Thus, analysis is intrinsically related to design thinking.

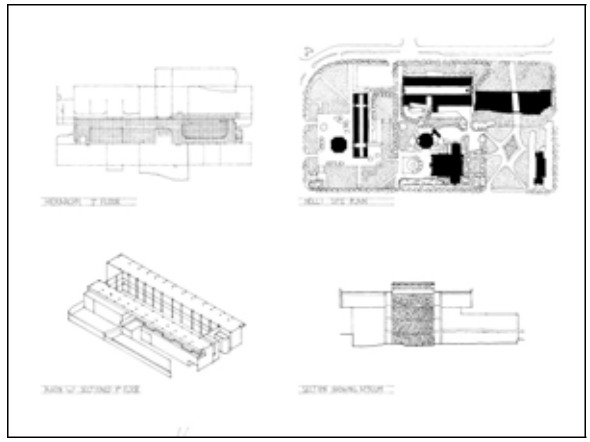


Fig. 3. Analysis of the Art + Architecture Building at the University of Tennessee.

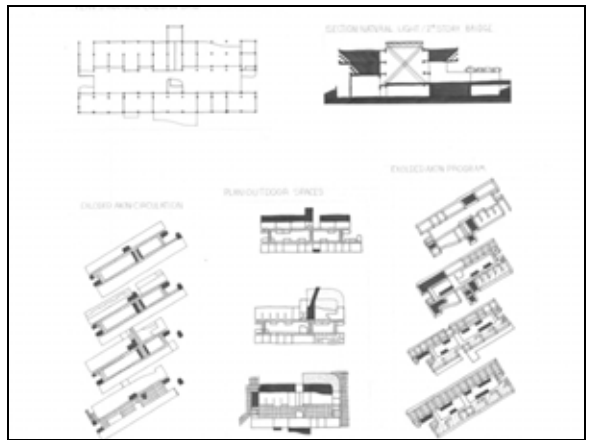


Fig. 4. Analysis of the Art + Architecture Building.

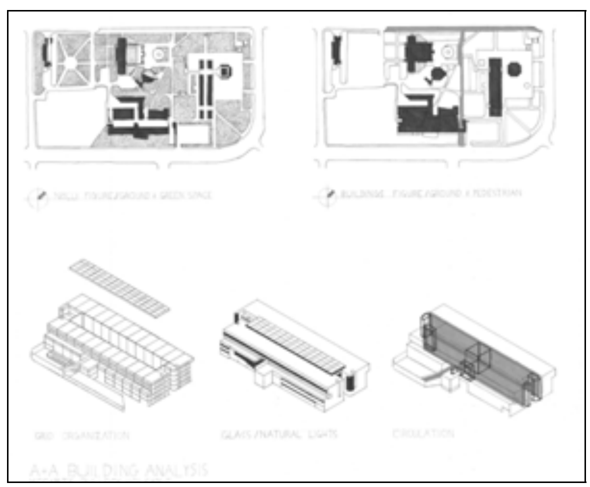


Fig. 5. Analysis of the Art + Architecture Building

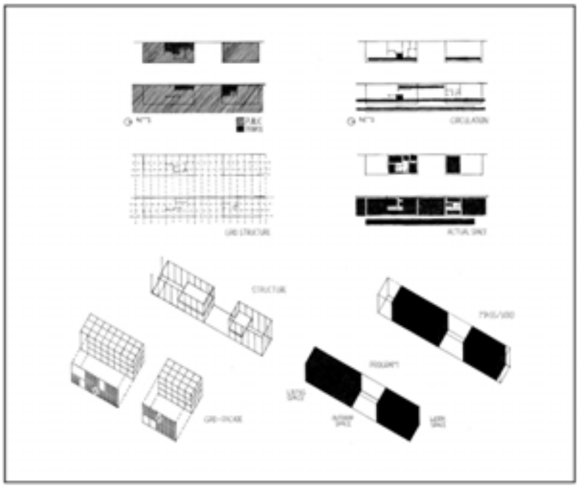


Fig. 6. Precedent analysis: Eames House.

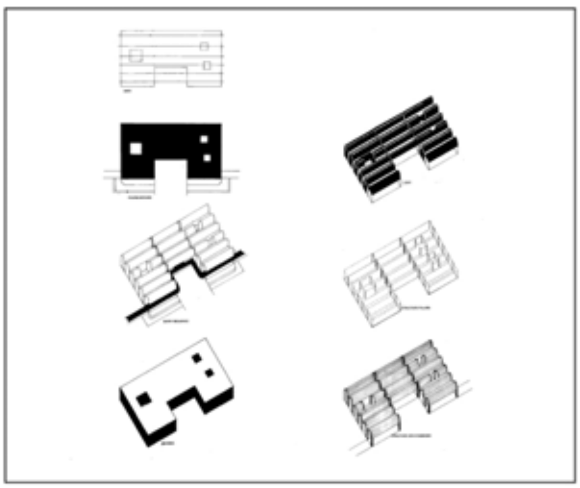


Fig. 7. Precedent analysis: Kimbell Art Museum.

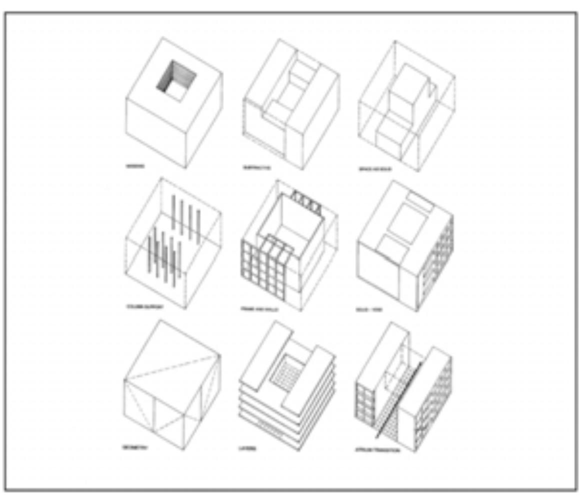


Fig. 8. Precedent analysis: Casa del Fascio.

3. Constraints: the "kit of parts" (Figures 9 - 17)

The utilization of a limited "kit of parts" with clear ground rules is a useful way to develop spatial thinking. A streamlined definition of elements promotes conceptual, abstract thinking within parameters defined by pedagogical objectives.

The classic example of the cube problem, and all its permutations, comes to mind: define a cube of space using three non-orthogonal planes. The one-year pedagogical agenda of "nine-square" exercises by John Hejduk demonstrates the range of thinking possible within limited constraints.

In my experience, I consistently tried to alternate an abstract compositional exercise, with parameters in the "kit of parts" that were ultimately related to the subsequent site and program design assignment. This was another clear technique to help students understand the interrelationship of abstract thinking and the realities of a site and program.

Tectonic constraints are useful in introducing students to the inherent spatial characteristics of structure and material. For example, a requirement to use concrete block, with limitations on openings and spans, creates spatial constraints related to a conventional material that students have encountered. A defined structural system has inherent spatial properties.

Thus, a beginning design student understands design as a way of seeking possibilities within constraints. This prepares the student to subsequently develop one's own conceptual constraints, as well as preparing one for a meaningful career within the constraints of practice.

4. Representation: abstraction and spatial thinking

The importance of conceptual line drawing as a visual thought process of abstraction cannot be underestimated. Line drawings are an ultimate form of spatial abstraction: every line defines an edge and the gradation in line thickness implies depth and space.

Thus, one-dimensional lines, on a two-dimensional plane, define a three-dimensional space.

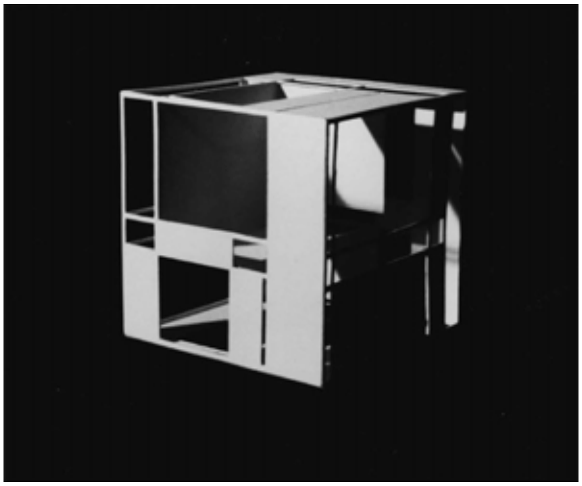


Fig. 9. Abstract exercise: cube of space.

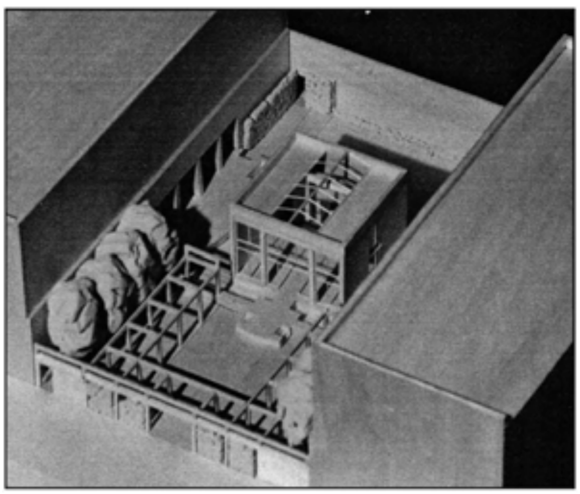


Fig. 10. Event space in a courtyard garden.

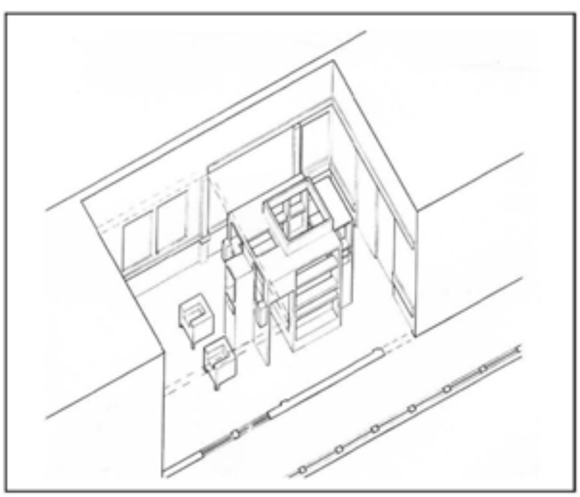


Fig. 11. Faculty office.

Line-weight communicates the continuity of space and spatial experience in architecture. This is true in both freehand sketches based on line drawings and in perfectly executed line presentation drawings.

The use of line drawings can be traced to Bernard Hoesli. The requirement for black and while line drawings was an explicit critique of the popular rendering techniques of architects at the time. In his Design Manual for the school, Hoesli stated:

"Drawing is primarily a means of investigation and not an instrument for the camouflage of appearance. Presentation should exhibit the intrinsic architectural reality of the design and not the accidental impressions that it might provoke under temporary atmospheric conditions. Major studies are to be made in black and white."(3)

Given the current seduction of digital rendering techniques, we should reconsider this return to the abstraction of line drawings as a basis for understanding space.

5. Pedagogical trajectory of the semester

The faculty conceptualizes the student learning experience for the entire semester, by identifying goals and designing a series of assignments. These assignments are not necessarily cumulative steps in the development of an initial design idea, but are complementary, autonomous explorations. One assignment might intentionally be the inverse of the previous assignment, or might be related in some conceptual way. These assignments were not formulaic each year. Goals may remain similar, but different faculty can reinterpret the goals in different ways. Thus, the assignments are re-invented, while faculty have creative opportunities to meet clear goals.

The reflective thoughts of Hoesli permeate this spatial approach to teaching, in which the faculty members critically assess the pedagogical effectiveness, not just the student product outcomes. Occasionally, I would survey the students to ascertain the effectiveness of the various assignments, asking them to rate the learning experience of an assignment, along with identifying what they had learned. The student perceptions were remarkably similar to the faculty goals and assessments.

Faculty Leeway within a Spatial Tradition

One challenge in teaching first year is finding a way to give creative leeway to the various faculty, while creating a common denominator experience for the students. Simply having a "unified" series of assignments reduces the faculty to teaching assistants. Bernard Hoesli's technique of identifying a framework of goals gives faculty leeway in exploring different ways to meet these goals, while promoting innovation and experimentation.

For faculty, the pedagogical goals of a first year experience should be clear. When a first year program is reduced to a series of "common assignments", faculty may lose intellectual engagement. Conversely, a first year in which each faculty member is exploring dramatically different goals results in a group of students with uneven preparation for the next few years.

When faculty have leeway in achieving common pedagogical goals, their intellectual engagement in the studio is contagious. In programs with multiple sections in first year, it is insightful for students to see the different approaches of different faculty in meeting similar goals.

Conclusion

This spatial tradition in teaching is a conceptual, analytical, and flexible framework for designing the learning experience, not a series of formulaic exercises. For beginning students in architecture, understanding the interrelationship of abstraction and real experience of space is a critical necessity.

In a pedagogy derived from the spatial tradition I have described, beginning architecture students gain conceptual, spatial, and representational under-standing of architecture. This is a strong foundation for integrating more complex ideas related to technology, program, culture, context, and meaning into their subsequent design work.

For students, one might ask: does such a rigorous approach to design limit creativity? Creativity is possible within constraints: Students see almost infinite possibilities even within the narrowest of constraints. This indeed is the basis of the practice of architecture.

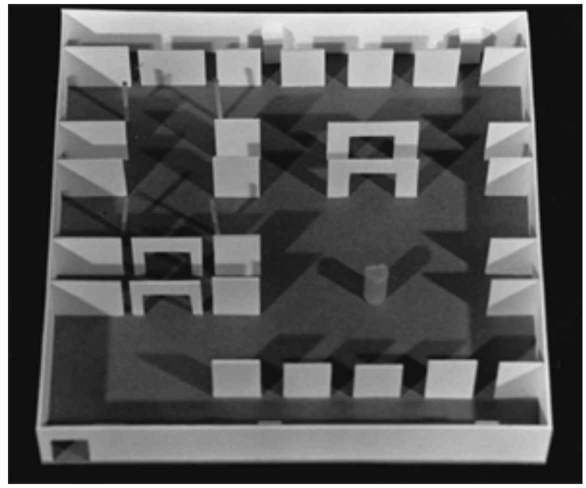


Fig. 12. Abstract exercise: parallel walls defining space.

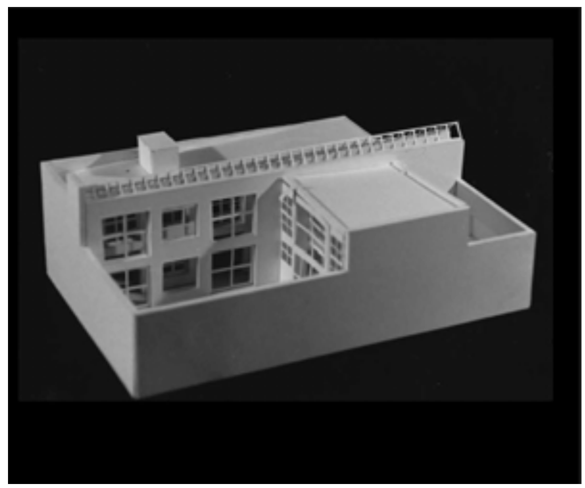


Fig. 13. Courtyard house composed of block walls.

Fig. 14. City composed of courtyard houses.

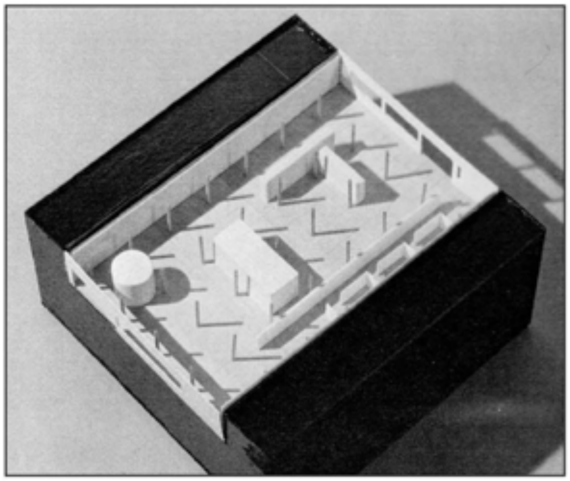


Fig. 15. Abstract exercise: elements in field of columns.

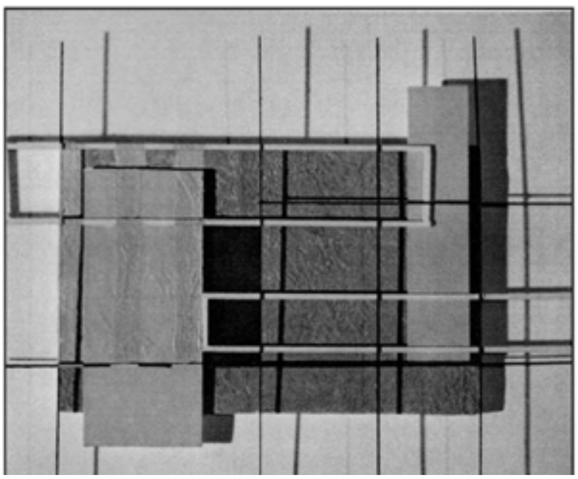


Fig. 16. Compositional studies for advertising agency.

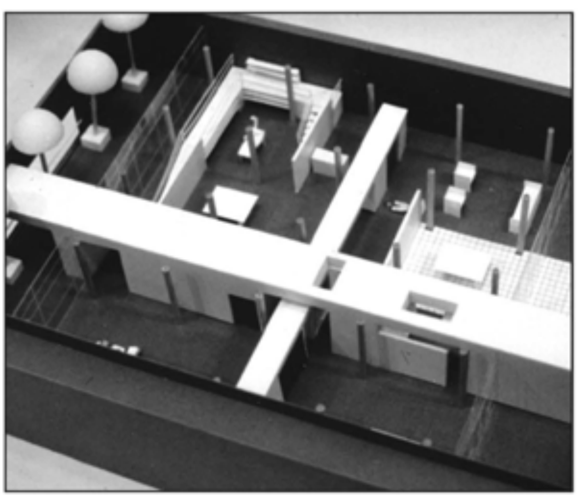


Fig. 17. Advertising agency.

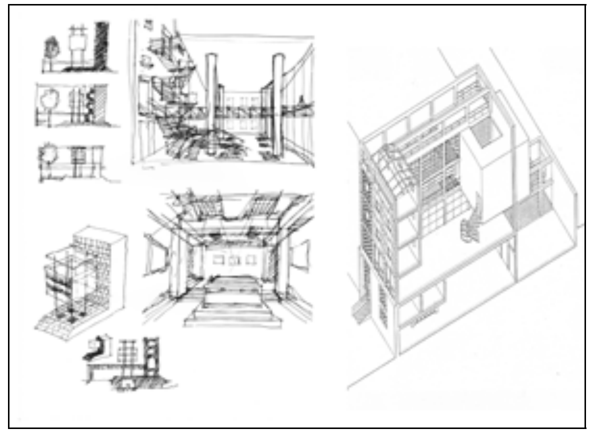


Fig. 18. Student design process and presentation.

Notes

[1] Caragonne, Alexander. 1995. *The Texas Rangers: Notes from an Architectural Underground.* Cambridge, Massachusetts: The MIT Press.

[2] Eisenman, Peter and Ariane Lourie. 2008. *Ten Canonical Buildings: 1950-2000.* New York: Rizzoli.

[3] Caragonne, Alexander. 1995. *The Texas Rangers: Notes from an Architectural Underground.* Cambridge, Massachusetts: The MIT Press. p 44.

All illustrations are work of first year students in Marleen Kay Davis' first year studio courses at Syracuse University or at the University of Tennessee.

Measures of Place:
The Eidetic Image in Design

Amber Ellett, AIA

University of Arkansas

Fig. 1. Early eidetic image that analyzes urban fabric and agricultural land, New Orleans. Brendan Smith, 2014.

A Position Toward Site

The most important quality of architecture is the way it relates to, signifies, and dignifies a place on earth.[1]
–W.G. Clark

A student's understanding of place in design remains an elusive yet critical ambition in design education. The introduction of site issues in beginning design often assumes the site as a given rather than something discoverable or constructed. The awareness of site is reduced to something that is visual, knowable, quantifiable, while deeper, phenomenological aspects remain unstudied. Such an approach is limiting, as it suggests that designers have no role in determining sites, and no responsibility in finding meaning in a particular setting for a project. Robert Smithson's notion that "perception is prior to conception"[2] reveals a more valuable way of approaching the issue of site: rather than being viewed as an *a priori* condition, a site may be understood as something which is studied and discovered. In this sense, ideas follow an analysis of existing conditions. All ideas stem from the perception of conditions already extant—conditions that can be documented, represented, dissected, and otherwise analyzed through the use of various tools of perception and manipulation.[3]

The range of terms used to describe a site in architectural discourse (place, property, ground, setting, context, situation, landscape, etc.)[4] explicates the complex nature of the site as a design construct. The notion of site is embraced in each of these words, but none is sufficient or equivalent on its own. Though these terms strive toward clarity in meaning, the site remains an elusive thing. For this reason, it is beneficial to present an architectural pedagogy that avoids making easy distinctions between site and architecture, instead considering both as fully integrated operations in the built environment. This approach borrows from the discipline of landscape architecture, accepting a holistic approach of cohesion with the surroundings.

This paper discusses such site explorations as studied in an undergraduate architecture elective course.[5] In an effort to engage students' understanding of site as a synthetic human experience, a pedagogical approach of mapping was employed. Speculative mapping exercises hold potential to provide clarity to design students addressing site issues. Clarity of recognition of important issues will encourage specificity in the design approach, rather than acceptance of a generic site condition. The engagement of students through graphic exercises of this nature holds them accountable for their intellectual recognition of a particular place. Indeed, the primary role of speculative mapping is not to provide an objective measure of the landscape but rather to envision possibilities for further exploration.[6] As Denis Cosgrove states, the map is both a "spatial embodiment of knowledge and a stimulus to further cognitive engagements."[7]

Collecting Dirt

The project through which these site positions were studied is a graphic mapping exercise referred to as the "eidetic" image. The eidetic image is a mental conception, acoustic, cognitive, or intuitive; a representation of one's perception.[8] As an evidentiary product of measured analysis, this constructed image holds potential in revealing both the material (tangible) and immaterial (intangible) aspects of a place.

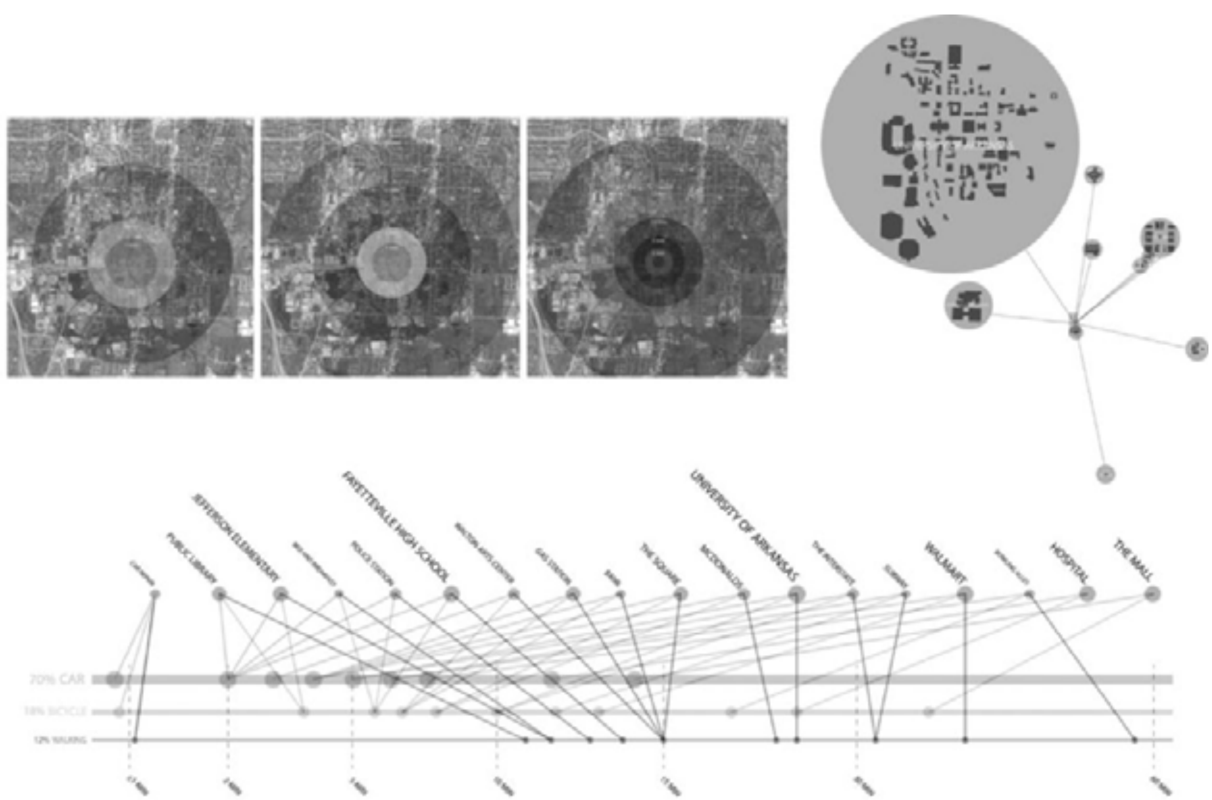


Fig. 2. Site analysis, Fayetteville, Arkansas. Colby Ritter, 2013.

A curricular bias in this course is that the site comes before the idea. Thus, the goal in this project is not the generation of ideas or design proposals (the nature of the seminar course would not allow such explorations, which are better suited for a studio setting), but the collection, organization, and analysis of existing conditions. Thus, the first step in the project was the acquisition and assembly of information, or "dirt."[9] This site analysis phase lasted one week. Students were instructed to operate under the understanding that analysis is design; that is, factors that were admitted to the study and those that were excluded ultimately framed the result. Accepting Carol Burns' conception of the site as a "construct"[10] of histories, perceptions, and experiences, students were asked to distinguish the temporal, cultural, perceptual, spatial, and spiritual dimensions of that place.

Eidetic Operations

After the comprehensive site analysis phase, students moved into a two-week mapping phase. Students were encouraged to be fearless

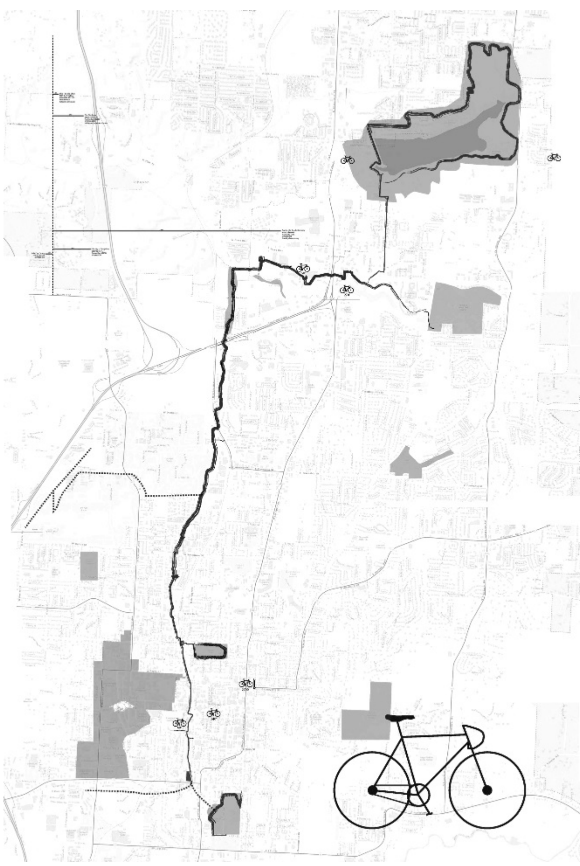


Fig. 3. Analysis of bike routes, Fayetteville, Arkansas. Tiffany Henry, 2013.

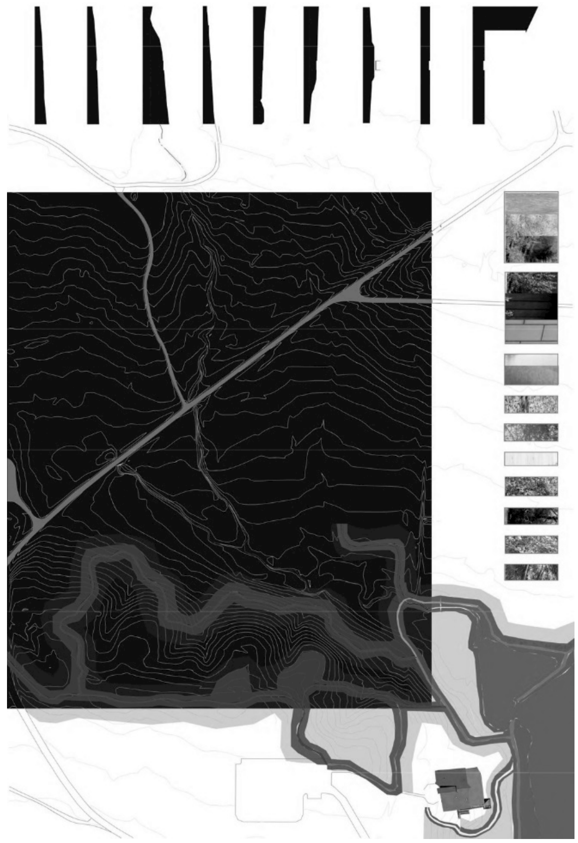


Fig. 4. Eidetic image of site for Museum of Hard Wood, Ft. Smith, Arkansas. Kimberly Murray, 2013.

in their investigations, all the while striving toward a graphic representation that would illuminate the physical (ecological concerns—connections between natural/hidden systems—sun, wind, and light), cultural (measures of inhabitation), and spiritual qualities of the place.[11] Multiple types of imagery and drawings (aerial, orthographic, perspective, etc.) as well as both digital and hand media were employed. Students were required to critically consider representational methods, as ultimately the artifact was to communicate their own perceptions and understandings of the place of study. A synthetic, layered approach was used, with the goal of a clear, informative, elegant graphic as an end result.

The focus remained on the observation and analysis of the site, not on a design proposal. Because the setting studied in this project coincided with the students' current studio project site, a synergistic level of learning resulted. Students began to approach site design issues in their studio projects from the position of being "of" the place rather than "on" it.[12] The eidetic image became an avenue for discovery; multiple layers of information were used, which avoided the oversimplification or reduction of issues. An understanding of various elements in relation to one another meant that it was much less about a visual composition of discordant parts, and more about the integral operative function of each.

The Synthesis of Site

The goal of this project is the students' awareness of the reciprocal and interactive relationship between site and architecture, and an awareness of the influences of human perception and experience in design. Through layered, graphic representations, the site/project bifurcation is able to be tempered. By engaging in measured analysis, students are able to gain a greater understanding of the integral relationship between humans and nature, building and place. The eidetic image, as a speculative mapping exercise, holds potential as an instructive pedagogical tool of place-discovery for the beginning design student.

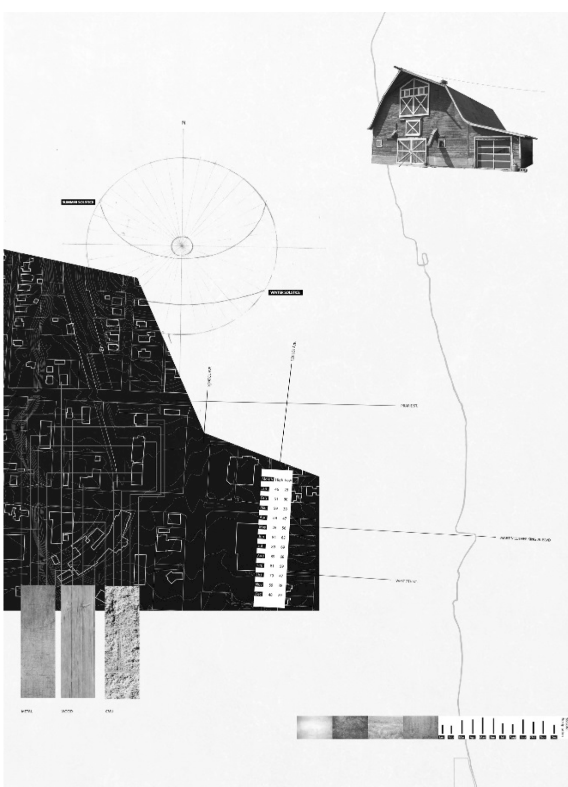


Fig. 5. Eidetic image of vernacular materials and structures in Fayetteville, Arkansas. Colby Ritter, 2013.

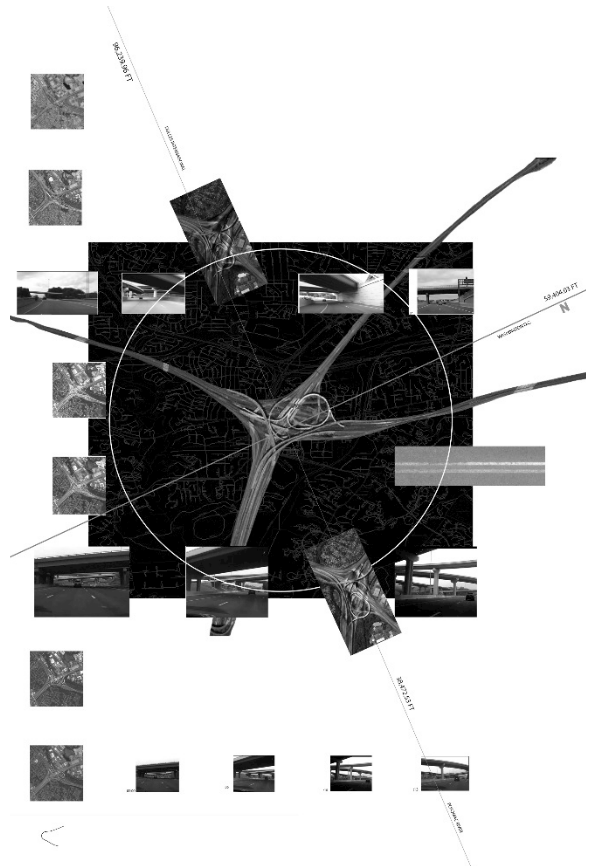


Fig. 6. Eidetic image of interstate interchange. Ross Pugh, 2013.

Notes

[1] W.G. Clark, "Writings" from *Clark and Menefee*, Richard Jensen (New York: Princeton Architectural Press, 2000) 13.

[2] Robert Smithson, *Robert Smithson: The Collected* Writings, ed. Jack Flam. (Berkeley: University of California Press, 1996), 96.

[3] An important reference related to meaning in human experience is Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. Colin Smith (London: Routledge, 1962).

[4] Carol J. Burns and Andrea Kahn, "Why Site Matters," in *Site Matters: Design Concepts, Histories, and Strategies* (New York: Routledge, 2005), xiii.

[5] The projects discussed in this paper were generated during a three credit hour, semester-long undergraduate architecture elective course entitled *SITE*, taught by the author and offered in the spring 2013 term at the University of Arkansas. Although not part of the core beginning design curriculum, potential exists to integrate this pedagogical approach toward mapping, analyzing, and understanding site issues in beginning design studios.

[6] Alan Berger, *Reclaiming the American West* (New York: Princeton Architectural Press, 2002), 118.

[7] Denis Cosgrove, *Mappings* (London: Reaktion Books, 1999), 1-2.

[8] The notion of the eidetic image is inspired by James Corner, "Eidetic Operations and New Landscapes," in *Recovering Landscape: Essays in Contemporary Landscape Architecture* (New York: Princeton Architectural Press, 1999).

[9] Dirt in this case is understood as a fertile medium, explicitly productive, as described in Megan Born, et al., *Dirt* (Philadelphia, PennDesign, 2012), 8.

[10] Carol J. Burns, "On Site: Architectural Preoccupations," in *Drawing, Building, Text: Essays in Architectural Theory*, ed. Andrea Kahn (New York: Princeton Architectural Press, 1991), 165.

[11] These three "places" correspond to the body, mind, and spirit, as discussed by Clark, "Writings," 13.

[12] Ibid., 12.

Transparency of Ground

Burak Erdim and Patricia Morgado

North Carolina State University, College of Design – School of Architecture

Since at least the second quarter of the twentieth century, the discipline of architecture has suffered a significant divide into two separate camps often defined as the formal and the social fronts. Mary McLeod's well-known essay, "Architecture and Politics in the Reagan Era (1989)," traced the formation and the shifts of the discipline between these two camps, following political movements.[1] At the same time, she found that the pendulum, so to speak, generally rested not in the middle, but on the formal side, following short periodic swings to the social end, revealing a curious bias in the profession. McLeod's essay provided the post-World War II chapter to what Catherine Bauer had already identified in her earlier essay entitled, "The Social Front of Modern Architecture in the 1930s."[2] Bauer's essay had featured one of the well-known encounters between these two fronts during the making of the Modern Architecture Exhibition in 1932 at the Museum of Modern Art, where the curators of the exhibit described the new architecture primarily in formal terms and as a style, casting aside its social concerns.[3]

During the postwar period, Colin Rowe can be counted among the most influential voices who helped to continue this trend. Fueled by Clement Greenberg's propositions, Rowe strengthened the formal front, but for his own reasons, as an apology for a late and decontextualized modernism devoid of social and political responsibility. Colin Rowe and Robert Slutzky, in their influential essay entitled, "Transparency: Literal and Phenomenal," conceptualized the spatial aims of Modern architecture through a limited analysis of only the formal characteristics of well-known modernist works.[4] Pointing to what should have been seen as not-so-relevant parallels between Modernism and the Renaissance, they recast Modern Architecture as a part of a longer tradition merging in a single swoop any remaining differentiation between the Beaux Arts traditions and Modernism. Their propositions were so influential that one now finds many of our colleagues re-introducing the social front as a newly discovered niche, under titles such as "public interest architecture." All the while, proponents of public interest find themselves defending their positions, both in education and practice, actually through the aesthetic qualities of their works.

Through the reconceptualization of the ideas of ground and site, our projects seek to reintegrate the social and formal fronts in architecture at the very beginning of an architecture student's career.[5] Likewise, we are interested in introducing site as a force that determines or affects form as well as a material that can be sculpted to make space. We do this in two steps, by first, re-examining the surface or the ground of the paintings that Rowe and Slutzky had examined in their influential essay: Georges Braque's *The Portuguese* (1911), Juan Gris's *Still Life With Bottle* (1912), and Pablo Picasso's L'Arlessienne (1911-1912). Our goal in re-examining these paintings is, as Marshall Berman suggests, to go to a point in history where we can come to a fuller understanding of the conditions of modernity and to reconstruct both the social and the formal aims of these paintings, something that Rowe and Slutzky had deprived us of.[6] At the same time, a careful reading of the Rowe and Slutzky essay exposes students to phenomenal transparency, an idea fundamental to creating relationships between figures and ground and between buildings and their social and formal contexts.

Second, we take what we learn from the study of the ground of these paintings to a city, in this case, Charleston, South Carolina. In this second project, we again examine the structure of the ground, in order to, as Robin Dripps suggests, understand "its potential for making connection," between the spaces of the city, its social groups, classes, temporal modes and histories. Here the students analyze both the literal and the metaphorical ground of the city to distinguish between what is revealed and hidden; portrayed and erased; ultimately problematizing the constructed or the invented nature of Charleston's picturesque and uniform identity built on spectacle and value production.[7]

Therefore, we propose a reconceptualization of site in relation to the idea of the ground in order to provide a critique of the division between the social and the formal fronts as well as of a proliferation of site-less buildings in the urban and the rural landscape.[8] As Hans Ibelings also points out in his book, *Supermodernisms*, many what he calls supermodern object-buildings do not engage their context. As figures, they make no attempt to engage their ground.[9]

Whether working in a natural setting or an urban area, our work as architects consists of adding “figures” to a ground, consequently altering an existing figure-ground relationship. At the scale of a site, the success of our project depends largely on the relationship between the figure (or figures) and the ground. This is even more critical when the form is the result of an assembly of parts.

We take advantage of the parallels between the plan of a city/environment and that of a painting. In both, we can identify figure-ground relationships, regulating lines, geometry, and repetitive/unique parts, to name a few. Thus, adding a building to an urban or natural environment would be equivalent to taking a brush and adding a shape, a painting, a figure to a ground.

The site for the first project is one of three cubist paintings. The project is divided into three parts: a. analyzing the painting; b. translating a painting to site; and c. adding figures to an existing figure/ground condition.

Analyzing the Painting

Through a series of diagrams, the students study, to use Dripps' words, the “structure of the ground” they will intervene. Specifically they look at figure/ground relationships, regulating lines, geometry, proportion, and repetitive/unique elements, and transparency (Fig. 1). This analysis serves as a vehicle to discuss multiple aspects about composition. Through these diagrams, students explore the strategies these paintings use, or the structure of their ground, to create connections between figures and their surroundings, a quality that Rowe and Slutzky define as phenomenal transparency.

In regards to figure/ground, for example, the students tackle questions such as: What is figure and what is ground? Can a figure be ground for other figures? How do we diagram figure/ground reversal (phenomenal transparency)? Where does the figure begin and where does it end? Was the ground designed or was it a result of the placement of the figures? What role does contrast have in defining figure from ground? This last question is particularly relevant as they move on to the design stage of the project because value determines the maximum height of the new figures they will be adding so that these fit within the existing figure/ground condition.

Equally interesting are the questions that arise as they study the geometry and proportion found in the painting. It is probably in this diagram that they can realize the existence of an underlying structure and its role in the decision making regarding placement of parts.

Translating the Painting to Site

To translate the two-dimensional painting to a three dimensional site, students use a gray scale finder to identify the different tones found in the painting and assigning a topographic elevation to each one of these values (i.e. 20’ to 100% and 40’ to 0% at a scale of 1/32”=1’). These elevation changes, in combination with the regulating lines, are transferred onto the surface of a 2”-3” thick high-density foam and then carved to obtain a three dimensional representation of the painting. In order to map the three-dimensional representation of the painting onto a topographic map, students carry out the following process. First, they cut the foam model along regulating lines that traverse multiple tones (elevations) to reveal the sectional quality of the site. On individual sheets of paper, they draw each of these sections, including the corresponding horizontal lines for elevations every 2.’ Rather than building

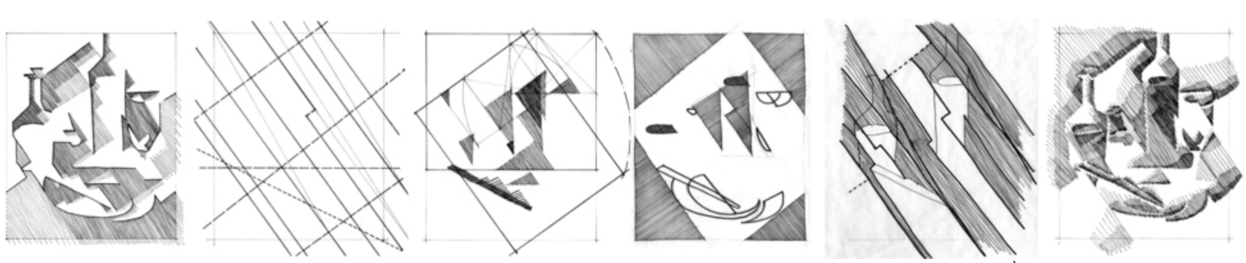


Fig. 1 – Figure/ground, regulating lines, geometry, repetitive/unique elements, light, and transparency (M. Parrish, S. 2014)

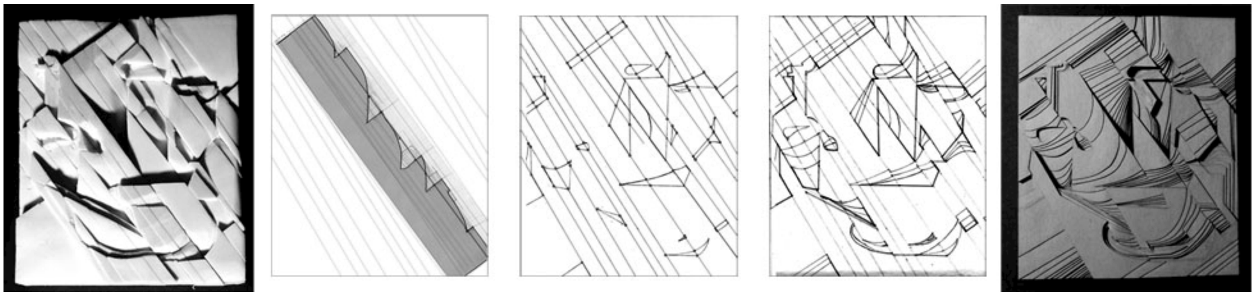


Fig. 2 – Translation of three-dimensional representation of the painting to a site (M. Parrish, S. 2014)

a complete topographic map, students work their way through drawing a topographic map for each elevation level. Thus, for every elevation they found in the sections, they set up a base-map, a framework, with the regulating lines used as section lines. By aligning each section parallel to its corresponding section line, students transfer the location of the intersection of the section line and the elevation line onto the plan. Once the information of all of the sections has ben transferred onto the base-map, they connect the different dots that define each contour. Finally, the topographic maps of all of the elevations are compiled to make a single topographic map, and consequently, a topographic model (Fig. 2).

Adding Figures to an Existing Figure/Ground Condition

Once the analysis of the "structure of the ground" and the topography were complete, the students were asked to design a visitor center for the site. The project required them to add two major figures (two volumes, one cubic and one linear) and a total of 4 walls that may, or may not enclose the two volumes. This program challenges the students to consider not only the arrangement of each of these programmatic elements as figures and lines on an existing figure/ground condition, but also as a kit-of-parts, the program asks them to consider the organization of these elements within themselves.

The value of the Rowe and Slutzky essay was in re-emphasizing how strategies used in cubist paintings to open up objects to the phenomena around them could also be used in articulating relationships between inside and outside spaces in architecture and between the figure of a building and the ground the site. Regarding Juan Gris's *Still Life*, for example, Rowe and Slutzky discuss how Gris suppresses the literal transparency of the glass of the bottles in favor of a transparency of the gridding, which in this case, represents a light source, and becomes a central component of the structure of the ground or the surface of the painting.[10] Through the interweaving of the vertical and the oblique grids, the objects such as the bottles become a part of the world, or the phenomenon around them, creating a reintegrated universe that goes beyond the edges of the canvas. The students, in their attempt to engage this universe, so to speak, had to identify the structure of its ground and then make decisions in terms of how they might engage it.

The question was presented to the students in two primary ways. How would you add *figures* to this site, which happens to be a master cubist painting? Or, what would you do that would reveal the structure of the ground and/or the organizational principles of the painting or the site?

Expanding on these two primary questions, the second time we proposed this assignment, we asked the students to begin with four strategies: *mimicking* the site; *completing* the site; *embedding* their proposal into the existing structure; and *revealing* the painting's underlying structure. To help them assess their work, the students were asked to work in model and to map their proposals on copies of their previously completed analytical diagrams. In doing so, they would be able to assess their strategies and those of the site in regards to regulating lines (or structure), geometry and proportion (form and scale), repetitive/unique elements (hierarchy), and more importantly, figure/ground relationships, the relationship of the figure(s) and its surroundings in all three axes. We called these strategies the transparency of the ground. Using these four strategies, the students further developed methods of emphasizing or revealing while also creating relationships between the figure of their building and the ground of their site. The methodology reversed the ways in which the students usually approach making at this early stage of their architectural education (Fig. 3).

Therefore, in this first project, the students were given methods through which to analyze and develop a clear conceptual basis for what a site is in architecture. Their analysis of the structure of the ground of cubist paintings provided this conceptual basis. Even though the structure of a painting could not provide the social and political complexities of an actual site, it gave them a place to learn and develop their skills of making connection. Studying the idea of phenomenal transparency inherent in the structure of the ground of these paintings provided the primer to the idea of the transparency of the ground. Through analytical diagrams, they found ways to distill the organizational principles of their painting and to understand how figure/ground relationships were organized within this structure. By utilizing the structure of the ground in developing their proposals, the students learned strategies through which they could make clearly identifiable spatial and experiential connections between their building and the site. Lastly, by studying early cubist paintings, they also learned about the dual concerns of these paintings that brought together the social and the formal fronts. They understood that the formal strategies in these paintings and the flattened picture plane were attempts at reintegrating society through relationships, which were largely fragmented by the economy and culture of spectacle in the metropolis.

Reading the City and its Parts

In project two, which takes up the larger half of the semester, the students were asked to apply what they learned from the analysis of cubist paintings to the analysis and conceptualization of the city as a ground. Charleston, South Carolina acts as the setting for this exercise.[11] In preparation for our two-day field trip, students compile information as well as historic and contemporary maps of the older portion of the Charleston peninsula to analyze the shaping of the city over time. Additionally, these maps serve as the base for the information they are to collect in-situ of the precinct surrounding their site to be analyzed in closer detail at their return to Raleigh. To do so, they are introduced to other influential ways of mapping cities, such as Giambattista Nolli's map of Rome. At this point of the project, we also ask the students to read another one of Colin Rowe's influential essays, "Crisis of the Object: Predicament of Texture," in order to understand how the idea of figure/ground can be utilized in mapping and understanding the urban fabric.[12]

However, by and large, Robin Dripps' essay, "Groundwork," is the central text guiding our investigation. In her essay, Dripps provides a social and environmental critique of formal approaches by conceptualizing an awareness and understanding of the structure of the ground, "so that its potential for making connection can become a part of any architecture that engages it."[13] In her proposal, Dripps describes the structure of the ground in terms of its literal and metaphorical interpretations, bringing together its social and formal functions. She writes, "The term *ground* will be used in a literal sense to describe the structure and processes of the earth, but also as metaphor. Metaphorically, ground refers to the various patterns of physical, intellectual, poetic, and political structure that intersect, overlap, and weave together to become the context for human thought and action."[14] In our analysis of the patterns of Charleston, it is this dual understanding of the structure of the

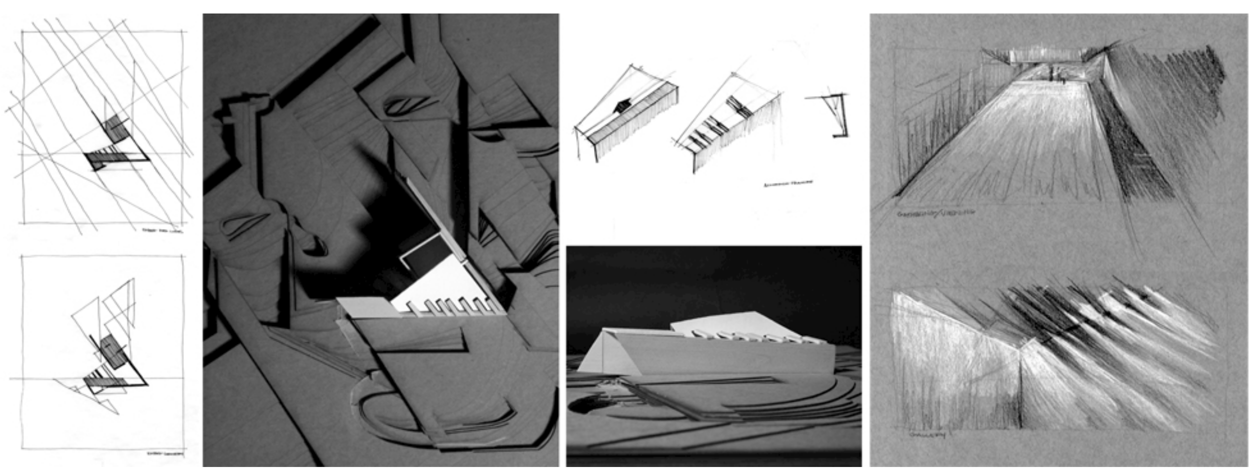


Fig. 3 – Study drawings and model for Visitors Center (M. Parrish, S. 2014)

ground, both its literal and metaphorical layers, that ultimately become useful. This approach allows us to understand the city beyond the spectacle of streets, facades, and private gardens and as a historical, environmental, and political entity. In this analysis, the layers or the structures of the ground that are missing or hidden from view become equally relevant, revealing how capital production, protection of market values, race, class, religion, identity, and politics play into the making of the invented "image" of the city.

The students engage their precincts by documenting their sites but also by understanding them in connection to the larger city through the analysis of the structures of the ground. They map the structure of this ground through models and drawings (Figs. 4 & 5). Through these analytical exercises and models, the students look for strategies to map how a city that used to be demographically diverse and open to the ecological structure of its surroundings gradually became homogenized and commodified, creating closed blocks with boundaries between interiors and exteriors.

Fig. 4. Precinct Diagrams (Carly Meekins, S. 2013)

In the analysis of the precincts and sites, the definitions of site and ground become operative. At the beginning of our field trip, we initially don't tell the students where their building sites would be located. First, they are assigned a slice of the city that we call precincts and they analyze the whole extent of their precincts as a ground. This allows the students to be able to take the time to look at the parts of the city more broadly. Dripps makes a similar distinction between the definitions of site and ground. She writes,

A site, in contrast to a ground is quite simple. This is undoubtedly why the idea of a site becomes so appealing to architects and planners. A site possesses a reassuring degree of certainty, whereas the ground is always in flux. A site's edges are known and a center can always be found. Connections to the world beyond are limited and tightly controlled. Sites can be owned. In other words, the site takes on many of the qualities of an institution. As such, it reduces the complexity of both human and natural interactions to guide with assurance the polity it has gathered within. It has become a figure and has thereby reduced the potential for accommodating the fullest range of human possibility.[15]

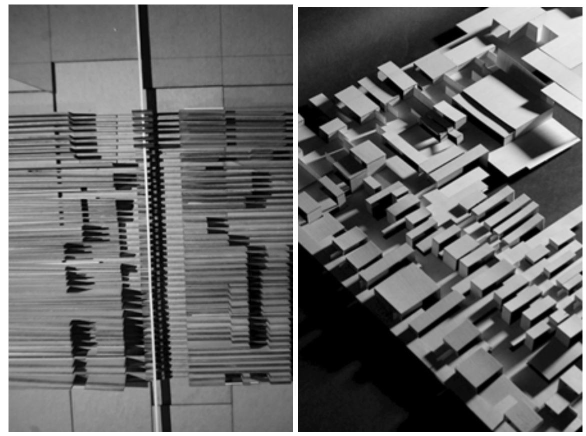


Fig. 5. Precinct Models (C. Richeson-A. Dunn and C. Meekins-D. Impink, S. 2013)

Once the students are given their site, they are then encouraged to draw it in relation to the whole precinct, revealing the various layers and structure of the ground in their drawings and models (Fig. 6). The city is then depicted as a series of relationships, similar to the way objects are represented in cubist paintings. It is at this point that the students begin to understand the connection between the two projects. Therefore, when we say that the students look at the city as a painting, what we mean is that they bring together the formal and the social pieces of the city and construct them as a part of the structure of the ground, which they can now analyze and understand in spatial terms.

Fig. 6. Site-Precinct Drawings (C. Meekins, S. 2013)

Museum of the City

Walking through the streets of present day Charleston, one is drawn to the scale and the articulation of its streets lined with attractive and seemingly historical architecture providing an idealized view of a colonial American city. However, the picture one is presented with is far from

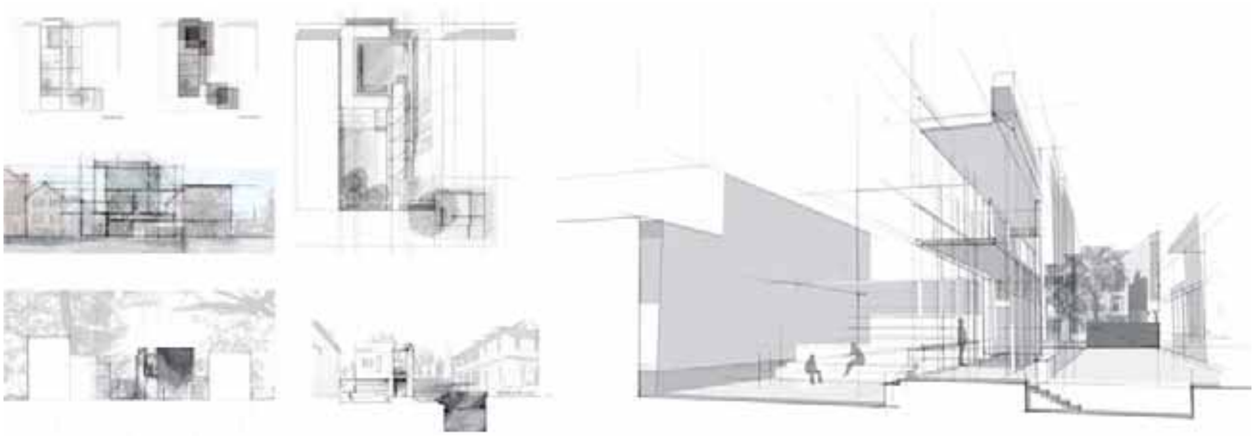


Fig. 7. Museum of the City - Charleston, S.C. (C. Meekins, S. 2013)

how Charleston used to be. Many pieces of the historic city have been erased in order to construct this idealized image. For example, only one of the over thirty slave market sites that used to exist in the city has been preserved. The inlets of water that once penetrated the peninsula have been filled in creating a more uniform landform with continuous edges. The interiors of the blocks, which were previously open to the public, are now closed with only one public park remaining in the historic district of the city. In other words, once one begins to realize how the ground of the city has been drastically altered, it becomes clear that this is not a historic city at all. On the contrary, the current city displays vignettes of history as spectacle for visitors. This spectacle then increases the exchange value of private land with boundaries while it decreases its use value for the public.

In the Museum of the City project, the students are asked to provide a social and environmental critique of the city by discovering and revealing the histories and spatial conditions hidden by this new city of spectacle. Through the spatial conditions that they create in their respective sites, they are to reveal certain qualities which not only expose this spectacle, but also re-aligns the city with its own historical and political complexities.

When the emphasis is shifted from the street view of the blocks to the analysis of the ground, even in the final drawings of the project, the spaces in the interiors of the blocks become the areas of investigation, revealing how these spaces were once diversely inhabited and operated to provide connections throughout the city (Fig. 7). By the same token, the idea of a building and a site emerges as an extension of a broader and deeper fabric made up of both literal and metaphorical layers.

Conclusion: Paintings and the City

In articulating the idea of the ground and its potential to making connection, Dripps discusses another colonial city, Williamsburg, Virginia. Looking at historical maps, she discusses how the original city was constructed in a completely open way, unlike the European city with its medieval walls, to the ecological structure of the landscape around it. She identifies the openness of the interior of the blocks and the city to its surroundings as one of the underlying characteristics of American urbanism. The analysis of the structure of Charleston's ground also reveals this quality, even though it has been largely erased and hidden in present-day Charleston.[16] Only a close analysis of the layers of its ground reveals these connections between the street, the bounded site, the block, the city, and the landscape beyond. The ability of the literal and the metaphorical structure of the ground to make these connections and to reveal what has been hidden is conceptualized in our project as the transparency of the ground. Therefore, both its actual material as well as its metaphorical content is utilized to inform decisions regarding interventions on a given site.

Moving from the ground of cubist paintings to the ground of the city, students cross a span of one hundred years. The structure of phenomenal transparency found on the picture plane of cubist paintings can in no way match the historical, social, and political complexity of the ground of the city. However, we share with the students that these paintings and their formal structure were an artistic response to the fragmented spaces of merchant capitalism. In exploring relationships between figures and the ground, the paintings questioned to notion of spectacle prioritizing relationships where multiple and contradictory views could occupy the same space. Robin Dripps' notion of the structure of the ground provided a similar social and environmental critique of site-less architecture. The study of the ground of the paintings provides a departure point to understanding the complex ground of the city. In the city, the students have to reconstruct the structure of the ground. Even though the city is complex, its layers and structure are often hidden and they require the experience and the agency of the students to once again make them transparent.

Notes

[1] Mary McLeod, "Architecture and Politics in the Reagan Era: From Postmodernism to Deconstructivism," *Assemblage* 8 (Feb 1989): 25-59.

[2] Catherine Bauer Wurster, "The Social Front of Modern Architecture in the 1930s: More than a 'style'? Promising principles unfulfilled," *The Journal of the Society of Architectural Historians* 24, no. 1 (1965), 48-52.

[3] Henry-Russell Hitchcock and Philip Johnson, "Introduction: The Idea of Style," in *The International Style: Architecture since 1922* (1932) (New York: The Norton Library, 1966), 17-21.

[4] Colin Rowe and Robert Slutzky, "Transparency: Literal and Phenomenal," in *Mathematics of the Ideal Villa* (Cambridge, Mass.: The MIT Press, 1982), 158-183.

[5] Don Kranbuehl and Mary Englund also co-taught in the sophomore studios where these projects were introduced.

[6] Marshall Berman, "Introduction," *All That Is Solid Melts Into Air* (London: Penguin, 1982), 15-17.

[7] Robin Dripps, "Groundwork," in *Site Matters: Design Concepts, Histories, and Strategies*, ed. Carol J. Burns and Andrea Kahn (New York; London: Routledge: 2005), 59.

[8] Diane Ghirardo's book, *Out of Site: A Social Criticism of Architecture* (Seattle: Bay Press, 1991), utilizes site as a critique of architectural practice.

[9] Hans Ibeling, *Supermodernism: Architecture in the Age of Globalization* (Rotterdam: NAi, 1998), 88-102.

[10] Rowe and Slutzky, 164.

[11] The Charleston studio is a traditional studio in the School of Architecture at NC State. Both undergraduate and graduate students analyze its urban fabric. Our approach to examining the ground of the city through the idea of the transparency of the ground, moving from cubist paintings to the social, ecological, and political layers of the city is a new take on existing methodologies. The Charleston studio has been taught by numerous teachers including but not limited to Wendy Redfield, Sara Queen, Ellen Weinstein, Ashley Ozburn, Don Kranbuehl, Frank Harmon, among others.

[12] Fred Koetter and Colin Rowe, "Crisis of the Object: Predicament of Texture," *Perspecta*16 (1980): 108-141.

[13] Dripps, 59.

[14] Dripp's emphasis. Ibid.

[15] Ibid., 61.

[16] Even though Charleston had protective walls during the 18th century, the city and its blocks remained open demographically and ecologically.

Making Projection Matter

Fırat Erdim

IE University, Undergraduate Architecture Program, Spain

Setting the Table

In *A Scientific Autobiography* (1981), Aldo Rossi describes architecture in relation to the term "apparecchiare la tavola, meaning to set the table, to prepare it, to arrange it," ultimately regarding architecture as "[...] the instrument which permits the unfolding of a thing."[1] Setting the table, as a metaphor, points to a critical dialogue across the unfolding of the project within the studio, the unfolding of architecture within the site, and the unfolding of life within architecture. Across these three situations of something coming into being, projection and the construction line act as instruments to navigate the way between the material and the immaterial, between what is there and what might come to be.

At the time of Rossi's publication, it was possible to see the drafting table as the archetypal ground of architecture, and the construction line, or projection, as the archetypal means of unfolding. Today, the instrumental role of projection as a means of unfolding has become less self-evident, and increasingly difficult to communicate to the beginning design student.

Marco Frascari, in Eleven Exercises in the Art of Architectural Drawing (2011), argues that the change from manual to digital in the nature of the primary tools of the studio has led to the displacement of descriptive geometry as a form of cognition in architecture.2 Some of the means native to the digital workspace have made the often-laborious process of projecting and constructing architectural drawings largely unnecessary, and thus absent from the day to day thought-process that a student of architecture goes through. Often, students are still asked to utilize the conventions of orthographic projection in the presentation of architectural drawings, even when it is not instrumental in the construction of those drawings. It seems inevitable that the trend towards the disappearance of the use of projection in the architectural design process will continue, especially as the truly instrumental links between processes of design and of fabrication are further streamlined within digital means. That disappearance may also have implications for the instrumentality of the studio, as a physical and social space for "throwing forth" and unfolding architecture. Without the presence of projection as a material practice, is the studio nothing but a classroom?

Nevertheless, as the incisive use of projection becomes the exception, rather than a vehicle of convention, there is an opportunity to re-examine its critical and transformative potential in the making and teaching of architecture. Orthographic projection is not strictly a way of transporting information from one view to another across a sheet of paper. More importantly, it is a means of continuously re-orienting oneself in relation to the whole of the envisioned space, whether existing or anticipated. It is in this latter sense that it relates to other forms of projection, such as cartography, scenography, and anamorphism. In the intense period of experimentation during the Italian Renaissance and Baroque, projection of all kinds, less differentiated, involved the use of specially constructed instruments, as well as the performance of specific rituals of orientation and measurement within a setting, linking subject, place, and the passage of time within the act of drawing.[3] The approach to projection presented in this paper is inspired by those early instruments and practices, as seen through the lens of performance art. It also shares the hyper-material, and hyper-literal approach suggested by Frascari, as well as by Juhani Pallasmaa in his book, *The Thinking Hand* (2009).[4] However, the pedagogical assignment, and the series of independent experiments by the author that are presented in this paper re-examine architectural projection as an instrument negotiating between not only the material and the immaterial, based in performance and corporeality, but also grounded in the specificity of place, time, and community. The objective of these experiments is to address the multi-layered dialog between the different contexts of unfolding; between the drafting table, the site, and programmed space; as suggested by Rossi's metaphor.

Unfolding in the Studio/ The Inverted City

The Inverted City was a pedagogical assignment in an introduction-to-architecture course developed in 2009 for students at Marwen, a foundation providing free classes in visual art to underserved middle and high school students in Chicago. These young architecture students drew inspiration from Antoni Gaudi's hanging string and chain constructions to envision architectural structures, utilizing gravity as a means of projection to explore concepts of compression and tension.

The assignment grew out of the specific constraints of the Marwen studio and of the participants: the still-developing motor-skills of the younger students in the class; the need for a concrete, tactile, and direct means of working; the very limited budget for materials, and active work-time allowed for the course; and finally, given that the studio had to be utilized for other classes over the course of the week, the lack of storage space for three-dimensional work.

Fig. 1. The Inverted City (photo by author).

The students began the project by drawing compositions of platonic shapes, primed by a discussion of a set of aerial photographs, onto foam-core boards. These boards were suspended upside-down from the exceptionally tall ceiling of the studio. Chains of paperclips, weighted with metal washers, were then used to project the drawings into three-dimensional structures.

Fig. 2. The Inverted City (photo by author).

This method of projection acted as a motor for the unfolding of architecture, where form and articulation were expressed in resistance to that motive force. Though we did not re-project these constructions back into a plan view, the initial compositions of geometries that they were projected from became increasingly more sophisticated and purpose-driven as students became more experienced, and aware of what they could make, over successive iterations. As they were drawing these later boards, they were already projecting, mentally, what they might be able to construct from them, seeing the "plan" as a set of parameters to work from in relation to gravity, and setting the table for the constructions more consciously.

Though concepts of scale, program, and site were not addressed directly in the constructions themselves, they were addressed indirectly in how the space of the studio was utilized for the project. The class would begin with the students and instructors clambering around the columns and beams of the studio like sailors tacking a ship, lowering the in-progress constructions to working height, and end by hoisting them back up again to safety. The other classes that took place in the studio over the rest of the week were given an evolving constellation of architectural structures to ponder overhead. Through this theatrical process of lowering and raising the work, the physical parameters of the studio were utilized as the instrument of another unfolding.

Unfolding in the Site / The Peripatetic Table

In many architectural design projects, the act of measuring a site, and drawing a site plan are what set the table for the project to come. There is a significant transformation from the first physical confrontation with the site, occupying it corporeally, to the graphic realm of the site plan. The plan has a less palpable relationship to the sense of sight than elevations or sections; it has been considered to be more abstract and notational than the other two orthographic views.[5] Plane table cartography on the other hand, akin to some methods of marine navigation, offers an

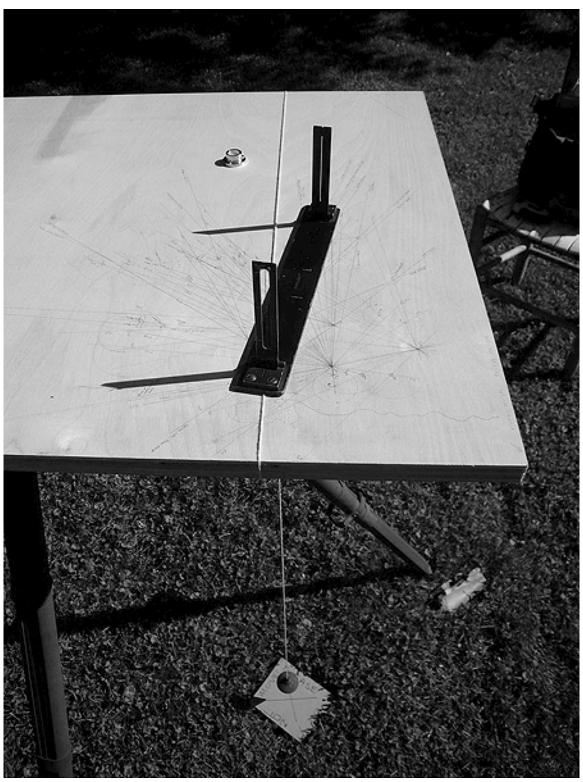


Fig. 3. Plane table surveying process (photo by author).

opportunity to re-envision the plan as a projection in direct relation to the sense of sight, orders of movement through space, and the passage of time.

The plane table is a cartographic instrument, dating back to at least the 16th Century, which utilizes the principle of stereo vision to survey, or navigate a site. The triangulation based on the distance between our two eyes is one of the primary ways we perceive the position of objects in space. The plane table uses the same principle, but extends the distance between the two eyes to different positions, or station-points, in space. Edges, corners, and points are plotted through the intersection of sight lines taken from these station-points. Through this process, a plan is defined by extending the visual sense of the body to the measure of the site. The drafting table, made mobile, becomes the vessel for the navigation and observation of space.

This peripatetic drawing is not only a representation of the site but also the instrument of measurement for it. The nature of a plan delineated through such a stereotomy of sight lines depends on the order of movement between station-points. The duration of time spent at the site is also a factor, as it can lead to the plotting of serendipitous events, or stories told by passersby within the site plan.

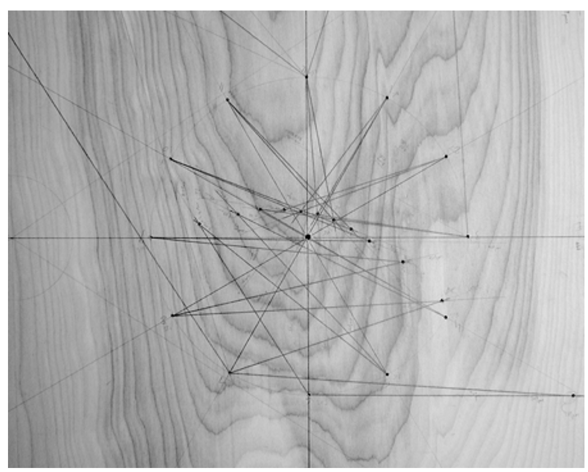


Fig. 4. *VSC Sun Survey* (photo by author).

VSC Sun Survey is an independent experiment conducted by the author at the Vermont Studio Center in 2012, exploring the time-based aspect of plane table cartography. A plane table was used to survey the shadow cast by a vertical pole, by moving from station-point to station-point on a circle centered on the pole, over the course of a day. Because the height of the pole was known, the path of the sun across the sky during that day could be re-projected using string, creating a weaving between the rotation of the earth and the revolution of the observer around their discrete axes, as recorded at that site, on that particular day.

The rituals of meeting, observing, measuring, and occupying a site can be critical architectural acts in themselves. The rituals of measurement developed in *VSC Sun Survey* were re-deployed in a performance by the author at the Konak Clock Tower in Izmir, Turkey, in 2013. The performance took place at the height of the Gezi Protests, which were initially instigated by the authoritarian attitude of the Turkish government for the re-development of public spaces in Istanbul. The Standing Man protests invented by the choreographer, Erdem Gündüz, where a person uses her stationary and speechless body to make herself a part of a public monument, were happening in every major city throughout Turkey. This meant that even standing still in one place in a plaza became a form of protest, and made the atmosphere in public spaces all the more tense between security forces and members of the public.

The Konak Clock Tower in Izmir was designed by Raymond Charles Père, and built in 1901, as a gift from Emperor Wilhelm II to Sultan Abdülhamid II, the modernizer, who in 1878 had replaced the fledgling Ottoman parliament and constitution with his autocratic rule. The Clock Tower was designed for a much smaller plaza than is there today. Over the last century, the plaza was gradually widened into a vast expanse encircled by headquarters for government agencies and security forces. The widening of the plaza unwittingly opened up the alternative possibility of the Clock Tower acting as sundial, a more archaic clock.

The performance, titled *Yeryüzü+Gökyüzü // Zenith+Nadir*, utilized the 20 radial segments of the plaza paving as 36-minute intervals by which to record the shadow of the Clock Tower around the plaza, on the 21st of June, the longest day of 2013.

The rituals of taking measure in this case were a means of occupying that charged public space over the course of that long day, recording not only a shadow of the Tower and the path of the sun, but also conversations with undercover

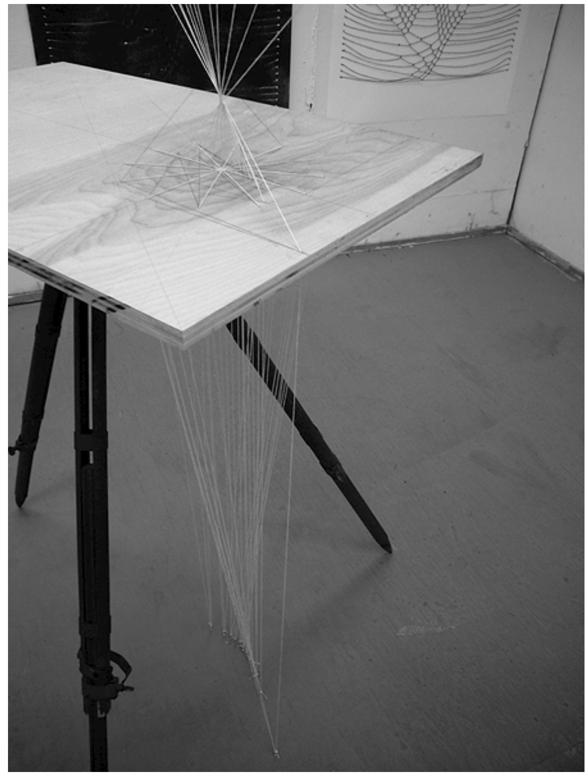


Fig. 5. *VSC Sun Survey* Construction (photo by author).

cops, journalists, protesters, curious passersby, and fortune-tellers in the plaza.[6]

Unfolding Program / Second City @ Flash Atölye

The project titled, *Second City* (2012), explored the role of projection to locate and challenge the boundaries of the studio. This was the inaugural installation at Flash Atölye, a project space for art and architecture that the author co-founded with Olivia Valentine, in Izmir, Turkey, in 2012. Though this was not a pedagogical studio in any sense, it was a space that asked a globally distributed community of artists and architects a question: to make of it an instrument to engage a local community that did not share a common cultural background or even, in most cases, a common language with them.

Flash Atölye was located in a commercial "pasaj" (covered arcade) in one of the old market places in Izmir. The market, as well as the pasaj itself, is a smorgasbord of small businesses: tailors, barbers, printers, yarn stores, leatherworkers, dough-makers, and so on. Over the 10 months of the project, artists and architects from Chicago, New York, Atlanta, Singapore, and Izmir, constructed installations, did performances, formed collaborations, and organized happen-

Fig. 6. Flash Atölye and pasaj skylights (photo by author).


Fig. 7. Tracing light from the skylights (photo by author).

ings that engaged this place and its community. A shared concern with the labor and craft of making allowed an unlikely dialogue to emerge between the participants in Flash and the community of the pasaj, where both were able to learn from each other. The space itself was constantly being re-made, a rectangular void incessantly reframed in a Sisyphean process of construction, as if a new store was preparing to open every two weeks.

The part of the pasaj that this studio was in has three skylights from which cold air and rain enter as readily as light from the sun. These skylights are reflected in the glass walls of Flash Atölye, persistently projecting a fourth, illusory skylight that, if real, would be inside the enclosed space of the studio.

To inaugurate the program for this space, we used the glass walls to trace the light cast by the skylights outside, and then transplanted that drawing onto the interior wall of the studio. This transplant of light was used as a stencil to materialize the presence of the illusory, interior skylight. In this case, the boundaries of the studio were used as projection planes. The projection of light opened a dialogue through those boundaries. The magical manifestation of this “missing” skylight inaugurated Flash Atölye as a participant in the communal space of the psaj, and set the table for the exchange across cultures and communities that would unfold over the following year.[7]

Re-projecting the Studio

One can add innumerable other means to this list of gravity, sight, and light as ways of making projection matter. Projectile means of any sort, including the use of sound, cameras, projectors, chisels, or literally, projectiles could be used to construct effective pedagogical experiments that allow beginning design students to explore projection as an active spatial agent in new and vital ways. This opportunity is only opened up if we allow ourselves to look at projection in a wider context than the existing conventions of architectural representation and pedagogy. Making projection matter requires us to situate it as an action, in a literal sense, with specificity in the world. Though not pedagogical assignments, the experiments with the plane table and at Flash Atölye were presented in this context to highlight the value of that specificity in regard to place, time, and community. Such an approach necessarily challenges the conventional sense of what a studio, and what a studio-based architectural practice is, by re-investing it with a vital instrumentality in the multi-layered unfolding of architecture.

Fig. 8. *Second City*, with reflected skylight (photo by Olivia Valentine).

Notes

[1] Aldo Rossi, *A Scientific Autobiography* (Cambridge, Massachusetts & London: Opposition Books, MIT Press, 1981), 5.

[2] Marco Frascari, *Eleven Exercises in the Art of Architectural Drawing: Slow Food For the Architect's Imagination* (New York: Routledge, 2011), 48-54.

[3] For a detailed study of the history of these instruments, see: Alberto Pérez-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge* (Cambridge, Massachusetts & London: MIT Press, 2000).

[4] Juhani Pallasmaa, *The Thinking Hand: Existential and Embodied Wisdom in Architecture* (West Sussex: John Wiley & Sons Ltd, 2009).

[5] Robin Evans, *The Projective Cast: Architecture and Its Three Geometries* (Cambridge, Massachusetts & London: MIT Press, 1995), 113-119.

[6] For images of this project, see: "Yeryüzü+Gökyüzü // Zenith+Nadir;" http://firaterdim.net/yeryzgkyz-//-zenithnadir.

[7] For these projects, see: *Flash Atölye Blog*, http://flashatolye.tumblr.com/.

Seeing to Begin

David Fox

University of Tennessee

Introduction

Drawing defines the identity of an architect. The ability to *show* the complexities of a design idea with simple, straightforward images is essential to success for both students and professionals. The oldest traditions of architecture actively employ careful hand eye coordination. Technology is rapidly altering the means to represent the spaces we imagine and thus challenges this paradigm.

This presents four projects demonstrating how freehand techniques and digital apps can augment each other. The work is from AR 121, which is a required freshman course (typical class size is 75) with the emphasis on 3D visualization. All architecture and interior design students take this class to learn a basic vocabulary of graphic, pictorial elements necessary to communicate a spatial idea. Typically, students use freehand drawing to construct perspective, isometric and diagrammatic images that offer a visual evidence of their logic.

The outcomes are how well a student can express various shapes and objects with speed and precision to straddle a line between art and engineering. The course meets four hours per week, half of which are lectures introducing content and the other half is studio work practicing techniques. Out of 25 class meetings, 2 address basic line and tone techniques; 9 lectures are on perspective; 9 on isometric projection and 4 focus on ideations and presentation drawings for a final. The last is a synthesis phase, testing how well they understand creative interpretations. This overall structure of this model separates lectures, techniques, three-dimensional views and applications into four distinct segments of the semester.

This paper presents a new organizational model where a lecture, practice and synthesize objectives combine into singular, short duration projects. Each employ drawing exercises, techniques and three-dimensional images (Fig. 1) that grow in complexity. The presentation of each project uses digital devices, such as smartphones, to record the process as a brief video 'story'. The goal of altering the format of the course is to increase learning outcomes by using photographic technology to test their ability to synthesize content.

The purpose is to enhance students' abilities to creatively explore the possibilities of design faster and more comprehensively. The pressures of rapidly evolving digital systems push against the inertia of traditional coursework. How do we change? Smartphone apps offer vast potential that will enable us to reach a student population in vast, new ways with new tools.

Fig. 1, Light and mood study, pen and ink on paper.

These four projects from fall semester, 2013 give an overview of the work and describe a variety of ways to integrate technology with the traditional hand drawings. Student results exceeded expectations demonstrating that this generation has an innate capacity to locate, analyze and employ digital content on a variety of levels. The necessity to challenge those capacities is now ours.

Project 1: Identity | Day one

A designer's identity must reside first within the experiences of our heart, our region and, finally, the world. Le Corbusier said architecture "use those elements which are capable of affecting our senses, and of rewarding the desire of our eyes". [1] The power of touch, and *all the senses*, gently articulates our humanity through line, tone, and color. Our imagination, thus, effectively captures an essence of intent in ways that a digital image cannot, which will enable us to continue making artistic and critical cultural contributions. This must come from the passions of the heart.

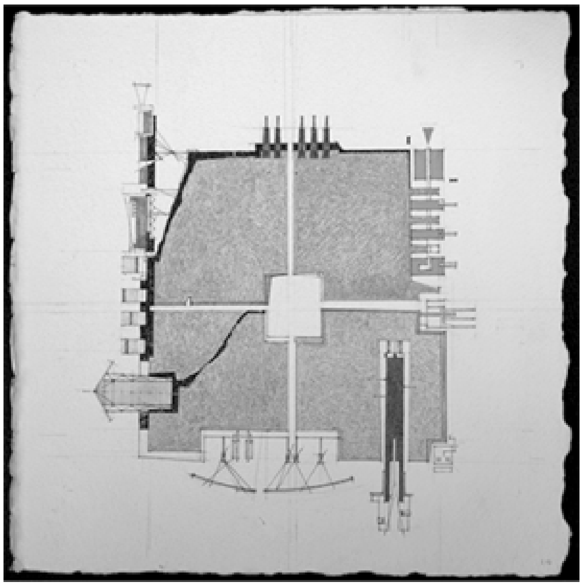


Fig. 2, Prototype Image study diagramming a factory town in Appalachia. Pen, ink, watercolor, marker and graphite on 150lb watercolor paper.

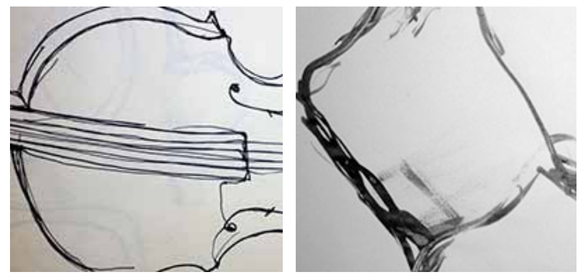
Drawing Assignment: Grasp and Contour

Drawing with pencils and pens can assert powerful means to create places of meaning where we can reveal our true selves. This language, visual and poetic, will forever give shape to how we see and feel the dynamic contexts of an ever-changing culture. (Fig. 2)

Begin with how to hold a pencil or pen. Avoid holding the device as if writing. In many sports activities, such as golf or tennis, the first lesson is grip. The way one touches the club or racket then determines the success or failure of the swing. Drawing is a distinctive act from writing and the device should lie lightly on the fingers, becoming an extension of the body. The drawing must flow smoothly from the mind, thus, if tense, the lines and tones are likely to reflect this disposition, which is okay in rare instances. For a drawing to course from the mind to the surface, the hand must be gently taut. This will suffice.

In these exercises, a contour line will define the exterior edge of an object or idea. This type of image asks each to make lines defining the outer edge of the subject. As one draws, do not remove the device from the surface and practice making light and dark lines to define weight. The darker portions will offer the greatest contrast and should reflect the point of emphasis of the subject. Light lines will serve to reinforce the major elements and shape. These images typically do not address shade and shadow, focusing instead on the shape and texture.

Using this contour line technique, define the object in space. Observe and draw the objects in three different light conditions; draw the space around the object; define the object by the figural qualities of the space around it.



Figs. 3, 4, contour line studies that begin to define a student's identity. Pen and ink on paper

Video Assignment: 24Hours

Use the limits of *time* to create a narrative of your *new design identity*. All are embarking on a career- journey that will define your life for the next 40 or so years. What are your first impressions and how do you see these elements in new ways?

Define your new identity as an Interior Designer or Architect across the arc of 24 hours. (Figs. 5,6)

Figs. 5, 6, contour line studies that explore aspects of time.

Each of you will produce a video of at least 1 minute and no longer than 1½ minutes. It should have a clear beginning, middle and end.

Tell the story of your new *identity* as either an architect or interior designer. Begin with drawing studies using the contour line technique, especially as they explore light conditions. Indicate a clear demarcation of time and end 24 hours later. Include the following aspects of architecture and interior design as vital elements of how we see, experience and shape space. (Fig. 7)

Fig. 7, Image still. Digital media

3 light conditions
3 surfaces
4 color or tone variations
2 campus buildings
4 sounds *(music, voice or ambient)*

A minute may not seem long but consider that a 30 second Super Bowl ad costs $4 million. You will come to see that a minute has considerable presence. Thus, look for ways to combine the elements to *tell a story*.

Use your phone or camera to gather the information and open source software for editing. 10-15 second 'clips' should suffice to document the element.

Each may explore combinations; each may share video-as long as the results are distinct.

Do not use images from the Internet. Each must use original footage!

Examine advertisements analytically. Understand that each 'minute', like a movie or television show, is composed of smaller, two to four second segments in a careful sequence of edits.

Think about 'point of view'-where is the camera? Birds' eye, worms', or normal eye level; panning and zooming. (Fig. 4)

Fig. 8, Image still. Digital media.

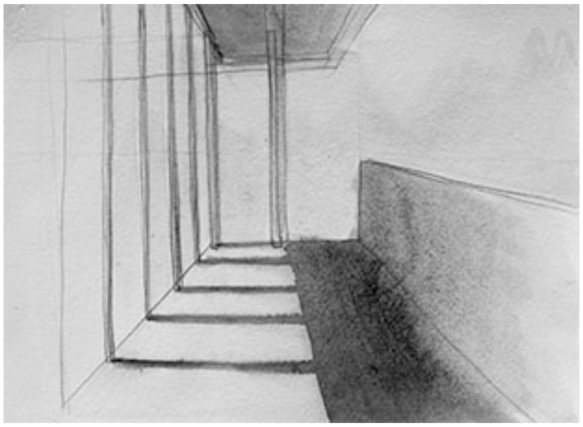
Project 2: Structure and Scale: ***line, square, rectangle***

This project parallels the design class that asks students to make a 2D spatial composition using only three basic elements. The *line, square, rectangle* assignment is elegantly simple. This project might be unclear initially but the results offer clarity. It is a means to understand the fundamental structure of design throughout the environment. Learning to *see* is critical to design success because it provides an outline structure for how we will shape a building or interior space. One of the most important evolutionary traits of humans is our innate ability to perceive patterns in the environment, enabling us to see and duplicate movements, compositions and systems. Pattern recognition is the basis for many different human activities, especially design.

Logic and order are the common denominators for how we shape space. Design composition begins with abstract thinking progressing into a clear organization of spaces. This assignment reinforces the use of abstract shapes as a way to search, analyze and *begin* and then continue the search for a consistent, poetic language that will bring order to how we create and inhabit architecture.

Drawing Assignment 2: *Seeing Design*

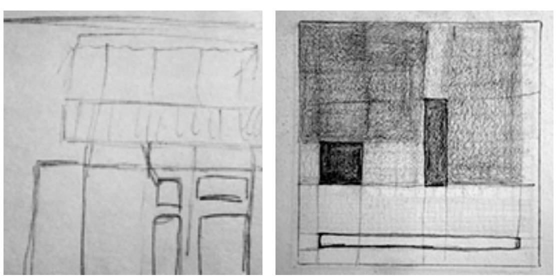
Begin with a poetic interpretation of what we see and experience everyday: a building, advertisement, chair, room, or, maybe, a window wall. (Figs. 9) What are the embedded design patterns; what is their logic? Maybe the design is good, maybe not? It is our prerogative to make this judgment by *seeing* with a critical eye and recognizing the fundamental elements such as ***line, square, and a rectangle***.



Figs. 9, Initial 3D study exploring composition. Graphite on paper.

The creation of good design is a patient search for 'things' that really aren't 'things'. It is vital to understand that impart the solution to this problem-and all problems- is within *your heart and soul*-not within the pages of a book or in the work of another. The answers are within you.

This problem challenges each to explore the commonplace (Figs. 10,11) to find examples of compositional elements of the line, square, rectangle assignment in those things we see and interact with on a daily basis. Each will have to begin with a diagram of the project and critically *see* the underlying structure of your solution.



Figs. 10,11 Two initial 2D analytical diagrams exploring composition, graphite on paper.

An architect or designer must carefully consider all visual work. Chairs, tables, spoons, forks, trays, shoes, and most everything we touch (excepting, for example, raw and natural products) have elements of design. What are examples or portions of good and bad design? What distinguishes an elegant chair from a clunky one? What makes Architecture different from a strip mall? How are the elements of composition manifest in each scale?

Video Assignment 2: Seeing the Environment

Find and document examples of design that approximate the compositional strategy of the ***line, square,*** *rectangle as they appear in the build environment. (Fig. 12) The variety of sizes will introduce the concept of scale and shape as determinants of form*

**S Five examples will be small, no larger than 24 x 24 inches.*

***M Five examples will be medium, no larger than 72 x 72 inches*

****L Five examples will be large, no smaller than 72 x 72 inches.*

The final video will be at least 60 seconds and no longer than 90 seconds.

Use your sketchbook to create a storyboard for the video. This will incorporate small drawings that approximate the images you will shoot and in the sequence of presentation. Make 6 small images per page (about the size of a small post-it note) that ‘map’ your idea.

Fig. 12, Image still using a video app to overlay lines onto photography and illustrate compositions in the environment. Digital media

Make at least 12 (two sheets) images for Small; 12 images (two sheets) for Medium; 12 images (two sheets) for Large.

Still photography is acceptable for approximately half of the examples, *use a Zoom for approximately half*. This will challenge you to find a *composition within composition*.

Explore the transitions between sequences to maintain interest in the flow of the images. It is critical that each photo sequence is *diagrammatically consistent.* Use the same diagram for each composition.

A strong, consistent narrative will be necessary to maintain interest. (Fig. 13) Consider the sequences comprising narrative. How well do they flow? For example: All small images that progress to medium that progress to large? Or, one small, one medium, one large...repeat? One still, one zoom, one still...repeat?

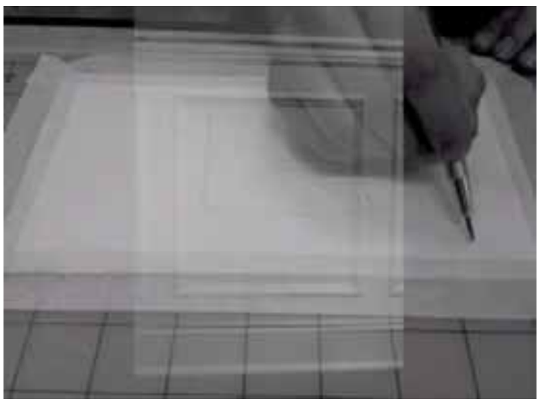


Fig. 13, Image still of drawing process overlaying compositions in the environment. Digital media

Project 3: Color in Motion

In this assignment we will examine various qualities of light and color as they relate to various media techniques. This allows the consideration how each affects our emotions. Color offers a powerful means to evoke mood or change the tenor of a room or space. Certain colors can work in combination with others to bring calm or instill excitement, making it critical for designers to understand its fundamentals.

Drawing Assignment 3: Color compositions

Using a small rectangular format (approximately 1 ½" x 4"), draw and paint gradients (tonal variation) of a single color. For example, red will first have a light tone at the top, progress to medium in the center, ending with a heavy tone at the bottom (avoid the heaviest, densest version of the color!).

As you make these tones pause and photograph the process. (Fig. 14) You might have a colleague shoot one or two sequences while you're drawing. They should demonstrate the logic of a drawing's construction.

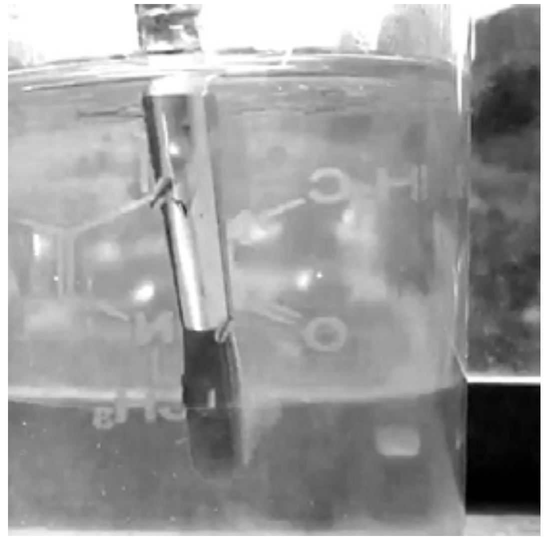


Fig. 14, Image still of the color process. Digital media

Complete this process to illustrate *some** of the following color combinations:

Primary
Secondary
Tertiary
Complementary
Gray scale (using graphite)
Gray scale (using ink + tone of lines)

**The number of combinations will vary relative to the total time of the video. For example, if you can 'produce' four combinations within the 60/90-second limit, this will suffice. If you can do five then do five. Again, the total number of combinations will vary relative to how long your sequences will be. The grading criteria will result from the quality of the drawings in combination with the narrative of the video. Can you tell a story with color? (Fig. 15) For example, you might create a video by drawing on separate pages a single red, yellow and blue gradient.*

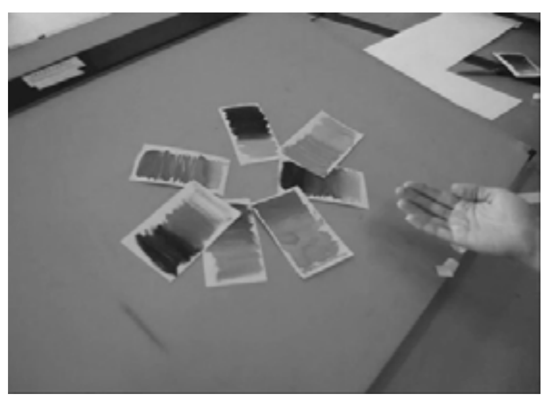


Fig. 15, Image still of color studies. Digital media.

Video Assignment 3: The World in Color

Initial drawing and watercolor studies offer a means to find similar combinations in the environment. (Fig 16)

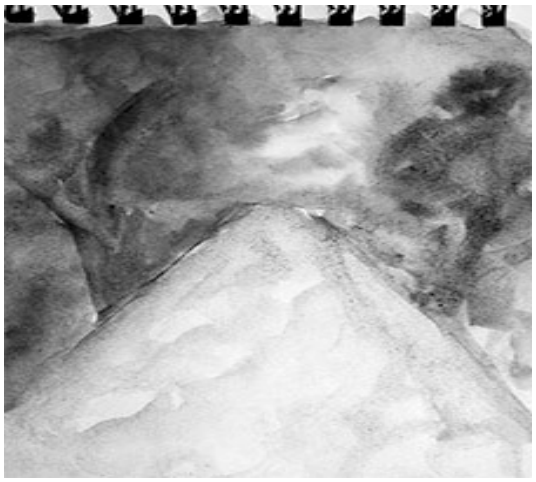


Fig. 16, Image still depicting a quality of light. Watercolor, graphite on paper.

Find and shoot similar examples in the environment (at any scale). One might shoot a light red object, a medium red object and bright red object. Or, perhaps, shoot the same red object in low, medium, and bright light, trying a time-lapse app. (Fig 17) Repeat the sequence for blue and yellow. Combine the drawing images with physical examples to create a Primary Sequence.

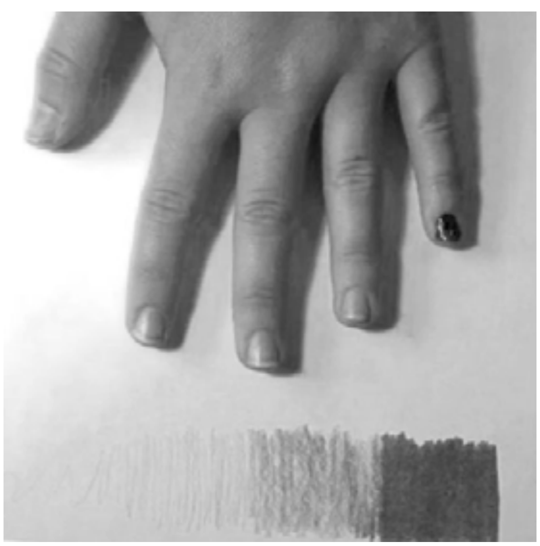


Fig. 17, Image still illustrating compare and contrast color variations (fingernail polish mimics the color combination). Digital media

Project 4: Volumes in Section

A *cross section* is an odd drawing. Unusual and quirky, it depicts an abstract idea. One never sees a section through a building. Its' value is in how well it describes the interaction of volumes, rooms, planes and light. (Fig 18) The reason we appreciate and respect a well considered section drawing is that it gives, perhaps, the clearest indication of a rich and vivid imagination. Architecture results when a section intersects with pragmatism to create a place where reality rests comfortably with dreams.

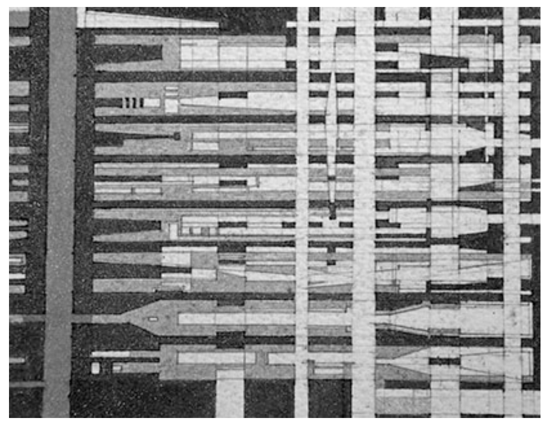


Fig. 18, Prototype image study diagramming sections through industrial buildings in in Appalachia. Pen, ink, watercolor, marker and graphite on 150lb watercolor paper.

Diagrammatic, analytic images offer a very fast means to visualize space. This work can then grow into three dimensional objects and space.

Drawing Assignment 4: Volume Composition

Axonometric and isometric images are a fast way to first see a shape or form. Working from a vertical line (always perpendicular to the bottom edge of the paper), extend parallel lines into space at fixed angles-the combination of which determines the title, such as Isometric always being @ 45º. (Fig 19)

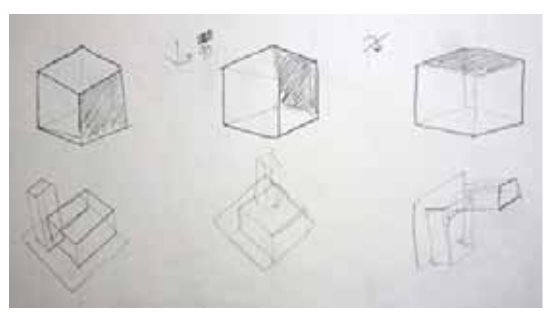


Fig. 19, Axonometric studies, ink and graphite on paper.

Make a series of drawings exploring compositions of cubes and rectangles.

The genesis of a section is a cut. For designers, it mostly imagines a slice through a hollow container but it can also describe a cut through building materials.

Video Assignment 4: Shaping Space and Form

1 Purchase two sheets of gray or black heavy paper (Canson or Strathmore) or the thinnest sheet of chipboard and cut into various pieces as per handout.

2 Fold into rectangular or cubic volumes. This will result in 18 shapes, 9 will be 1 ½ x 1 ½" x 1 ½" and 9 will measure 1 ½ x 1 ½" x 3". After folding, tape the inside to close the shape.

Stop Motion: Set the camera at a fixed location (or approximate the point of view and have a colleague shoot) as you make the cuts and folds, shoot periodically. (These shots will form the beginning of a three dimensional exercise).

3 Cut from a single ply sheet of chipboard a 9 " x 9" square and draw a 1 ½" grid using ink (felt tip pen). This will be the *Site.* (Figs. 20-23)

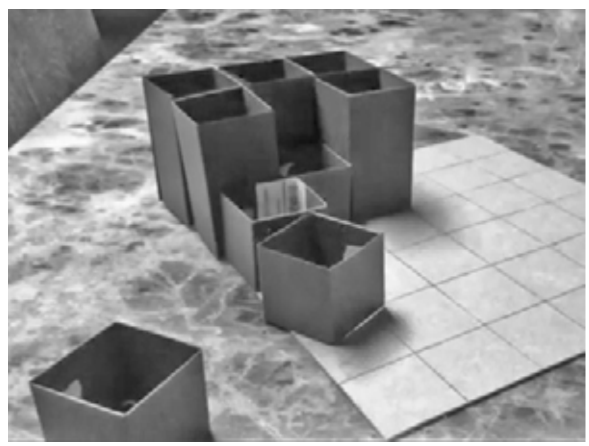
Figs 20-23, Stills from video of composition variations as they change. Digital media

Asymmetry/Balance
Emphasis of a Corner
Asymmetry/Balance
Sound

Do not use music for this assignment. Instead, imagine acts of cutting, moving, stacking and sliding. What do they sound like? What are the sounds of building? Given that the section is a fragment of a vivid mind, so too is *its* sound. Loud and soft, fast and slow sounds offer perceptual cues that heighten visual experience. For example, watch a movie with muted sound. An ambulance with no siren offers considerably less anxiety than one blaring down the highway.

During the video presentation explore tempo, speed and rates of composition to give interest and variety to the composition. Ask, "What devices make cutting sounds?" (Figs. 24)

A knife; a saw; a laser; cutting torch or a tear? Or, more specifically, a butcher knife; pocket knife; razor knife; or butter knife? Or, perhaps, a table saw; masonry saw; hacksaw; and band saw? Does their loudness assist, deter or create interest? Capture ambient sound, cutting, snipping, folding, and stacking to reinforce the actions in the scene.



Figs 24, Still from video of a composition variation as it changes. Digital media

Conclusion

Beauty emerges from an often painful, yet liberating desire to find elements of the human heart dwelling outside our common contentment. Drawing is a remarkable way to enable this search and define a territory binding the past, present and future into one volume. Technology is, too often, overwhelming the processes of making architecture. Now, it is far too easy to *not draw* and, instead rely on the power of the machine to represent an idea. The fatal flaw of this scenario is the loss of those delicate tracings that ultimately breathe life into inert materials.

Yet, the marvels of the machine enable the realization of shapes, forms and spaces never before possible. The challenge is to find ways, methods, techniques or processes that bring the gentleness of the hand in contact with calculating indifference of zeros and ones. There is no right way, better way or easy way to coexist. The only true way is to draw first and then allow the machine to have *its* way, whatever that may be.

Notes

[1] Le Corbusier, *Towards a New Architecture*, trans. by Frederick Etchells. (New York, Praeger Publishers, 1960).

Figures

1 Photo used with the permission of the University of Tennessee, drawing by Emily Lange.

2 Photo and drawing by author.

3,4 Photos used with the permission of the University of Tennessee, drawings by Anna Katherine Biggs.

5,6 Photos used with the permission of the University of Tennessee, drawings by Blake Kotti.

5 Photo used with the permission of the University of Tennessee, drawing by Emily Lange.

6 Photo used with the permission of the University of Tennessee, drawing by Emily Lange.

7 Photo used with the permission of the University of Tennessee, video by Carter Daniels.

8 Photo used with the permission of the University of Tennessee, video by Carter Daniels.

9 Photo used with the permission of the University of Tennessee, drawing by Emily Lange.

10,11 Photos used with the permission of the University of Tennessee, drawings by Blake Kotti.

12 Photo used with the permission of the University of Tennessee, video by Mary Pruitt Smith

13 Photo used with the permission of the University of Tennessee, video by Mary Pruitt Smith.

14 Photo used with the permission of the University of Tennessee, video by Kara Williamson.

15 Photo used with the permission of the University of Tennessee, video by Erin Lynch.

16 Photo used with the permission of the University of Tennessee, video by Blake Kotti.

17 Photo used with the permission of the University of Tennessee, video by Meredith Graves.

18 Photo and drawing by author

19 Photo used with the permission of the University of Tennessee, drawing by Blake Kotti.

20-23 Photos used with the permission of the University of Tennessee, drawings by Christian Torbett.

24 Photo used with the permission of the University of Tennessee, video by Kimberlee Ballard.

Into the Fold:

Introducing New Projects to Faculty

Kerri Frick, Manuela Mariani, Lee Peters

Boston Architectural College

The New Foundation

Beginning in the fall of 2012, the BAC began piloting new foundation studios aimed at guiding students through a generative design process that was also less figurative in the conception of ideas. The foundation studios were remade in order to create a new *foundation program* that directly addressed the needs of students from all the disciplines the school serves; architecture, landscape architecture, interior design and design studies. The nature of this endeavor will be presented through the discussion and introduction of one short, three week project.

Pedagogical Discussion

The goal is not to simply learn techniques and then apply them, but instead to understand them in order to subsequently transform them[1]

The new foundation program marks a pedagogical shift in the way we teach beginning design. The iterative process was always at the heart of our pedagogy; however, frustration was mounting in response to figurative work that was the representation of an idea, rather than the idea itself. We wanted to shape a project that engaged productive making (and failure), promoted a growing design conversation, and helped a student see how making can generate sophisticated ideas such as operational logic.

We adapted the first project from the first year design course at the *Eidgenössische Technische Hochschule Zürich*. (ETH) This well-written pedagogy of foundation design was of particular interest to us. The project consisted of:

Starting with an 11x17 sheet of paper with a wiring diagram printed on its surface, students will execute a series of operations such as folding, cutting and re-joining to create volume out of the flat plane. (fig. 1)

The sheet of paper and diagram defined a common 'site' for the class that the students needed to translate into their own logic and reveal intentions. We transformed the ETH design problem, which requires thinking about a dream space and applying adjectives to the spatial construct, and exchanged the dream-space metaphor with a toy marble. The new assignment is to manipulate the printed-plane through a series of cuts and folds to move a marble in a purposeful manner. (fig. 2)

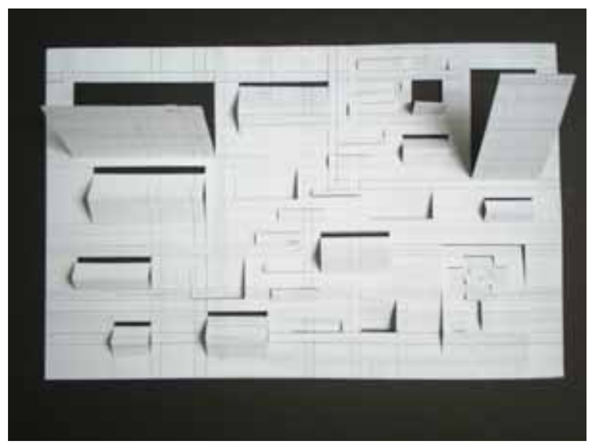


Figure 1. BAC Student: Abigail Pleiss

Why did we start with a project from another school? We needed an outside project to focus the attention of the stakeholders; the Heads of the schools of Architecture, Landscape Architecture, Interior Design, and Design Studies. We needed to engage them as critics by removing personal attachments to existing design projects and challenge their pre-conceptions. During this time, the foundation team had to learn to manage the competing interests of the school leadership, and did so through our own applied design exercise involving research, innovation, iterative process and open critique.

School Structure and the Process of Innovation

The Boston Architectural College was established to provide evening instruction to working architectural draftspersons. The school's founding traditions extend to the present and its DNA sets an integrated relationship between practice and education. It has always relied on the service of Boston's own architecture firms where architects and junior employees extend the design conversation into the evenings for educational benefit.

It is likely that some design educators reading this developed their first teaching experiences with the BAC.

The school has evolved through a recent 15-year growth and established several new disciplines in spatial design. Likewise, the personnel structure evolved from an alliance of firm employees to an expanded and organized governing body of educators.

While traditional schools have been shifting to employing adjunct teachers more and more, the reliance on working professionals to teach part-time has always been the BAC culture.[2] The school's mission and curriculum are managed by a team of full-time directors who enjoy direct involvement with adjunct instructors and students.

Heads of Schools

The educational body is a hierarchical framework, but with plenty of vertical interaction among its constituents. The Heads of Schools assume responsibility for the program definition and success, while the directors advise the Heads through strong connections with Adjunct

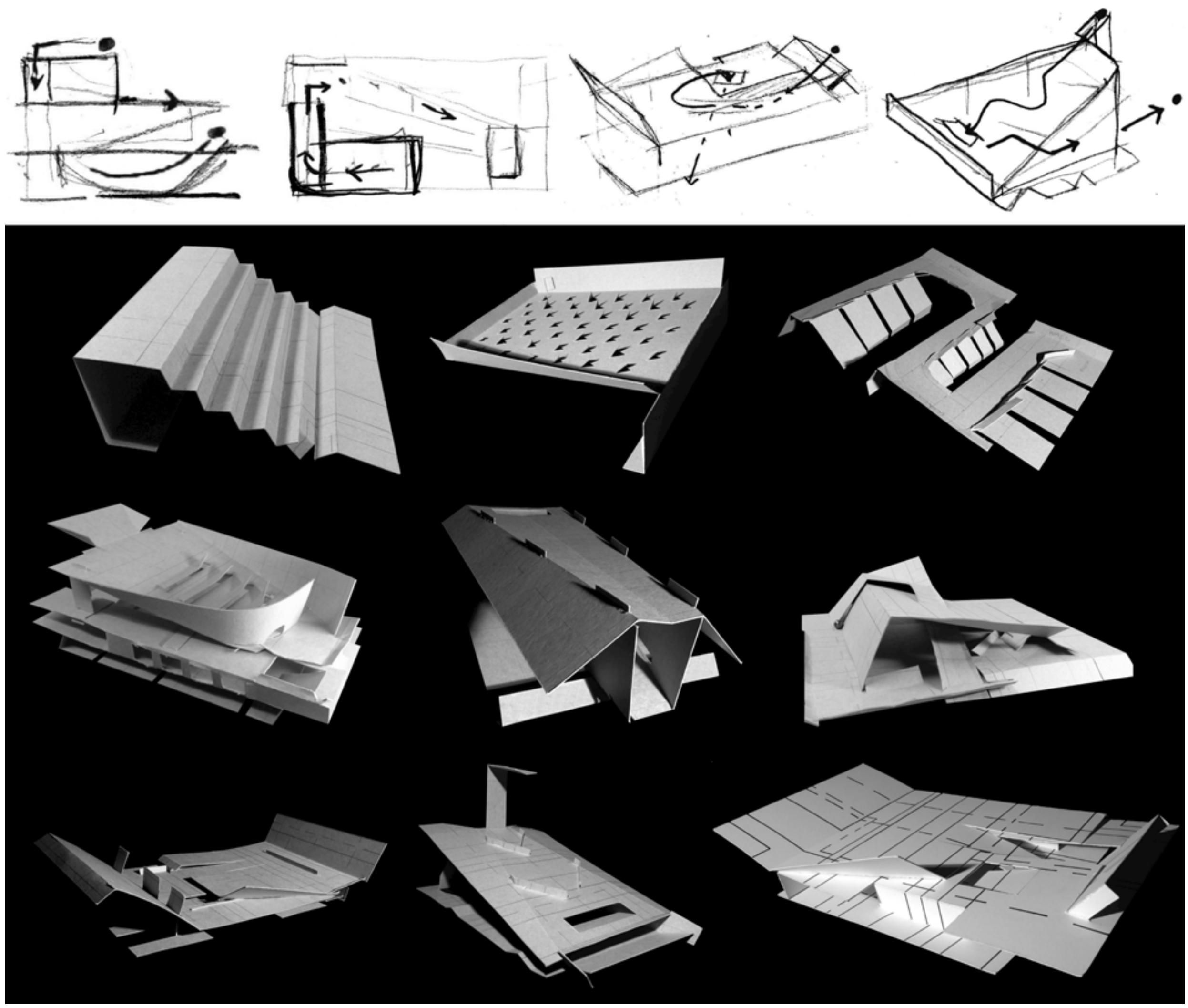


Figure 2. BAC Student: Cameron Christopher

Teachers. While the organization chart might define boundaries, the boundaries are crossed regularly: heads and directors all hire faculty, teach and supervise the curriculum. The teachers are encouraged to share their voices over issues small and large.

While all colleagues at the BAC seek unbounded interaction to develop students given the constraints of the BAC's limited contact hours with students and faculty, there are moments when the heads have to assert authority.

Curriculum Design by Committee

The curricular redesign began as series of engaging meetings that invited participants to think deeply about the kind of student the BAC wanted to produce. This process stretched out over years and the meetings about the new foundation began to languish in generalities. A moment came upon us when the circular conversations about design learning had to find a new path. We had to move beyond list-making such as 'learning goals' and 'upon graduation students will understand'. And with the new path, the heads of schools set a frightening deadline.

The school heads were in agreement that a shared foundation experience is fundamental to the mission of an open admission design school. The new disciplines had been added without reconsideration of the shared foundation curriculum. The new curriculum would be defined by all of the stake-holders. They all agreed that there are basic skills that need to be taught; however, there was much disagreement about how to teach these skills. Individual curriculum designers were drawing largely upon personal educational experience. We put the ETH project forward (a third party) mentioned earlier, to both guide critical discussion and remove personal investment.

The Foundation Program Director at the time, Chala Hadimi, applied the design studio model of performance, presentation, and critique to the curriculum design. The curriculum designers and heads of schools tested the assignment with folded planes, wiring diagrams and a toy marble. At the end of a few minutes, each person presented their own design responses to each other.

Instead of critiquing the individual work, we critiqued the assignment. Each of the disciplinary Heads had their own view of the project. Through the assignment they were able to define their position and themes developed in their schools for the benefit of the curriculum design team rather than conflicting over assignments. The ETH project focused the curriculum designers.

The project drew out some core principles for the different disciplines that would be developed in the studio. The principles are still fluid, but a focused set are now integral to the discussion. These are:

- Moving beyond form/adjective based approaches to design, eliminating the metaphor in favor of generative approaches
- Promoting the role of research as a design generator, which may include testing ideas
- Developing problem solving skills
- Empowering making as a creative process
- Developing understandings of spatial composition, seeing volumetrically and applying logic or order (fig.3)

The folded planes/marble project functioned as a touchstone for agreement. It maintained openness to interpretation with the right amount of constraint to promote creative development and learning.

We regularly reminded ourselves of the disciplinary common ground in the design education. But, a fundamental difference between the disciplines was the scale of medium. If interior design develops thinking from the body outward, landscape architecture works in a distributed and widened field. The project drew the scales into flexible interpretation.

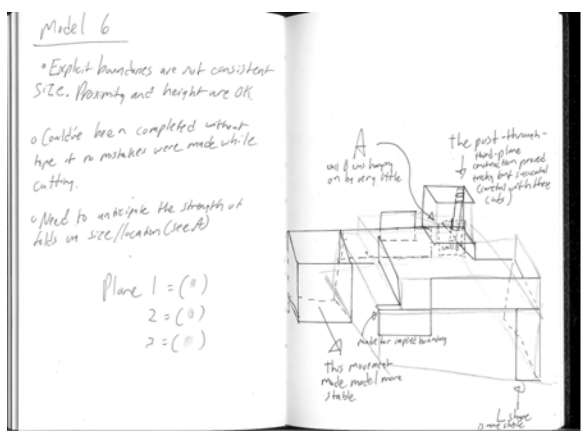


Figure 3. ETH derived. John Poillucci - Folding and Operation studied in sketchbook.

Innovation with Adjuncts

As the school leadership performed a hands-on test of the new design project, we used the same event to advance the project and its themes with our adjunct teachers. The teachers all tested the project as a group. The event worked to draw out their excitement for design teaching and their concerns while underlining the new curricular themes for the course and program. With the project in hand, we were able to have both a rich and focused meeting. Consternation was mixed with appreciation for inclusion. Each teacher had a different reaction personally, but the group's mood toward change was positive.

We have found that our adjunct teachers like to be informed and involved, but with reasonable demands on their time. We introduced this exercise also as an invitation to help us develop this project.

In the project introduction meeting, we had the teachers fill out a form to prepare them for the focused meeting, then for our use after as meeting notes. We had them respond to these prompts:

- Clarifying Questions
- Marble exercise reaction
- General Thoughts
- Reflection notes

The instructors' reactions were mixed, some were unsure how the project would become more than a path, but were excited to help work out the details. Others fell back on defending the credibility of former projects, while others felt this pedagogy fundamentally at odds with their own teaching philosophy.

We divided the teachers into teams and had the teams work on developing handouts for this short, three week project. All handouts were shared amongst the teams and all were invited to revise as they wished. It was interesting to see how different teams interpreted the movement of the marble on the plane. Some key ideas began to emerge:

- The number of actions/reactions between marble and plane
- The defining of complexity through tectonic and structural challenges inherent with the number of planes utilized
- The choice of material to be used for the exercise (chipboard, paper, Bristol, cardboard)
- The role of joints or adhesives
- The role of the wiring diagram (fig.4)
- How the designer would organize the system of marble, plane, and diagram into an intention

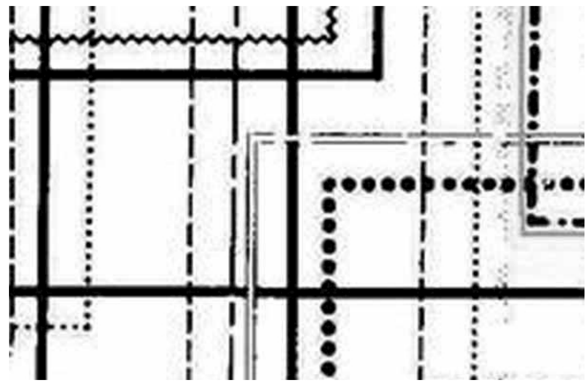


Figure 4: Sample Wiring Diagram

Discussion Outcomes

After the project concluded we reconvened with the teachers and the completed student projects. We organized the meeting using a collaborative assessment protocol shared with us by our former Director of Faculty Development, Tina Blythe.[3] The collaborative assessment led a productive conversation among an outspoken faculty. We used the process to undo defensiveness in favor of drawing out ideas. The protocol begins with teachers making observations about the work without interpretation or judgment. Then, the teachers are invited to ask questions about the work, but the subject instructor does not respond. Next, the teachers speculate about the student's intent, and finally the instructor is invited to present the work as she sees it, may answer questions brought up earlier, and provide any other clarifying information.

The meeting notes generated were valuable in sharing thinking across the faculty. The faculty could refer to them later, and it focused the learning evident in the student work. Through looking at the work collaboratively, the teachers were able to see the successes and challenges brought on by the project.

One evolving question is what is the agency of the marble? Should the action of the marble suggest how the next iteration evolves, or should the instructor request particular actions such as stop, slow down, change direction? How does each approach affect the kind of work a student produces?

The role of the wiring diagram was the topic that divided teachers the most. Some let the wiring diagram fall completely away over the course of the project, while others encouraged students to re-interpret the lines as a key to reading their models, not as a guide for making.

The Evolving Project

Most teachers saw immediate improvements and reinforcement of overall foundation studio goals, but also hoped to continue evolving the projects. The first delivery of the assignment began the feedback loop as the teachers anticipated results for the project based on actual projects over what was projected in our initial development.

Making & Independence

Given that this is the very first course of design studies these students encounter, the tone of the course is set in the first hour with making exercises that promote trial and error and stimulate natural tendencies of ingenuity. The problem to be solved is right in front of them, and the students are agents in the solution. The teachers see how the students receive immediate feedback from the marble, helping them to feel more control over the medium.

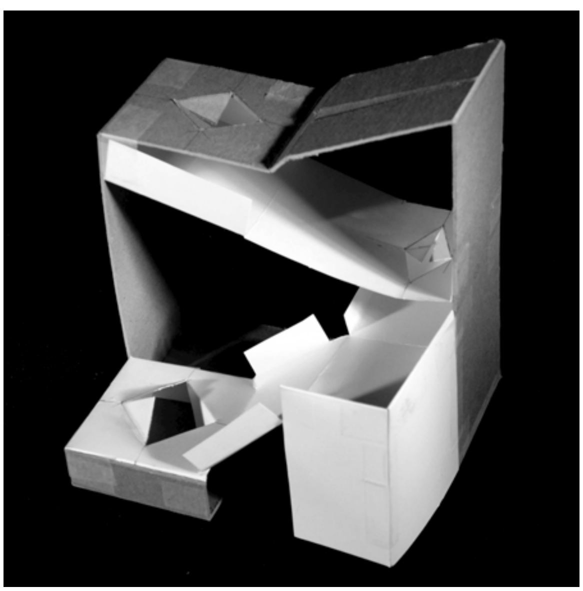


Figure 5. BAC Student: Jonah Prada

Teachers find that students are able to move beyond the given wiring diagram into an independent idea that comes into focus through iterative testing. The project itself sets forth generative thinking and designed metaphors appear less frequently. The project helps students interpret their making over an external compositional term.

Design Thinking

Iteration and agency are at the center of the project because of the immediacy of paper, hand-folding and free-rolling marbles. In real time, teachers hold reflective discussions in the midst of the design process. Reflection is presented as part of the iterative process and incorporates goal-setting and re-evaluation of the design problem.

Without the limitations of the designed metaphor, the teachers can directly lead the students through a new visual and verbal vocabulary. Students are discovering a shared interpretation of visual relationships, space and operative making. In the progression of the work, tectonics is uncovered as process of making and performance. Ordering principles and internal logics are brought out through careful study of their work.

Concerns to Address

There are trends and categories of projects that may be working against the course goals. For instance, a number of projects in a studio may be called the ‘tower’ or ‘chutes and ladders’ (Fig. 5) where the project’s identity is reduced to a single descriptor. The concern here is that a student is favoring a successful and guaranteed movement of the marble over ideas like internal logic, material qualities of the plane, a variety of interactions between marble and plane. There is danger in merely solving the problem, without a critical evaluation of their design logic.

The project is only the first of three in the semester. Our goal is to better connect this project with the ones that follow. We plan to take this up with instructors next.

Conclusion

The monumentality of a curriculum re-design and the presumption of high-stakes make it a difficult task to execute. It is easy to get caught in a cycle of asking big-questions and generating reams of material that lack the information and direction to design the projects that we want students to produce. It is also difficult to build consensus without a framework for discussion.

Starting with a third party project and using the shared process of production, presentation and critique, we built a framework for us to gather consensus and set goals for the foundation studio. Our generous faculty helped us to refine the project development and implement our learning goals within the studio.

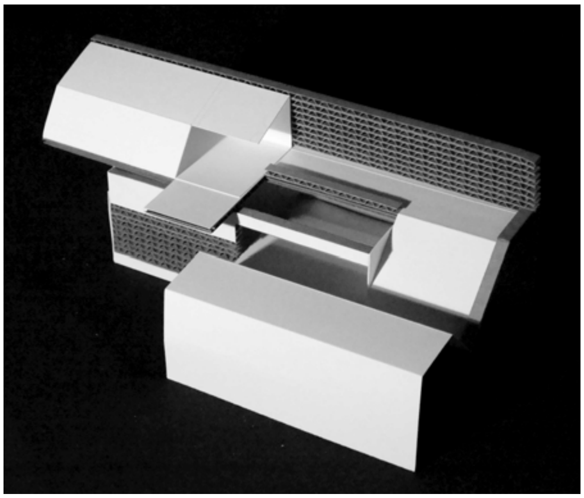


Figure 6. Zoe Nemetz

Notes

[1] Marc Angélil and Dirk Hebel, *Designing Architecture: A Manual.* Basel: Birkhäuser, 2008.

[2] Kezar, Adrianna, and Daniel Maxey. "The Changing Academic Workforce." Association of Governing Boards. Trusteeship Magazine, n.d. Web. 26 Jan. 2014.

[3] Tina Blythe and Associates. *The Teaching For Understanding Guide.* San Francisco: Jossey-Bass, 1998.

Art in Beginning Design:

Color Space, a Romance of Painting and Architecture

Henning Haupt, PhD

Florida Atlantic University, School of Architecture

The interdisciplinary relationship between art and architecture can be demonstrated by considering color and space. This paper emphasizes an argument that is based on selected historic, contemporary and theoretical approaches to understand color in art and architecture and to describe the significance of beginning design education today.

Cézanne - Color Space

The journey of the French painter Paul Cézanne follows a path from representational painting to the use of "color per se." Cézanne painted only the color itself, neglecting representational means of perspective. The colors in his paintings of *Montagne Sainte-Victoire* 1904–1906 (Fig.1.) are thick, heavy chunks of oil paint that build a visually interwoven, spatial composition on the canvas. The color accumulates a spatial illusion perpendicular to the painting plane – the color space.

Fig.1. Paul Cézanne, *Montagne Sainte-Victoire*, 1904-1906

Other artists in various forms of abstraction continued the use of "color per se" or film colors, which are colors with little or no context information such as perspective means. The use of film colors, colors as observed through a long pipe, sets a condition to perceive the qualities of color space more obviously than in object colors that are connected to other object information such as context, texture, etc.

Kandinsky - Psychological Color

The painter Wassily Kandinsky taught at the Bauhaus from 1922 to 1933. In *On the Spiritual in Art: And Painting in Particular*[1] Kandinsky writes about the spatial expression of color contrasts, visual space and movements of colors and the emotional relations evoked by colors (Fig.2.)

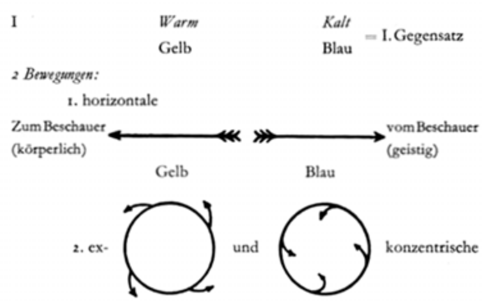


Fig.2. Wassily Kandinsky, *On the Spiritual in Art: And Painting in Particular*, Diagram on the visual, spatial movement of colors on a surface

Kandinsky tried to find rational arguments for the relationship between color, form and space to support the Bauhaus ideology of building "good form" by developing quantitative reason for the choice of "good color." Kandinsky undertook a survey among students and faculty at the Bauhaus by asking them to relate the primary colors red, yellow and blue to circle, square and triangle. The idea was that a majority would vote for the same combination – e.g., a triangle should be yellow, a circle red, etc. The thesis did not prove itself. Nevertheless the combination of form, color and emotional reactions was extensively discussed in Kandinsky's paintings. In continuation of this discussion the foundations for a pseudoscientific reasoning was established that used the relationship between color tone and emotional reaction as the primary argument to choose color tones. The relation between color and emotional reaction, the "psychology of colors," became the quantifiable, modern reasoning for "good choice of color" in architecture based on a generalized emotional reaction of a white middle European man to colors.

Heinrich Frieling[2] published The Language of Color in 1939 as a handbook for the appropriate implementation of colors in functional design following psychological reasoning. The base was his psychologically based "theory" that would justify color choices on a collective color appreciation. In order to define a collective color appreciation Frieling valued highly the biologically based arguments for color perception and appreciation (Fig.3. *Pyramid of Color Perception*, biological reaction on the widest side of the triangle). Red fruit, for instance, alerts animals to its edible character (there are many examples in which red alerts animals or human beings). Civilization inherited red as a color that alerts. In contrast, Frieling's "theory" states that culturally coded appreciations and personal preference of color has less value and impact in shaping a collective color appreciation (see diagram Pyramid of Color Perception, personal relation on thin tip of the triangle).

This evaluation system for color appreciation allowed Frieling to describe generalized color appreciation that serves the modern, positive design agenda. Frieling's handbook established

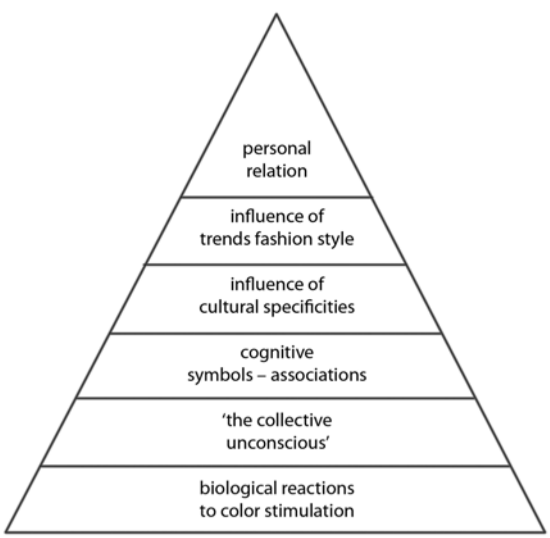


Fig.3. Heinrich Frieling, Pyramid of Color Appreciation

color schemes in relation to the use of a space. This is a confirmation of color conventions justified through generic emotional reactions and functionality. New editions reflected changes in new taste and style[3]. The most recent edition was published by his followers in English in 2007: Color: Communication in Architectural Space[4].

Le Corbusier - Architectural Colors

The purists in France, Le Corbusier and Ozenfant, had a different approach to color. Le Corbusier, both a painter and an architect, developed an elaborate color chart through his personal choice, the Polychromie Architecturale [5]. In this book of color samples the colors are grouped by titles such as sky, velvet, etc., which associate atmospheres that might be evoked as well by the colors. The purpose of the Polychromie Architecturale was to serve as a catalog and a tool to choose colors for clients and architects. A specific frame comes with the book that allows the reader to block out most of the tones on a sample page to specifically view a combination of two to four colors in larger or smaller portions equivalent to larger or smaller surfaces in the building.

Fig.4. Le Corbusier, *Polychromie Architecturale*, open page: ‚Espace'

Le Corbusier did not justify his choice of colors by scientific theories. Instead he relied on his artistic experience, knowledge and sensitivity to choose colors according to a conceptual idea and title. He superimposed the selected colors and ideas for atmospheres on the architectural design of his buildings. The three-dimensional form was designed first and color was added secondarily to enhance the architectural idea. Selected surfaces were painted with a monochrome color to articulate more clearly its role within the three-dimensional architectural composition. The monochrome color on the entire surface of an architectural element, a line, plane or volume, became the "architectural color."[6]

Mondrian - Color Style

While Le Corbusier was both a painter and an architect, the architects of the de Stijl group in the Netherlands relied on the artistic expertise of various artists and architects. The painter Piet Mondrian was a leading figure in the group. Mondrian took a long journey from representing landscapes on canvas to highly abstract paintings. He abstracted the form and reduced the palette to a few primary colors – colors that can be controlled perfectly and that are suited for reproduction and for architectural implementation. This and the collaboration among artists and architects fostered the use of color in space. Each architectural element such as line, plane and volume is separated visually by means of detailing and by color. De Stijl followed their manifesto: “free the color from the easel painting.” Color was placed in space to compose objects, constructions and architectural space in a manner similar to Le Corbusier’s architectural color, although the spatial formation was different. Le Corbusier designed more complete, stereotomic buildings, while the de Stijl architects, e.g., Gerrit Rietfeld, built an additive flow of colorful objects constructing space (Fig.5.).

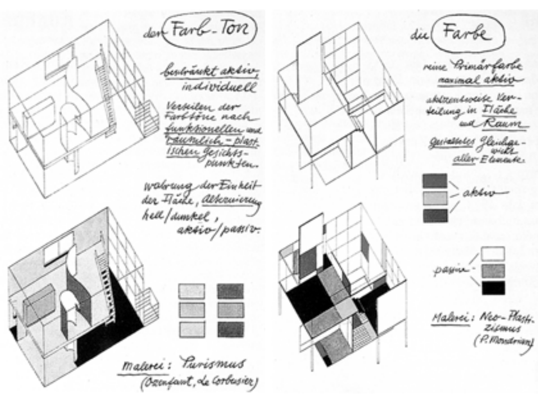


Fig.5. Alfred Roth, Purismus and de Stijl in Analyse der farbigen Oberflaechengestaltung von Raum und Volumen, 1949

The primary colors in these designs used in high values and strong contrasts avoided individual appreciation, undetermined atmospheres and historical or cultural references. These colors were successful and became popular among the avant-garde in a small country with many international connections, ethnic varieties, traditions of advanced technologies and a cheerful monarchy and democratic community. Mondrian’s paintings became a style. Artists, designers and architects collaborated closely in the group de Stijl, promoting their art, design and text in their own magazine, thereby leaving a visible mark on the color choices throughout Europe, including projects designed at the Bauhaus.

Albers + Interactive Colors

After the Bauhaus closed in the early 1930s the story of color and architecture continues in the USA. The Bauhaus educator Josef Albers became a teacher at Black Mountain College and later at Yale University. Albers continued to teach color foundations and focused on paintings. His painting series Homage to a Square demonstrates an organized artistic inquiry. Albers dramatically defined the “factual,” technical production for the paintings, allowing for the relational, nonfactual but “actual” qualities of color to become obviously visible.

By doing so Albers provided a visual comparison of color expression relative to its neighboring color tone as context and delivered proof for the relativity of color as documented in The Interaction of Colors,[7] (Fig.6.) as a grammar for a language of color.

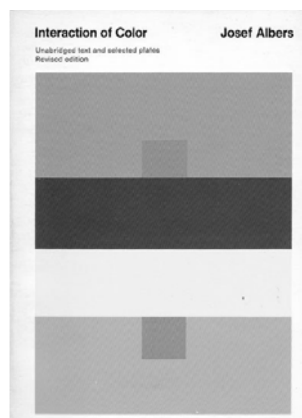


Fig.6. Josef Albers, The Interaction of Colors

The Interaction of Colors also describes assignments for his color classes. Albers relied on and trained the individual sensitivity to perceive colors, understanding that first, all of us see colors differently, and second, we see color differently depending on its context. The red one person sees is a different red than another person might see; red next to green appears differently than red next to yellow. With these propositions students automatically integrated their own, individual ways of seeing into the otherwise regimented process. Albers’ students experienced that the appreciation of colors is relative and that each solution would not be a generic truth, but a specific quality in a specific situation in relation to place, time, cultural tradition and identity.

The Divorce of Architecture and Painting

The colors of the Bauhaus, Le Corbusier and de Stijl were lost for a while. Modern ideas were imported to the United States in 1933 for the exhibit of black-and-white photographs curated by Philip Johnson at the Museum of Modern Art in New York, and the international style was born: white. “Natural” colors of materials were acceptable to introduce more specific atmospheres than generated in a colorless, idealized form. A condition was set for corporate architecture mass-produced for a white man in a correct, elegant architecture worldwide. The branding of architecture as a style excluded colors as much as possible due to their perceptual and historic qualities that may lead to undetermined interpretations. Gray suits in the city during the day and blue jeans on the countryside or at night became the collective choice for the user of corporate architecture. Colors were happening outside of that realm for entertainment, sex, drugs and rock ‘n’ roll, to create the identity of queer being, and in the nonacademic worlds of individuality and emotions. During the 1950s young consumers were offered colors of celebration and the new marketing strategies related to the local Zeitgeist. In Germany, still under the influence of the “good choice of color,” those vibrant colors were critically considered rather than appreciated by the architect’s world and the separation between colors and architecture took off. Over there colors found their way back into architecture through the interest in the historic heritage and the goal of protecting the existing assets. The monument conservators started in the 1970s to excavate historic colors. Those were covered under thick layers of “brown” tones of the 1930 and ‘40s, the colors of the 1950s and 1960s and the post-modern white paint of the 1980s. Conserving architectural heritage like the Papageien Siedlung in Berlin by Bruno Taut presented the power of color to inhabitants and architects as it was for the first time. The conservation projects set precedents. Architects considered color again and even hired artists and “colorists” to add individuality, identity and diversity to the cities.

The divorce between art, painting and architecture allowed the genres to develop in different directions. In contrast to the development of (corporate) colorless architecture, colors in American art emerged drastically during the 1940s and ‘50s. The American Abstract Expressionists extended modernist abstract painting by including an elaborate integration of materiality and color to generate meaningful space and form on the picture plane. Later in the 1960s Frank Stella employed painting procedures to shape the canvas. His striped paintings (Frank Stella, *Ifafa*, 1964, Fig.7.) present an inseparable connection between the painted illusion on the picture plane and the physical form of the canvas.

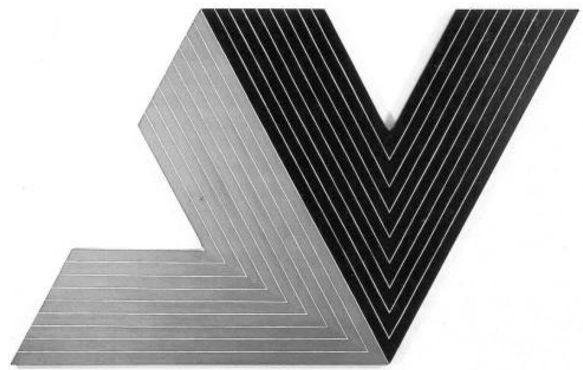


Fig. 7. Frank Stella, *Ifafa*, 1964

Color was once again freed of the easel painting and placed as an (architectural) object in space. In continuation of these results, installations today address procedures of painting and question space. They are, as architecture is, context-related, a context that is changing by location and over time.

Art, Painting, Architecture – a Romance

As the built, social and political context changes, perception changes due to an extended exposure to mediated images. The artistic production reacted to the change of context: newspaper, magazine and later online images became the source for artistic productions. “…from the 1960s and onwards we have seen the development of an immediated painting that presupposes an origin, whether it be the picture world of the mass media or of art history” (Peter Weibl[8]). Following this conceptual frame, paintings since the 1960s relate immediately/directly to imagery, whether the images are those of media or of art history. Nevertheless painting can be understood as a direct relationship of painter, process and result. “Traditional conceptions of painting of art are based on the assumption of a direct relation between colour, canvas and the subjectivity of the artist as the sole mediator.” The viewer may intimately relate to the action of the painter through the observation of the final piece of art.

In regard to more recent painting since the 1990s, Peter Weibl continues: "...paintings were not a reaction to the surrounding pictorial world of the mass media or to art history as mediated by this work, but an attempt to take their effects on painting for granted and overcome them in the very act of painting."

These quotes by Peter Weibl offer a theoretical framework in which painting may find ways to include the changes of technical process and electronic media in procedures and practices. Instead of visual qualities, production processes serve as conceptual points of orientation. Painting questions its form while reassuring painting as a genre. The critical discourse to question oneself from within the field, from the perspective of its own production, opens the chance to renew its qualities.

Another source of an accelerated development in the arts is the crossover between genres: painters build sculptures, sculptors paint, printmakers take videos, artists curate exhibits and art historians make art. In the architectural design praxis the crossover with engineering, design and business is more common, while the crossover to the arts is rare. Art and color are added once the building is completed. Conversely, public space becomes more and more a realm for participatory activities of the arts; the surface of a city is the canvas or screen vitalizing public space, building atmospheres[9] and identity. Artists are invited to celebrate difference, critique and content in the forum on our public spaces. Sylvia Lavin claims in Kissing Architecture: "Today, we need aesthetics to produce new experiences rather than to evacuate them and more forms of interestedness rather than less." [10] Lavin discusses video projections in and on architecture as a kiss between art and architecture. Her book encourages taking the chance that is hiding within the kiss more seriously. Maybe a kiss of art and color turns our sleeping beauty architecture into"Superarchitecture, ... architecture in contact with incommensurable forms of time, movement, and immateriality that coalesce to produce socially enveloping and therefore political effects."

The interconnection with the subject's body and mind with the world and its phenomena serves as a means to understand context in the sense of placemaking and identity. This is an appropriate phenomenological approach, if architecture builds spaces to be experienced by human beings. Painted installations are architectural interventions in which the viewer experiences a phenomenological presence, but the same installation, as a work of art, may question its context. For example, has this space a function? What is the value of this space? Who pays for this work and why? Is this piece to be exhibited in a gallery or museum? Can it successfully work in a public space? What is the market for installation? Maybe a contemporary hybrid building acts similarly. While its functionality changes over time, the architectural qualities such as relation to the site, a spatial idea, form, material and construction act as a lasting, sustainable implementation.

Color and Space

Architecture and painting both build space of colors. To understand the relationship we can identify two kinds of space that are differentiated by two modes of perception. One is the tangible surrounding such as the physical, architectural space that is measurable and built out of materials such as stone, wood, metal or glass. The other kind of space, the color space, is the visual phenomenon perpendicular to the picture plane or on any surface of a material evoked by colors. Cézanne used the second kind, the color space by painting "color per se" instead of perspectives between houses or elements placed in a landscape. He painted spaces perpendicular to the picture plane between colors. Our perception of these color spaces is a sensing of space. It is not a representation of space through means of perspective. We can see the spatial illusion, yet it is intangible and immeasurable. We project ourselves into these color-spaces and an emotional reaction stimulates an affect that informs us about the space presented. The aesthetics of empathy, started by Wilhelm Worringer,[11] describe this phenomenon as a corporeal perception. It is different from the bodily perception of the first, the architectural space. Here we use our body as a scale and we implicitly understand the three-dimensional physical condition of space. We literally grasp and comprehend (German: 'begreifen') dimensions with our hands or by the span of our arms. These dimensions can be measured and represented in architectural drawings. By means of geometry these measurable qualities became the primary tools for architectural design.

Theoretically the two means of perception are distinct. In our surroundings, when certain criteria are met, we experience color-space and physical space as combined. We relate at the same moment to colors on the wall, to a painting and to the space in which we are standing. Color in architecture is perceived in both ways, as a physical material in space, and as a visual illusion of space. Color can be constructed like a material in space, while its expression relates directly to our emotional consideration.

This emotional reaction is based in the nature of color perception. The frequency of light reflected off a colored surface is measurable. The human eye measures those rays, yet the brain sees color. This seeing is an emotional reaction similar to the perception through other senses like temperature by the sense of touch. Even if two individuals are situated in the same temperature, one might feel cold while the other feels cozy. This coexistence of perceptions surely exists for all materials, yet it is especially obvious in colors. This might be why colors are not included in the list of building materials of our textbooks of design and construction; colors are reserved for the artist.

Theoretically we can differentiate the qualities of colors from other materials, but in the presence of the object, in the room of a building, we relate simultaneously to the form, construction, space, material and color (Simultaneity, Wollheim[12]). The empathic sensing of space and the measuring of a distance by our body are combined in our experience. Within this experience, the terms of aesthetics are juxtaposed with the rules of geometry in comprehending the design of a three-dimensional construction. When we pay careful attention to the constructed color in installations or architectural space and become aware of our emotional reactions to them, we begin to appreciate the color and color-spaces as parts of the physical design. Corporeal perception, bodily perception and the ratio of our mind together allow for a multilayered, highly relative and individual appreciation and consummation of the spatial color design. The individual consummation takes place in a self-directed motion through space; the viewer of the color spaces is invited to engage personally. " ... involvement is a dominant mode of reception in installation art as it is usually based on an ambition to awaken the viewer's awareness of embodied perception. Involvement in the 'here and now' of the work directs the viewer's attention to his or her bodily performative navigation through the space of the installation." (Anne Ring Petersen)[13]

This performance in space, the personal movement and the individual consummation bring us to the acknowledgement of other individuals or groups preforming as well in the same space. The agreement for inhabitation and use of the space sets the base between groups to build a community. The interaction of individuals in space relates to the physical, tangible qualities of space as well as to qualities in the space that are perceived rather than by empathy. With that aesthetics of space plays a role in the formation of a sensitive community.

Color Space Praxis

In architectural praxis the companionship between art and architecture seems vague and rather dominated by architecture. Traditionally the use of color and artistic practices is rare in architectural education. Learning from the historic precedents we have to place our teaching of color in a contemporary context that includes the relation between meditated information and immediate appreciation of color. This relates to the stretch between a global access and a local identity of color. In the classroom this juxtaposition between mediated and immediate offers the chance to work theoretically and digitally, while employing hands-on experiences to sensitize students' minds and crafts through the immediate production. For teaching color in architectural terms we should include the three-dimensional perception and appreciation of space, color and color-space.

As faculty (painter teaching architecture) I had the chance to craft a class first at the Technical University in Braunschweig, Germany, while working on a dissertation on the same topic and later and currently at Florida Atlantic University in Fort Lauderdale. Theory, results and class outlines are previously presented at NCBDS conferences and published in the proceedings: Henning Haupt "Relative Dimensions of Architecture – Colors in Architectural Education" (NCBDS 2013, Temple University, Philadelphia, PA) and Henning Haupt "Color in Making" (NCBDS 2010, UNC Charlotte, 2010). The class is one example of integrating artistic praxis into the architectural design process as a color-space praxis that combines painterly and architectural design methods. It includes creative thinking and creative production and guides students through a production of results in a mostly hands-on process.

The five basic components of the class assignments lead from sensitizing students to color and its application to architectural construction.

- Painting of chromatics (including information on film and area color, color-space perception, color materials, application techniques)
- Drawing of gestural lines (including line quality, movement of hand and body, proportions)
- Construction of two- and three-dimensional objects (designed in relation to the intangible qualities of previously developed two-dimensional color-space compositions)
- Installment of architectural interventions (the larger scale integrates the movement of the user, including shifting temporal and spatial perspectives and drifting points of view leading to performative qualities)
- Context (location, semantics of color, form, space and functionality related to place and time)

The class is usually structured in compact (weekly) assignments. Students in their foundation years are guided through small steps to learn. Nevertheless the relative qualities of color and its discussion in terms of aesthetics, instead of functionality, practicability, etc., opens the discussion to a larger picture of the creative process and the implications of its results. This class is well suited in the foundation years to integrate the awareness and consideration of relative arguments throughout a student's education. It offers chances for the student to discover personal preferences and abilities early on to choose appropriate majors in the art and design field.

Conclusion

Colors are not only relative and affective but also culturally coded (location, tradition, collective conventions, individual appreciation) and gender-related; they exist in relation to a sociocultural context of time and place. Architecture of color is a physical construction of atmospheres as a product and result of sensing and knowing in context. The Color-Space Praxis class attempts to train the individual "intuition" in relation to specific conditions of a project to provide for the interaction of color and space. This approach challenges students to include the phenomenon of color-space as an aesthetic argument for architectural making.

The color-space praxis is a model for strategies that include relational, aesthetic and factual conditions to build constructions. Color could be substituted by other media, but it is suited for education since its qualities are obvious, controversial and easy to implement in a design process. The combination of relational aesthetic considerations and measurable arguments leads to a comprehensive understanding of architectural space and its design. The engagement in conceptual thinking early on in the education includes an awareness of sociocultural codification of color and of all components that construct spaces and atmospheres. In Sylvia Lavin's concept of Kissing Architecture, we might say that color and its artistic process of implementation and consideration is romancing and finally maybe seducing architecture.

Notes

[1] Kandinsky, Wassily. Über das Geistige in der Kunst, 1911 (1912). Bern: Bentelli. 1952

[2] Frieling, Heinrich (1910-1996): Die Sprache der Farben. Vom Wesen des Lichts und der Farben in Natur und Kunst., Muenchen, Oldenbourg Verlag, Muenchen 1939

[3] Mensch Farbe Raum, Grundlagen der Farbgestaltung in Architektur, Innenarchitektur, Design und Planung, München Callway, Birkhaeuser 1998

[4] Meerwein, Rodeck, Mahnke: Color: Communication in Architectural Space, Birkhäuser 2007 (1st English edition of the above)

[5] Rüegg, Arthur: Polychromie Architecturale, (Farbmuster / Farbklaviaturen / Textband), Le Corbusier Farbklaviaturen von 1931–1959, Basel: Birkhäuser, 1997

[6] Braham, William W.: Modern Color / Modern Architecture, Ashgate Burlington, 2002; Jan de Heer, The Architectonic Colour, Polychromy in the Pursit Architecture of Le Corbusier, 010 Pubishers, Rotterdam, 2009

[7] Albers, Josef: The Interaction of Colors, Yale: University Press, 1963

[8] Peter Weibl (Head of Zentrum fuer Kunst und Medientechnologie in Karlsruhe, Germany and Professor of Media Theory at the University of Applied Arts, Vienna, Austria), Pittura /Immedia – Painting in the Nineties between Mediated Visuality and Visuality in Context in Contemporary Painting in context, Anne Ring Petersen (Editor), Musuem Tusculanum Press, Univerity of Copenhagen, 2010

[9] Böhme, Gernot: Architektur und Atmosphäre, München: Wilhelm Fink Verlag, 2006

[10] Sylvia Lavin, Kissing Architecture, Princeton University press, Princeton & Oxford, 2011, page 21 (super arch on 57)

[11] Worringer, Wilhelm: Abstraktion und Einfühlung, Ein Beitrag zur Stilpsychologie, 1907, München: Piper &Co, 1976

[12] Wollheim, Richard. Painting as Art. London: Thames & Hudson, 1987

[13] Anne Ring Petersen, Painting Spaces in Contemporary Painting in context, Anne Ring Petersen (Editor), Musuem Tusculanum Press, Univerity of Copenhagen, 2010

Navigating Nevelson:

The Use of [Specific] Analogy in Beginning Design Studios

Frank Jacobus, Russell Rudzinski, Laura Terry

University of Arkansas

Introduction

In the spring 2013 beginning design studio at the University of Arkansas, Fay Jones School of Architecture, a design process was employed using Louise Nevelson's "Night Zag Wall" as the analogical precedent. This paper discusses the use of analogy as part of beginning design sequences generally, the important rules and limits set by certain analogical precedents, and the specific differences between this new approach and more traditional analogical design methods.

Analogs as Intuition Machines

I go to the sculpture, and my eye tells me what is right for me. When I compose, I don't have anything but the material, myself, and an assistant. I compose right there while the assistant hammers. Sometimes it's the material that takes over; sometimes it's me that takes over. I permit them to play, like a seesaw. I use action and counteraction, like in music, all the time. Action and counteraction. It was always a relationship – my speaking to the wood and the wood speaking to me.[1]
-Louise Nevelson

The use of analogy in beginning design curricula is a substitute for the student's inherent lack of disciplinary intuition, a mechanism to subvert preconceptions regarding formal or spatial outcome, and a conceptual bridge into the discipline built through rich connections to past experience.

Architecture is traditionally thought of as an art *and* a science. The solutions to most, if not all, design problems rely on more than objective reasoning alone. Powerful solutions to the subjective decisions within an architectural project require refined disciplinary intuition. In an article titled "Typology and Design Method" Alan Colquhoun describes the relationship between the objective or functional criteria of design decisions and the subjective choices that must be made in every project. He describes Yona Friedman and Yannis Xenakis as two designers who followed rigorously objective, computational design logics, but who both admitted that they still relied on intuitive, compositional decisions for final resolution. [2]

When an artist like Louise Nevelson describes her working process, as in the quote above, it is evident how much intuition plays a role in her ability to make decisions to advance the work. This intuition is born from years of experience, trial and error, and a long existence with the work itself. The use of analogy in the beginning design curriculum acts as a substitute for the student's lack of disciplinary intuition. The analog itself provides a "measure" for those subjective aspects of the design process that are not measurable. Although a seasoned architect may rely on past experience to solve for the subjective parts of the project, the student has not yet developed a disciplinary toolkit. The analog, therefore, becomes a formal or spatial precedent that stands in the place of disciplinary knowledge, and accounts for those parts of the project that would have relied on an abundance of past experience. In this way, analogy becomes a form of measure in that it provides causal relationships that do not inherently exist within the project.

In addition to the above, the use of analog in the studio becomes a constraint for the students that helps subvert preconceptions as to what architecture should be. Most of the students at the University of Arkansas have grown up in suburban or rural areas and do not have opportunities to visit a rich variety of good architecture prior to the beginning of their studies. Because of this the students tend to gravitate to the buildings they know as precursors for the architecture they *think* they should be creating. The use of a precedent analog, such as Nevelson's "Night Zag Wall", subverts this tendency toward preconception, injecting constraints that the students have to contend with in their search for a formal idea.

Finally, the use of analogical reasoning within early design curricula has the power to connect students to a world in which they've likely already developed some form of spatial expertise, be they state champion tennis players, expert computer programmers, or excellent musicians. It is incumbent on teachers to find approaches that tap into a student's pre-existing knowledge and make connections between it and architecture. Analogical connections with a student's lived experience act as pedagogical devices that engage personal memories that mitigate the abstraction beginning design students face when they are challenged to think about architectural space for the first time. By using this approach, spaces existing outside of architecture become fertile ground for architectural inspiration. This approach has the potential to transform the "non-architectural" world of space that the students continually encounter outside of the architectural realm into a generator of architectural ideas. In this case the world at large becomes a learning instrument for architectural design.

The human brain is an analogy machine.[3] In their book entitled "Surfaces and Essences", Douglas Hofstadter and Emmanuel Sander state that in "every moment of our lives our concepts are selectively triggered by analogies that our brain makes without letup, in an effort to make sense of the new and unknown in terms of the old and known."[4] We are constantly at work using prior experience analogically in an effort to situate ourselves in the present world. What this means for beginning design students is that they will be conceptualizing the litany of new information about architecture through the use of information gained through their past experiences. The use of analogical precedents in the design studio helped build a foundation for intuition in their future design efforts.

Analog as Filter, Rule, Limit

Leon Battista Alberti in On Painting stated, "When you practice, always have before you some elegant and singular example, which you imitate and observe."[5] Alberti suggested that it is not the subject that matters, but the singularity. A single idea or painting or object allows one to filter out unnecessary elements. For this studio, "Night Zag Wall" by Louise Nevelson is the singular focus of a series of projects ranging from analysis, collage, and print- and form-making. The Nevelson work is an ideal precedent because of the array of principles of architecture inherent within it: part to whole relationships, rhythm, repetition, anomaly, harmony, and ordering systems.

Alberti uses painting to make an argument for why painting should be the foundation for all studies in art, including architecture. He states, "…painting is composed of circumscription, composition and reception of light."[6] Alberti continues, describing the precision with which the outline (circumscription) must be drawn, and that no painting, regardless of its composition or light is a good painting unless the artist is also facile with drawing. By this measure, Alberti is advocating for discipline, stating, "To this, I insist, one must devote a great amount of practice."[7] Nevelson echoes this when she states, "without drawing, you wouldn't do anything."[8] As for composition, he writes, "I say composition is that rule in painting by which the parts fit together in the painted work."[9] In Nevelson's work, the part to whole relationship is the rule. For the beginning student, the work becomes an ideal study in ordering systems, the relationships between parts and composition.

Alberti stated, "When we wish to put into practice what we have learned from nature, we will always first note the limits to which we shall draw our lines."[10] Limits and rules link Alberti with Nevelson across 400 years. Artists and architects have used limits to ground their work, and as educators we use order to ground the design studio. Order is the subject. Through carefully designed projects, students understand the power of order within "Night Zag Wall." And this is why the Nevelson work is ideal for the beginning student. To them, it is a work of art, something that exists outside of "architecture" as they know it. But when they delve into the piece, into the act of dissecting it, they discover a series of applicable architectural references: part to whole relationships, ordering systems, dualities, and anomalies. More importantly, the students author the discoveries, and deepen their investigation, the more they discover.

The last of the three components of painting described by Alberti, reception of light, is where Nevelson's work aligns most explicitly. Nevelson has described herself as an "architect of shadow." She has been quoted extensively regarding the use of black, and she has stated that by painting the materials black she "cancels out their former identity."[11] But more so, she is limiting her palette, and as a result, the formal qualities of the objects become spatial and volumetric receivers of light and shadow. Alberti writes, "When you know it well, with great restraint you will commence to place the white where you need it, and, at the same time, oppose it with black.

With this balancing of white and black the amount of relief in objects is clearly recognized.[12] By denying all other colors, Nevelson set careful and particular limits for her work.

These two artists share a common principle: the power of limits. For beginning students, limits are seen as a negative. Limits stifle their creativity. But both Alberti and Nevelson individually argue that limits, whether in the laws of proportion or color or order, allow one to focus intentions, practice discipline and create harmonious works. Alberti argued that painting is an appropriate subject for learning these fundamentals when he states, "Never doubt that the head and principle of this art, and thus every one of its degrees in becoming a master, ought to be taken from nature. Perfection in the art will be found with diligence, application and study."[13] For the beginning design studio then, it is not the subject of the study that matters, but the discipline and application by which it is recorded.

The Case for Navigating to Nevelson

So Hofmann taught Cubism: the push and pull. Positive and negative. Cubism gives you a BLOCK of space for light. A BLOCK of space for shadow. Light and shade are in the universe, but the cube transcends and translates nature into a structure.[14]
-Louise Nevelson

If there is general agreement that analog design exercises are beneficial to a beginning design curriculum, and that using examples from the visual arts has potential benefits, then what analog would be versatile and comprehensive enough to address the broad range of traditional and contemporary design issues in architecture today? Louise Nevelson's work, particularly the self-named "environments" that she began producing in earnest from the mid 1950's offer a rich and multi-facetted alternative for an analogical design pedagogy in a beginning design studio environment.

The use of an "elegant and singular example" (to borrow from Alberti) as a point of departure for teaching an analog design process is a common teaching strategy in schools of architecture. Early modern paintings are commonly chosen for these exercises but they have important limitations. First, although the argument in the Colin Rowe- Robert Slutzky article "Transparency: Literal and Phenomenal" tied modernist architecture to Cubism and Purism, that link is relational rather than causal. For example, while painting did inform Le Corbusier's ideas throughout his career, there is no evidence to suggest that he literally generated architectural space from one of his own paintings. Second, using paintings as analogs in beginning design demands selecting works that meet limited compositional criteria such as imbedded ordering systems, superimposed figures that imply multiplicity and instances of geometric character, all of which have direct application to the design of architectural space. These characteristics are readily apparent in Cubist or Purist paintings, making them amenable to this kind of translational exercise. Third, those characteristics depend almost exclusively on profile and contour line thus marginalizing painting's true medium—color—in the translational process. This raises questions about the transferability of the method to paintings that eschew line in favor of color and atmosphere like the work of Rothko, Pollack or Clyfford Still. Lastly, and most significantly, in using painting as an analog the translation from two dimensions to three, arguably the most important step in the process is, also the most subjective and therein lies a significant obstacle for beginning designers who are making the transition from two to three-dimensional thinking.

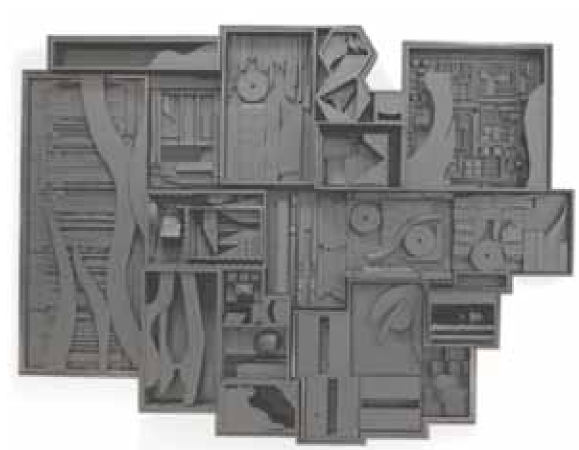


Fig. 1. "Night Zag Wall", Louis Nevelson 1969-1974

In the mid 1950's Louise Nevelson was beginning to create the large wall-pieces that ultimately became her signature work. Nevelson characterized them as grounded in the liberation of Cubism yet still capable of embracing the architectural qualities of light and shadow, space and form. The wall pieces emerged as tightly bounded proto-architectural vignettes aggregated into larger constructions that collaged superimposed orders within the regimented discipline of the asymmetric grid. Although not beginning from a specific painting but rather embodying the *ideas* of cubist space, Nevelson's sculptures essentially became (certainly unbeknownst to her!) a sophisticated instance of the most important step in the analog challenge—translating Cubist ideas from two to three dimensions. This reason alone makes Nevelson's sculptures a potent alternative for an art-to-architecture analog project. Beyond their real three-dimensionality, however, the "environments" provide multiple opportunities of engagement for beginning designers to study both traditional and contemporary issues relevant in architecture today. *Night Zag Wall* (1969-1974) (Figure 1) illustrates this versatility.

By suppressing the role of color, the monochromatic aspect of Nevelson's work serves to direct students' attention to the relationship between form and space, two significant pedagogical objectives of beginning design. The "environments" demonstrate a multiplicity of embedded orders at a range of scales from the parts to the whole. Traditional ordering systems like linear, centric, grid and pinwheel are complimented by more contemporary orders of field and serial progression. The sculptures lend themselves to multiple methods of teaching basic representational skills from tonal studies to strict orthographic projections including diagrams, axons and proportional studies. The "environments" exhibit a playfulness that is measured and disciplined, leading students to discover the potency of anomalies within an ordered system; furthermore, they play with sophisticated figure/ground relationships and multiple ambiguous interpretations that afford young designers a sense of discovery and originality. The integration of orthogonal and curvilinear geometries provide opportunities for students to study complex geometric form that may lead to parametric or other computer studies. Lastly, Night Zag like all of the "environments" expresses the assembled nature of its construction process, thus giving beginning designers a direct analogy to the fundamental understanding of architecture as a constructed artifact. This provides engagement to the work through potential analog modeling, "disassembly" studies or generating technical drawings.

Conclusion

Alberti recommends an "elegant and singular example" to focus an artist's study. The case for navigating to Nevelson in an analog foundational design exercise is strong because the elegance of the "example" is grounded in its layered multiplicity and the versatility through which students can engage the work. A critic wrote that Nevelson's *Sky Cathedrals* are "…profoundly exhilarating in the way they open an entire realm of possibility."[15] Indeed, opening realms of possibility is essential to the success of any analog process, and ultimately defines what beginning design is all about.

Notes

1 MacKown, Diana, comp. *Dawns + Dusks*. N.p.: Encore Editions, 1980.

2 Colquhoun, Alan. "Typology and Design Method." *Perspecta* 12 (1969): 71-74.

3 Hofstadter, Douglas, and Emmanuel Sander. *Surfaces and Essences*. Philadelphia, PA: Basic Books, 2013.

4 Hofstadter, Douglas, and Emmanuel Sander. *Surfaces and Essences*. Philadelphia, PA: Basic Books, 2013.

5 Alberti, Leon Battista, *On Painting* (John R. Spencer, trans.). New Haven: Yale University Press, p. 95.

6 Ibid, p. 68.

7 Ibid, p. 68.

8 Nevelson, Louise, *Dawns and Dusk: Taped Conversations with Diana MacKown,* New York: Scribner, p.64.

9 Ibid, p. 69.

10 Alberti, p. 72.

11 Hobbs, Robert, "Louise Nevelson: A Place that is an Essence," *Women's Art Journal,* Vol. 1, Issue 1, 1980, p. 42.

12 Alberti, p. 83.

13 Ibid, p. 91.

14 Albee, Edward, Ed. *Louise Nevelson: Atmospheres and Environments*. New York Clarkson N. Potter, Inc., 1980, p 22-23.

15 Kramer, Hilton. "The Sculpture of Louise Nevelson." *ARTS Magazine* (June 1958).

Thinking to Making:
Foundational Curricular Design

Brian M. Kelly, RA

University of Nebraska-Lincoln

Introduction

*How do beginning design students learn design **process**? How do beginning design students integrate **making** as a core mindset in the development of an idea? How might we train beginning design students to be part of a **collaborative** team?*

These questions served as catalysts in developing and deploying a new beginning design curriculum (d.oNE) that aggressively seeks to shift mindsets. d.oNE has six courses that constitute the breadth of requisite foundational knowledge. Two of those six courses, Design Thinking (dThink) and Design Making (dMake), are the subject of this paper. (Fig.1)

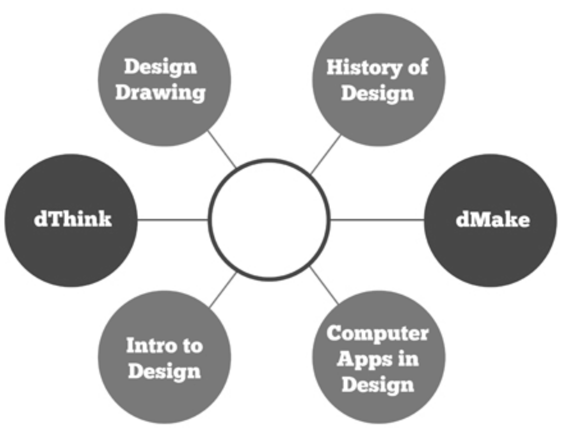


Fig. 1. d.oNE curricular diagram

Mission, Curriculum, Purpose

In 2013, the College of Architecture set out to redesign a new curriculum with the goal of responding to the professions' demands for a new type of practitioner for the 21st century. Change was initiated through a redefinition of the College as manifest through a strategic plan to reflect a new mission focusing on design thinking and design research. Design thinking and collaboration skills are introduced to the freshman design student, while design research competency is continually elevated as students move through the professional program. The development of this new curriculum was catalyzed through the writing and approval of a new College mission and description statement. The statement is as follows.

The mission of the College of Architecture is to develop design professionals who will effect cultural, societal and environmental change.

The College of Architecture brings together an array of disciplines to address real problems and difficult challenges with innovative and collaborative action. United by a commitment to the transformative power of planning and design, students and faculty come together in a creative environment integrating studio-based teaching, rigorous design-research and creative output, and community-focused engagement. By merging disciplinary theory and professional practice we innovate, add value and give form to all aspects of the designed environment.

Shifting Mindsets and transitioning Viewpoints

At a very basic level, curriculum design should address the traits of the incoming student body and project toward the desired identity of the graduate. To design a curriculum which meets accreditation standards is not sufficient as these requirements are minimum metrics for a professional education.

The beginning design student arrives on campus from high school with a mindset established through their background. Understanding that a significant percentage of our students come from an American K-12 education system, a context is established for the development of an introductory common first year suite of courses. Their educational background is typically not one that encourages or fosters the synergistic potential of teamwork, nor does it prepare a student to be comfortable with wide-open problem statements. Additionally, this student is not developed to a point of knowing how to think holistically and understand the broad context of a design problem. Good or bad, this establishes a base point.

In many regards, the design of the d.oNE curriculum is transitional. Transitional in the moving of students from a K-12 context to an environment where divergent thinking fosters impactful and empathetic design proposals. Transitional as it moves students from design thinking as discussed by authors including Tim Brown[1] and Tom and David Kelley[2] to "designerly knowing" as described by Nigel Cross.[3] Transitional as it moves from general beginning design education to one of disciplinary specificity. Transitional as it seeks to shift mindsets and empower a student with the ability to eventually address the significant challenges concerning the built environment of the future.

The beginning design student enters without prior design skills and throughout the academic year, d.oNE endeavors to transition them to disciplinary content at the beginning of their second year. Program focuses and skillsets include team building, design process, material and making awareness, full to scalar representation, and compositional proficiency in the elements and principles of design. As the core of this new curriculum, the following descriptions of dThink and dMake help to situate a significant portion of this transition.

Design Thinking: Teaching Design Process

Content

Often times, the beginning design student is expected to learn and develop design process in an implicit manner either through guided steps that are likely highly specific to the immediate problem or through observing and mimicking their peers. dThink is persistent in encouraging robust, collaborative processes of addressing a design problem while positioning the formation of an opinion and idea at the forefront. A purposeful and reflective process which is general enough to allow for application to problems of varying scale, culture, or context allows students to understand what it means to be in a posture of, for example, divergent idea generation versus evaluative analysis of that direction. This process encourages the development of an informed and exhaustive design investigation. The content for this course is not difficult or deep (it is essentially delivered in the first four weeks of the term); rather the course is about developing vocabulary and practicing the skills through high frequency repetition. The remaining portion of the semester sets forth design problems with increasing diversity, complexity, and openness.

Pedagogy

The College has aggressively adopted a blended learning approach to content delivery throughout the curriculum. The strategic use of blended learning through dThink includes teaching methods of face-to-face, flipped classroom, online synchronous and asynchronous content. Blended learning allows the administration to deliver the course with two lead instructors and meet current enrollment demands (180 students). This strategy simultaneously accommodates the need for a design course to have a level of intimacy and feedback mirroring the traditional studio model. Creating the feel of a smaller class was achieved through a complex system involving students, teaching assistants, and the instructional team. Enrollment is split into two groups of 90 students who meet with the lead instructors once a week on either Tuesday or Thursday. Each group of 90 students consists of 5 lab sections with 18 students that were led by a teaching assistant. Within each lab section of approximately 18 students are design teams of 5-6 students. (Fig. 2)

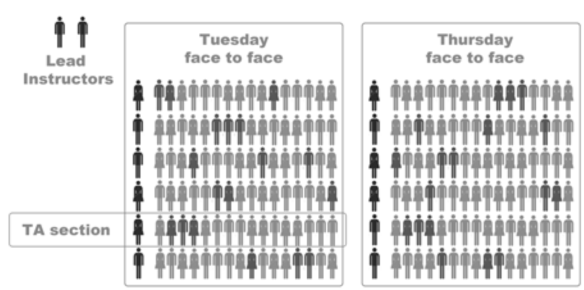


Figure 2: Course organization diagram

Lead instructors always conduct the face-to-face sessions where course content is delivered or discussed, and hands-on feedback is offered. This session is repeated twice a week, once for each group of 90 students. Days when students are not with lead instructors in face-to-face instruction, they are either in design team meetings or focused sessions with their lab section through an online platform (Google+ Hangout). In this scenario, teaching assistants are building team collaboration, reviewing and discussing asynchronous content, and giving focused feedback on the various portions of the design process and proposals.

Impacts

The results of this course are still being assessed through a quantitative data collection, as well as a qualitative review of reflection statements and course evaluations. Preliminary evidence is exhibited through students' general buy-in to the premise of the course. Students felt as though they were designing things that matter, and that their opinion and authorship in the design proposal was critical. The instructional team attributes this to design problems based in real conditions that were highly legible allowing students to respond in tangible ways. Real people were interviewed, research could offer direction, making created artifacts which could be tested, and presentation to professionals offered feedback which was free from architectural jargon and applicable to a beginning deign student. Additional impacts, as directly witnessed through dMake, are discussed in the following section.

Design Making: teaching designerly knowing[4]

Content

Building on rough prototyping skills developed in the first semester, dMake addresses material, craft, and tectonic in the framework of design problems. Compositional principles are delivered through an emergent technique where aesthetic composition is not the end goal. Rather, form and space exhibit a thorough understanding of the forces that shape them. Materiality is discussed with regards to design intentions through the lens of a performance agenda, addressing qualities of thickness, transparency, reflection, texture, strength, and pliability. Tectonic explorations are framed by contextualizing whether connections are within similar or dissimilar materials, joined through material manipulation, or fastened through techniques such as mechanical fasteners. These decisions are always made with clarity of design intent within the given context.

The design modules for this semester are established to transition from 'user-to-user' to 'user-to-surface' contexts. (Fig.3) Initial efforts focus on designing the interaction that embraces time, context, and are supported through the making of a small artifact. Later studies are focused on the design of a surface (which is a common condition with regards to all constituent disciplines) that interfaces with the user and encourages certain designed interactions. In all cases, the user becomes a vital point of departure and source of inspiration for innovation in the design investigations.

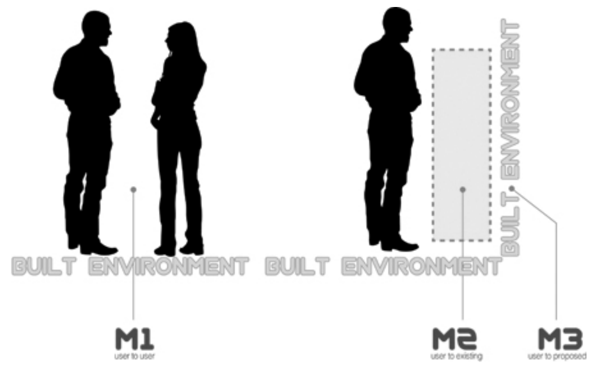


Figure 3: dMake course content flow

Pedagogy: Acquisition and Application

Blended learning techniques implemented in dThink were important as students move into dMake. Course modules were separated into two phases – acquisition and application. Acquisition prepared the students to operate within the modules and appropriated the blended learning technique of front-loaded content. Typically with front-loaded content, students review course materials prior to face-to-face or online discussions. Instructors then address more specific application of that content, achieving a higher level of learning as described by Blooms Taxonomy. Appropriated for this course, making techniques with hands-on instruction (skills acquisition) of casting, digital fabrication, joinery, etc. is then folded into the design module with higher familiarity and proficiency (application).

The application phase of the design module used acquisition skills in the context of a design challenge. This strategy separated the instruction of making from its use in the context of a design problem. At the beginning design level, this has been effective in establishing making confidence before using that skillset to solve design problems. (Fig.4)

Additionally, front-loaded content simultaneously builds on the divergent ideation skillset established in dThink through periodic Maker Challenges. Maker Challenges, built on the historical model of the charrette, are short, timed exercises in a specific material with direct compositional and tectonic goals. Examples of this type of charge include module aggregation, nesting, wrapping, external connection, and stacking. Materials explored might include plaster, playing cards, toothpicks, or mechanical fasteners.

Fig. 4. Castings: skills acquisition session in dMake

Outside of blended learning, dMake is a design course where students are aggressively engaging process in the context of a design problem. Feedback occurs through group discussions, team meetings, or individual desk critiques where students are developing critical thinking and analysis skills.

Design Modules

Module 1 asks students to design an installation in the architecture building that fosters designed interactions between uses. Hands-on experience with 1:1 materials brings a high level of engagement and immediacy to the investigation. Designs are prototyped, installed, documented, and deployed through a public event where people outside of the program, as well as upper level students, are invited to interact with the dMake students. The most successful designs were evidenced through the degree to which the users participated in their site.

Module 2 moves from a user-to-user to user-to-built environment context. Prompted by Juhani Pallasmaa's quote "The door handle is the handshake of the building,"[5] students were asked to reconsider the space that exists between the user and the built environment and to harvest its potential. Process investigations include sectional studies through body and edifice, photographic and diagrammatical analysis, and space-positive extractions. All design proposals were to exist within this space and responsive to an existing condition.

Module 3, the final investigation of the term, builds on module 2 and asks students to propose a new surface condition that is responsive and provocative with regards to the user. Students are given prompts such as "How might the exchange between the user and the built environment be mutually beneficial and responsive?" This module also moves students from 1:1 full-scale investigations into a scalar condition. Acquisition content includes scalar representation, surface manipulation and documentation strategies, movement analysis, and basic use programming.

Impacts

dMake is currently in its inaugural offering and is being assessed in situ allowing the instructional team to see comparatively the difference in students at this point as compared to previous programs. The differences, evidenced through the design modules and reflection statements, can be categorized by confidence in design process, meaningful and productive collaboration, and general willingness to seek out answers to unknowns (design research in its infancy).

dThink's goal of developing what Tom and David Kelley refer to as creative confidence[6] can be witnessed in a large percentage of the students in dMake as they move through the design modules. The end of dThink made clear that the design process is not a linear sequence, and proficiency in the process makes it clear to the designer whether they should be, for example, in a mode of divergent ideation or prototyping. The process within the modules is not explicitly stated through dMake. Since module statements are wide open and require more specific definition, students know they cannot move forward without becoming more empathetic to the user and bracketing the design investigation through informed definition. Students move back and forth in the design process knowing more implicitly when they should, for example, do more research into the user or material or ideate more solutions to the problems at hand. This awareness brings more confidence to the designer with regards to solving what Horst Rittel calls a "wicked problem," one that contains a high level of indeterminacy. [7]

The initial module in dMake is a team project to build on dThink, and to reboot skills after the holiday break. While dThink teams were randomly sampled and assigned, this project in dMake allows teams to self-form. Observation of team formation looked for emerging trends including power teams, similar demographics, or general lack of competitive edge. Interestingly, most teams did not have the foresight to strategize in that way, yet the team dynamics were highly rigorous and diverse. They were able to form teams, and more importantly work within those teams to exploit each member's skillset. Student conversations indicate this to be a residual effect of the use of team contracts and team assessment strategies in dThink.

A College curricular focus on design research means students need to progressively move toward self-initiated and directed research into identified topics. The development of this skill requires recognition of existing knowledge gaps where what a student knows does not match up with, or conflicts, existing knowledge. This directly ties into creative confidence where the identification of a knowledge gap does not become intimidating; rather it encourages the student to seek out answers to fill the gap potentially establishing new viewpoints. This life-long learning skill is currently being evidenced through dMake where students self identify the need to research material and making methods to support intent with the design module. Student work is exploring making and compositional strategies which require students to seek out answers and to establish informed viewpoints.

Conclusion

The inaugural version of dThink and dMake have yielded a student population who are confident, curious, and generally excited about the opportunity to author change in their respective disciplines. Time will tell with more course offerings whether current student traits were due to the design and delivery of the curriculum, or the demographic and identity of this particular group of students. We are confident that d.oNE program is situated to make significant change and to prepare a professional who is a meaningful member of design teams which are addressing the significant issues which are ahead of us in the next generation.

Notes

[1] Tim Brown, *Change by Design* (New York: HarperBusiness 2009).

[2] Tom and David Kelley, *Creative Confidence: Unleashing the Creative Potential Within Us All* (New York: Crown Business, 2013).

[3] Nigel Cross, *Designerly Ways of Knowing* (London: Springer-Verlag, 2010).

[4] ibid.

[5] Juhani Pallasmaa, *Eyes of the Skin, Architecture and the Senses.* (New York: Wiley Publishers, 1996) 56.

[6] Tom Kelley and David Kelley, *Creative Confidence: Unleashing the Creative Potential Within Us All.* (New York: Crown Publishing Group, 2013)

[7] Horst W. J. Rittel, Melvin M. Webber. "Dilemmas in a General Theory of Planning" in *Working Papers from the Urban and Regional Development.* (University of California Berkeley, 1973) p. 155-169.

Building Imagination:
Interdisciplinary Charrettes

Jodi La Coe

The Pennsylvania State University

Yet besides the images of form, so often evoked by psychologists of the imagination, there are... images of matter, images that stem directly from matter. The eye assigns them names, but only the hand truly knows them.[1]

In Bachelard's concept of the imagination, *poetic images* are embedded in both form and matter. While images may be derived from formal play alone, their loose relevance is exhausted through historical transformations. This is not to say that formal manipulations are not relevant to our cultural understanding of design; but when our disciplines' historical formalism is grounded in a balance of the *formal* and *material imagination*,[2] design pedagogy promotes the tangible, the multi–dimensional, the complex, the real, the haptic, embodied experience. It is in the joining of the formal and material where a sustainable imagination is constructed, where complexity enriches rather than bewilders.

Traditionally, beginning design has focused on developing the *formal imagination* through expanding visual literacy; but as David Orr outlined in 1991, the Postmodern challenge is defined by the terms of *ecological literacy*, not visual literacy.[3] If beginning design studio is to participate in these challenges, sustainable design pedagogy must begin in the concurrent development of both the *formal* and *material imagination*, as Bachelard deemed to be the key to enduring poetic imagery with cultural meaning. Our pedagogical challenge is to provide students with these meaningful and relevant experiences with the fundamentals of sustainable design without abandoning the role of the imagination in the pursuit of technical resolutions.

We developed a strategy for Interdisciplinary collaboration, which takes into account disparate course meeting times, diverse learning objectives, and large numbers of participants. Traditionally, collaboration is handled through interdisciplinary teams of students who are required to coordinate their work outside of class time. Many of us have experienced the difficulties generated through that model, not the least of which is that interdisciplinary collaboration becomes synonymous with an annoying, time–consuming, and fruitless experience. If our imperative as sustainable design educators is to introduce social and ecological complexities through collaborative experiences, we must grapple with a different model of interdisciplinary collaboration, which builds on the work of the imagination.

The Green Dorm Project[4] engaged beginning design students across five disciplines in the sustainable renovation of campus dormitories. Faculty and University partners developed this project across seven courses as a vehicle for interdisciplinary collaboration and service learning in support of sustainable design pedagogy.

Typically, an interdisciplinary project in academia relies on a common class meeting time to coordinate diverse student teams. However, since the Green Dorm project had ambitions to capitalize on existing required studio courses for beginning students, it was virtually impossible to coordinate a common schedule. As such, we developed a collaboration model akin to the one used in the professional world, in which various consultants convene at key points during the planning process.

Over the course of the fall and spring semesters, we met three times on Saturdays. We organized these charrette days around exploring the past, present, and future of East Halls. We asked the participants to explore: what students' expectations were fifty years ago, how have these expectations changed for today's students, and what will students' expectations be in another fifty years.

Past/ Present Charrette

We did not limit our investigation of students' expectations in the 1960s to housing considerations, but rather our collaboration model set a holistic foundation employing a twelve around one approach to whole system design.[5] From the standpoint of twelve cultural sectors, students were asked to compare the context of Penn Staters in the 1960s and 2010s in order to gain a broad historical perspective on their disparate housing expectations.

Fig. 1. Twelve–around–one diagram.

- JUSTICE: What were the rules in the East Halls dormitories in 1965? What happened when students broke the rules? What types of punishments were issued? Was this system sustainable? How did these rules relate to a national sense of justice in 1965?

- HEALTH: How did East Halls dorm life promote student health in 1965? What was on the menu in the East Halls cafeteria? What was the obesity rate of students in 1965? Was there a University Health System in 1965? Was this system sustainable? What was the state of health of the country in 1965?

- SPIRITUALITY: In what festivals and/or celebrations did students of East Halls participate in 1965? Did students participate in organized religious activities? Did students participate in alternative spiritual activities? Was this system sustainable? How did spiritual life at the Universities relate to the rest of the nation in 1965?

- INFRASTRUCTURE: What types of infrastructural amenities did East Halls have in 1965? How was the heating system conceived and executed? What type of cooling system and ventilation was provided? What types of plumbing and sewer systems were constructed? Was this system sustainable? How did the infrastructure compare to typical residential infrastructure in the nation in 1965?

- ENVIRONMENT: What environmental factors were considered in the design of East Halls in 1965? What relationship did students have with the environment? In what types of outdoor activities did students participate? What was the relationship between the interior and exterior space of East Halls? Was this system sustainable? How did this relationship relate to non-student housing in the nation in 1965?

- MEDIA: To what types of media were students commonly exposed in East Halls in 1965? In what spaces were different types of media consumed in East Halls? Was this system sustainable? What were national popular culture media trends in 1965?

- GOVERNANCE: What was the structure of student government at Penn State and in East Halls in 1965? How were elections to student government positions conducted? What were important student government issues in 1965? Was this system sustainable? How did those issues relate to political issues in the nation?

- RELATIONS: What types of relationships did students in East Halls in 1965 have? What popular student groups existed at that time? How did students greet each other, faculty? In what types of social activities did they participate? Was this system sustainable? Did these relationships reflect typical relationships in American society in 1965?

- ARTS: What was the role of the arts in East Halls in 1965? Was artistic expression encouraged/ discouraged? How so? What were popular art programs, movies, television, exhibits, and concerts? Was this system sustainable? Was the art scene in the United States similar to university life in 1965?

- ECONOMICS: What was tuition and room/board for East Halls in 1965? What were typical student expenses? Were students also employed? If so, where or by whom? What was the average family income of students attending Penn State in 1965? Was this system sustainable? What was the average family income in 1965?

- SCIENCE: What types of scientific advances were employed at East Halls in 1965? What were popular science programs at Penn State? Were there notable scientific breakthroughs at Penn State in 1960s? Was this system sustainable? What scientific breakthroughs can be highlighted in the United States in the 1960s?

- EDUCATION: What educational programs were conducted at East Halls in 1965? What was the academic structure at Penn State in 1965? What was the faculty/student ratio in 1965? How many degrees were offered in 1965? How many students attended Penn State in 1965? Was this system sustainable? What percentage of people in the United States attended university in 1965?

The dorm complex known as East Halls on University Park campus of Penn State was constructed between 1959 and 1964 in response to a dramatic housing shortage. Each building was named for a former governor of Pennsylvania: Bigler, Brumbaugh, Curtin, Fisher, Geary, Hastings, Johnson, McKean, Packer, Pennypacker, Pinchot, Snyder, Sproul, Stone, Stuart, and Tener. While there are two building design types, there are both Spartan.

These dormitories were built for economy, durability, and density. They were constructed quickly, employing low–cost, structural components and heating systems. With proper maintenance, their expected life–spans are at one hundred years. Each room houses two students in less than 190 square feet with communal bathrooms on each floor. East Halls continues to be the most economical campus housing option at University Park.

We designed the following worksheets for each of the twelve sectors to facilitate the connections between 1965 and 2011.

After a tour of the dorm facility, students participated in an icebreaker to get to know their team members and themselves. In their groups of twelve, students shared three things about themselves related to a cultural sector. After further discussion, students compared the student of the 1960s to the student of today, in terms of the same cultural sectors. In doing so, students attempted to describe the gap between student expectations today and 1960s in terms of the circumstances of East Hall's aging infrastructure.

Fig. 3. Student sharing his research and observations on student expectations exercise.

There were several interesting observations voiced during the Past/ Present Charrette. Students recognized that the bathrooms have assumed the role of public social space, since common rooms are routinely used as supplemental housing. Although a facelift is necessary, students didn’t mind the communal bathrooms given the design constraints and efficiencies gained. Students appreciated the density of East Halls in light of the savings that are passed along, in part, to the students. Students felt that more sharing of resources that expend energy was possible, including refrigerator–microwave units. Students recognized the gap in expectations in terms of technology and the energy used by these devices. Lastly, students questioned the need for storage. These observations formed the foundation of projects that followed.

There was only one project tackled between the charrettes. Architecture students explored the common and yet highly individual journey that a first–year student takes upon entering the University. The dormitory experience figured prominently in this journey serving as both a home–away–from–home and as an entirely new social and physical environment.

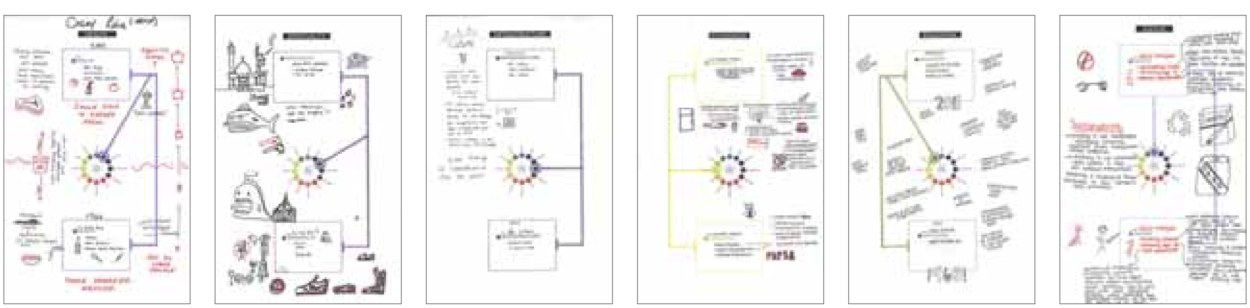


Fig. 2. Examples of team output in the student expectation comparison exercise.

The labyrinths served as a physical device to explore issues of self transformation through a metaphysical journey from childhood to adulthood, form dependence to independence, from home to college, from the natural world to the dorm room, thus, loosening the desire to create the ideal dorm room based on physical comforts and entertainment technologies. Students were required to reckon with the walls created by their labyrinth overlays through a series of physical models.

Fig. 4. Moving clockwise from the top left image, final dorm room–labyrinth exploratory models by Timothy DiPaolo, David France, Matthew LaMonte, and Casey Raia.

Present/ Future Charrette

In the first charrette, students focused on the present situation and described a gap in expectations. In the second charrette, they were asked to begin to describe future expectations in terms of design principles and stakeholders needs.

Some statistics were presented on East Halls to inform decisions. East Halls shelters approximately 4,300 students in seventeen buildings totaling 1.1 million square feet. The annual utility bill for East Halls alone is nearly $3.4 million including steam (53%), potable and sewer water (15%), and electricity (32%). The largest portion of the annual bill is to produce the heat from a centralized coal–fired steam plant. An alarming rate of use of window air conditioning units is currently at 40% coverage and on the rise for students with diagnosed environmental allergies.

LEED Fellow John Boecker, Founder Partner with the 7Group, conducted this portion of our second charrette. Under his direction, fifty students participated in the drafting of shared design goal and the identification of stakeholder needs.

Fig. 5. As shown in the above image, the goal of the Green Dorm project is “to develop and appreciate guiding principles as the fundamental basis of design in a way that energizes us around the value of working collaboratively to synthesize multiple perspectives and stakeholders interests so that we improve all aspects of the dorm life for students at Penn State and beyond.”

Sustainability is fundamentally about flourishing – having fulfilling lives as responsible members of the human and more-than-human communities of Earth. Engineering Design students were asked to assess the customer needs in terms of the five stakeholders as identified during the second charrette: users, co-creators, investors, community and the Earth. In order for the Green Dorm project to succeed, the designs must be attractive to current and future students, the design team, the University [faculty, staff, students and others], and the Earth.

While the students tended to focus on users’ needs and desires for dorm living, it was important to continue to balance the needs of the other stakeholders in this project. Foremost was

Penn State, Office of Housing and Food Services, who, in addition to providing attractive and functional rooms, must be fiscally responsible. The renovation costs, as well as the ongoing costs for utilities and operations, were also considered for each design solution. Another stakeholder group was all future students who must be factored in the designs, even though their voices were only imagined. The more-than-human communities of Earth, both present and future, were also key partners in consideration so that they, too, would flourish.

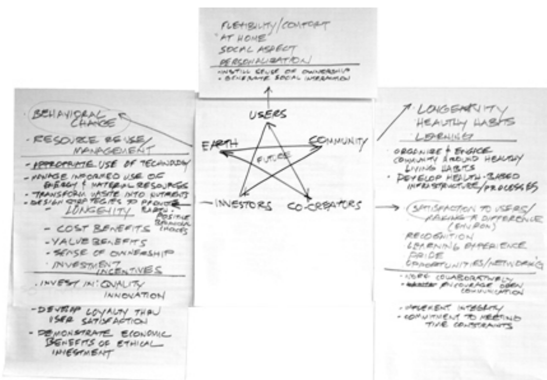


Fig. 6. Diagram of stakeholders needs.

USERS are interested in flexibility and comfort. They would like to feel like they are at a home away from home. They would appreciate the ability to personalize their spaces. They are missing a social aspect with the loss of communal spaces. From this understanding the students agreed that it would be important to instill a sense of ownership and generate social interaction in their designs.

The larger COMMUNITY, including all students, faculty/staff, alumni/visitors, and neighbors, are interested in teaching healthy habits over the long–term. This discussion led to the following priorities: to organize and engage the community around healthy living habits and to develop health–based infrastructure and processes.

CO–CREATORS, also known as the design team, is generally concerned with user satisfaction, design recognition, and future opportunities. Co–creators like to make a difference for people and the environment. They take pride in their work and hope that it leads to new networking opportunities. As designers, the students agreed to work collaboratively, encourage open communication, implement integrity, and commit to meeting time constraints.

Without vilifying INVESTORS, they are interested in longevity, like the community, as well as cost/value benefits, investment incentives, and pride of ownership. The design goals that were developed in response to these interests were to invest in quality innovation, develop loyalty through user satisfaction, and demonstrate the economic benefits of ethical investment.

If the EARTH was considered to be a stakeholder, its interests may have been in behavioral change and resource reuse/ management. As such, the students agreed to use technology appropriately, manage informed use of energy and material resources, transform waste into nutrients, and design strategies to promote positive behavioral choices.

Students were then encouraged to take a look at some of the big picture issues with Geary Hall, typical to most of the East Halls dormitories. They brainstormed several strategies for achieving stakeholder needs quickly focusing on the inadequate room size and dismal state of the shared bathrooms. It was quickly evident that user concerns outweighed some of the more lofty goals. It was necessary during group presentations to redirect their energies in committing to all stakeholders.

Fig. 7. Students at work on major renovation issues.

After returning to their respective disciplinary studios, student teams produced innovative and practical solutions to identified needs. Some projects tackled the room furniture with proposals to increase flexibility and address sustainable material choices. Other teams tackled electrical, heating and ventilation concerns with simple changes, as well as with elaborate renovation proposals. One example of a small change was that the refrigerator is currently placed in front of the heating vent, therefore decreasing the effectiveness of the rear condenser coils to dissipate heat. Simply relocating the refrigerator in the renovation would decrease the energy consumed by the unit. Another group proposed that creating a common kitchen area would increase casual social encounters necessary for a healthy transition to college and significantly decrease the overall energy consumed per floor.

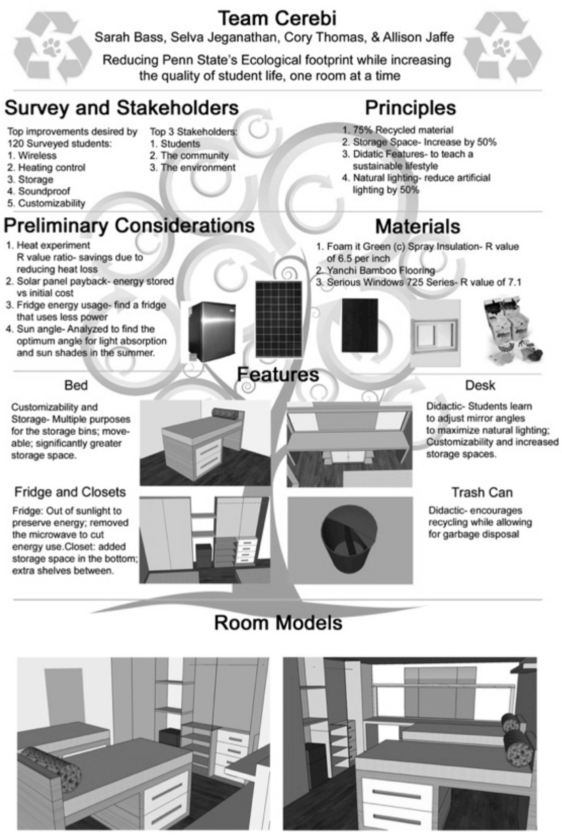


Fig. 8. Engineering Design students in *Team Cerebi* included Sarah Bass, Selva Jeganathan, Cory Thomas and Allison Jaffe.

Architecture students incorporated the stakeholders' needs in dorm room chair designs intended to achieve multiple functions in addition to an upright posture, such as a tray/ desk, storage, and lounging.

Photography students undertook to document regional projects, equal part with potential positive and/or negative environmental impacts. Their sties included the mine fires of Centralia, Pennsylvania, Marcellus Shale drilling sites, and Penn State's composting piles and wastewater recycling fields.

Fig. 9. Adaptable chairs by architecture students, Nicole Gioiella (left) and Galym Dyussembayev (right).

Fig. 10. Image of Marcellus shale facility taken by photography student, Kerry McIntyre.

Future Projects Charrette

While the work of the last several months was presented to a new crop of students, a discussion of principles and stakeholders needs focused the work on determining the future. In order to bring these students up to speed, we played some games to get to know the energy uses and sources available in the dorm.

In this game, a student team identified all of the items in a dorm room that required utilities, such as heat and air conditioning, lights, refrigerators, microwaves, lap tops, televisions, fans, printers, and water for sinks, toilets, showers, and clothes washing machines. Then, they worked out what types of utilities were required to run these items and from where these resources currently came. Lastly, they projected the types of renewable energy that may be produced and water conservation/ recycling on site.

Fig. 11. The third charrette format followed a typical presentation of work in progress. Students had the chance to explain their work to the entire interdisciplinary group, not only giving everyone a glimpse of each other's projects, but also allowing for comments and criticism. The group was directed to examine the merits of the designs based upon the stakeholders' needs developed in the second charrette. This juncture proved to be a fruitful step in the integrative process.

While students were surprised at the differences in expectations between themselves and past students, it is more difficult to forecast the future. With the help of design principles that respond to the needs of future stakeholders, they explored projects related to renewable energy, energy conservation through passive solar design, water collection and conservation, natural ventilation, flexible uses, and personalization.

Architectural engineering students attempted to address building integrated renewable energy systems exploring the potential of facade systems, roof gardens, water collection, and shading structures.

Architecture students tackled the lack of social spaces and need for personalization in bathroom, furniture, and movable partition wall designs. They developed a furniture system that is durable and allows roommates to customize the layout of their space while increasing storage.

Fig. 12. The team of Dana Burzo, Michael Hardesty, Tyler Poff, Kevin Ricart and Donald Stahlnecker employed an armature of gearless wind turbines, solar and glass panels, and wing walls on the southwest facade to capture and accelerate the prevailing west winds. Additional turbines above the opposite facade also capture the wind sweeping over the roof of Geary Hall.

Fig. 13. A sample dorm room layout using furniture modules to create a lofted bed. The design/build studio team included Shreya Agarwal, Mohamed Al Lawati, Tomas Brooks, Lindsay Connelly, Samuel Davison, Maxine Fox, Isobelle Le Francois, Elena Nentcheva, Jacqueline Nieto, Jeremy Ross, Gretta Safonova, Montana Stigger, John Stovall, and David Vanlandingham. Patent pending.

Approximately fifty Graphic Design students generated graphic forms around the themes of sustainability and ecology. Students began their process by researching the topic individually, and then coming together during class and working in small teams to ideate. The research included both verbal and visual elements, constituting a divergent problem–solving process. Armed with the results of this collaborative research, students then worked individually on their graphic marks.

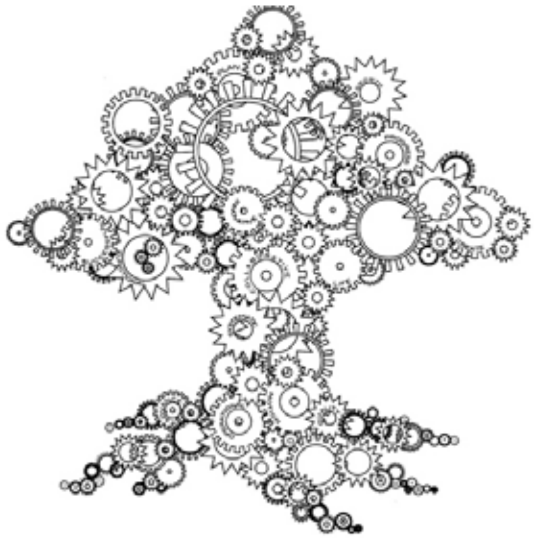


Fig. 14. Green Dorm iconography created by Graphic Design student, Jenna Brillhart.

The Benefits of Collaboration

The charrette model proved to be a viable way to collaborate between multiple courses engaged in a common project. Beginning design students benefitted from modeling best practices in design. We believe that faculty interaction during the collaborative exercises was key to the success of the charrettes, especially for beginning design students.

The individual studio solutions were greatly enhanced by the larger dialog running through the charrette sequence. Projects were able to tap into the insights gained during those difficult and ranging discussions of what is at stake in the transition to the University, to adulthood, to an independent leaner. These studio projects were able to incorporate a level of complexity necessary to accomplishing the difficult problems that we face together for the benefit of future generations.

Notes

[1] Bachelard, Gaston. “Imagination and Matter,” in *Water and Dreams: An Essay on the Imagination of Matter.* Edith R. Farrell, trans. The Pegasus Foundation, Dallas, 1983. [Original French, Librairie José Corti, Paris, 1942].

[2] *Ibid*.

[3] Orr, David. *Ecological Literacy: Education and the Transition to a Postmodern World*. [SUNY Press, 1991].

[4] The Green Dorm Project was generously funded through an Interdisciplinary Project Support grant from The Raymond A. Bowers Program for Excellence in Design and Construction of the Built Environment. Projects leaders included Mallika Bose [former Director, Hamer Center for Community Design], Lisa Brown [Associate Director, Sustainability Institute], Erik Foley [Director, Sustainability Institute], Jodi La Coe [Architecture], and Andy Lau [Engineering Design]. Instructors included Reggie Aviles [Architectural Engineering], Keith Cummings [Graphic Design], Lisa Iulo [interdisciplinary], Jodi La Coe [Architecture], Andy Lau [Engineering Design], and Katarin Parizek [Photography]. Expert partners included George Gard [former President, Students for Environmentally–conscious Design], Lisa Iulo [Architecture, LEED public housing], Richard O’Donald [Office of Physical Plant], David Manos [Associate Director, Housing] Al Matyasovsky [Director, PSU Recycling Program], and Timothy Simpson [Director, Learning Factory].

[5] Cole Hons championed the application of Buckminster Fuller’s twelve-around-one approach to whole system design in an academic design studio setting.

Community Building:

Introducing Urbanism and Design Practices for Small Cities

Charles MacBride

South Dakota State University

Introduction

The Community Learning Center at the South Dakota State University Department of Architecture (DoArch CLC) was developed to connect students and faculty with towns across the state for the purposes of outreach, service learning, design and study. Goals include presenting the physical, social and historical qualities of South Dakota's small cities and towns to design students as a working laboratory; generating interest in good design within individual communities; and increasing the awareness for architecture, planning, preservation and economic development.

Several cities are already actively working on projects with DoArch students. Some of these projects have also been established as partnerships with regional non-profit and community based groups. Typically, local chambers of commerce, economic development committees, and Main Street revitalization groups become points of contact and generate local awareness for the CLC.

The first connection with a partner community initiates an annual, ongoing, six-year study that connects architecture students with a single community to be revisited continually throughout their education. With each incoming class, a new community is adopted. Student projects begin with simple documentation and grow to include design-build projects, master planning, and detailed design proposals as part of the 4+2 Master of Architecture degree program.

SDSU DoArch was founded in 2010, the first ever professional architecture program in a state with a small population across a vast area, containing mostly very small towns.[1] Teaching students the importance of "making" and "learning by doing" is fundamental for architectural instruction and ultimately for professional success in this region. A hands-on approach to understanding the qualities of building and materials, its inherent connection to assembly and construction, and the ability to lead and direct work in the field is the basis for the curriculum, all of which support the predominant professional model in this region.

As part of the DoArch mission, community involvement comprises a large part of a student's introduction to the profession, establishing stewardship as an essential public responsibility, and using the city, even very small ones, as the workshop and location for architecture.

The DoArch CLC began in 2011 as an outreach project in Mobridge, SD. Seeing an opportunity for creating a design partnership, community leaders reached out to DoArch with an offer to imagine a long range plan for its undeveloped riverfront. A first-year student project and field trip was established to investigate, research and document Mobridge, and to present the results back to the city. The field work presented an opportunity to teach both beginning design and representation skills, and lessons on regional urbanism and physical history.

Fig. 1. Student field trip, Huron, SD (photo by author).

Using the same model, in 2012 DoArch initiated a partnership with Huron, SD (fig. 1) as a follow up to a "Main Street" visioning charette previously carried out by professionals connected with the non-profit *design:SD*. These partnerships have been expanded into a larger curriculum that stretches across the entire degree program.

Research and design opportunities for both students and faculty have also emerged. And each community has taken advantage of student enthusiasm to reinvigorate public interest in design and downtown development.

Teaching and Curriculum

Curricular goals of the DoArch CLC include teaching students the importance of involvement and good design at the community level, instilling the value of smart growth and sustainable development, and reinforcing the qualities and potential of the small cities that many of these same students come from. The synergy generated between students, faculty and the community itself are intertwined, and have generated a variety of initiatives at multiple levels.

With new partner communities added every year for each incoming class, teaching through the CLC allows DoArch to revisit towns throughout a student's entire academic career. The six-year program establishes a framework for students to identify incremental changes and growth and to actively participate as a designer in a real community. The city becomes a shared constant for a variety of coursework across the entire curriculum.

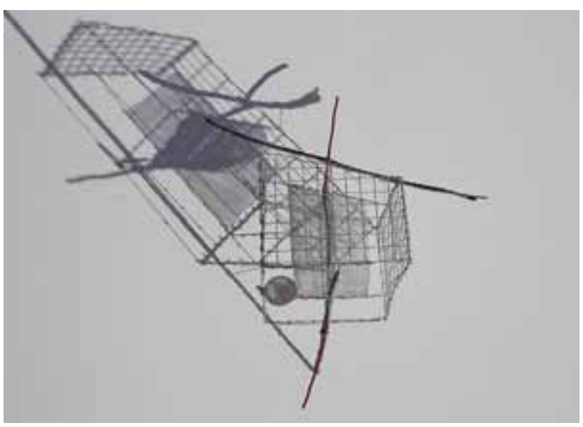


Fig. 2. First year studio project, abstracting city grids in wire (DoArch photo).

Pre-professional Coursework

Beginning CLC coursework introduces "small-town urbanism," describing historical, geographical and economic forces in place as the region's small cities were settled and have since evolved. These courses have been offered to first and second year pre-professional students, in both two-credit studios and "Introduction to Architecture" seminars. This coursework is likely to shift into a core curriculum that includes other design degree programs on campus, including Visual Art, Interior Design, and Landscape Architecture.

The CLC has established an appropriate a place within the larger requirements and goals of pre-professional education. This includes design studio and introductory courses in media, technology, theory and history. Thus far the CLC in beginning design studio has provided a vehicle for teaching both fundamental skills, such as drafting, documentation and model building, and also for abstract, compositional exercises, such as mapping, collage, and formal investigation (fig. 2). The study of the physical condition of small cities, including the overlay of rail and street grid infrastructure, Main Street scale and typology, and the centralized siting of industrial uses, have provided a framework for student projects and exercises.

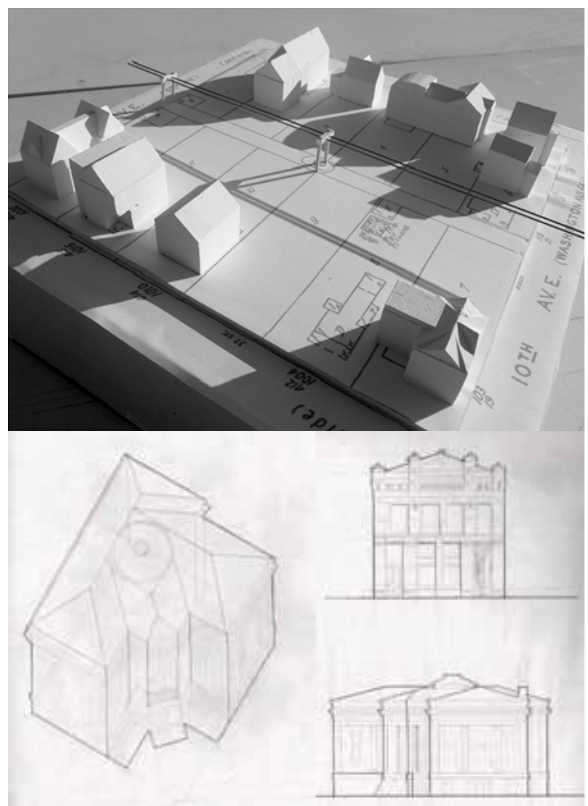


Fig. 3-4. First year studio: one city block from the large group model, and documentation of CLC precedent buildings (DoArch photos).

Fieldwork is an important part of attaching students to the real scale and materiality of cities. Exercises using a sketchbook, camera and tape measure are assigned prior to class field trips.

Results are cataloged and used in the studio for the development of various projects, including drafting of precedent and typologically categorized buildings, photo collages, and the construction of large scale models (fig. 3-4). These exercises, plus a long list of other site visit tasks, support the notion of “reconnaissance” and “learning to see.” The first hand measuring, drafting, and cataloging of a place is reinforced as the simplest and most straightforward way to understand and record that place. Field trips are highlighted by informal walking tours led by faculty, community leaders and local historians, describing not only the cities cultural history, but also identifying the physical and material qualities of the architecture.

Advancing the design studio work beyond straightforward documentation are projects that require analysis, identification and speculation of the physical, spatial and chronological layers of existing public systems and infrastructure. These urban traits are easily compared to the compositional and spatial investigations typical in beginning design (fig. 5).

Second year design studio projects have begun to utilize sites in partner communities. This is intended to reinforce issues of context, scale, and site design as it introduces more complex design challenges. Extra effort is made to advance the assignment beyond formal composition to include spatial, narrative and programmatic outcomes. This helps to defamiliarize the site so that the studio can sharpen its focus on design issues while still maintaining a connection to the CLC location.

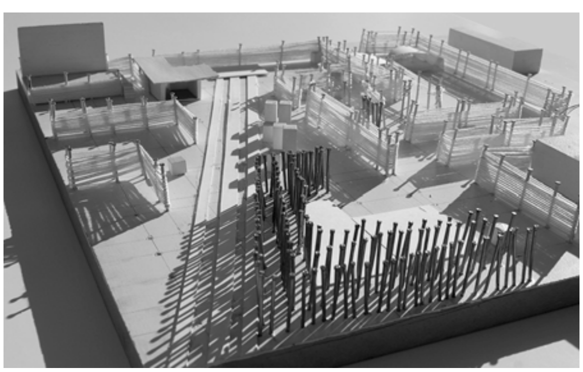


Fig. 5. Second year studio: revisiting Mobridge, SD and designing public spaces (DoArch photo).

Finally, and of great importance to the longer term connection that the CLC is forging with partner communities, is the construction of a large scale model centered on the downtown and Main Street. These models are built in pieces, each student team constructing a block or two, with the result being the entire downtown as an entire class project. As a beginning exercise, the model has proven to be more of a lesson in teamwork and craft. Its use as a design tool continues to emerge, but the potential is clear. The model itself is the CLCs evidence to communities that the students are “following up” with their fieldwork, and signals the promise of work to come.

Fig. 6. Student construction and assembly of the large model, its base the “ideal” city grid, with existing conditions to be layered on top (photo by author).

The compositional lessons of the model do go beyond simple representation. A graphic (fig. 3) and/or constructed (fig. 6) superimposition of the “existing” city against its “idealized” or original grid plan are assembled to juxtapose old and new, and to display larger scale changes such as street closures and the alteration of urban fabric.

The potential of these models remain. The most recent model will serve as a starting point for a community charette this fall. The charette, located in Webster, SD, has been designed to combine DoArch students with professionals from across the state. Goals include imagining physical and economic improvements for the city, and also strengthening the emerging relationship between DoArch students and South Dakota’s design professionals.

The large model has consistently prompted community interest, discussion and increased awareness in design (fig. 7). In every case, these beginning efforts have led to additional projects beyond the prescribed curriculum. They vary in scale, from building renovations and proposals for public spaces, to master planning and long term neighborhood development. These projects have also ranged in involvement, offering possibilities as entire studio projects, faculty research, or simply employing students in independent study. [2]

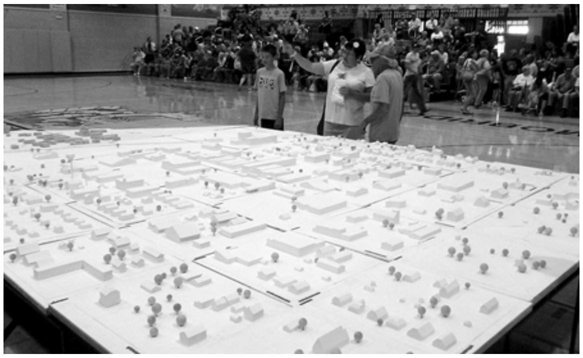


Fig. 7. Public presentation of the large model, Mobridge, SD (photo by author).

Beginning Professional Coursework

Professional coursework at DoArch begins during the third year of instruction. The first "re-visit" to the CLC partner community by students is made, with the assignment of installing a design-build project.[3] These projects evolve with input from community leaders, and are designed to reinforce Main Street as the active, civic heart of the city.

The design-build studio operates as a collaborative effort to "design the construction." With the design intent significantly in place, the studio is tasked with the problem of scheduling, coordinating, budgeting, and supervising installation in the field. Detailing and representation of the work, including shop drawings, 3D modeling, construction phasing and delivery are the real lessons of the studio (fig. 8).

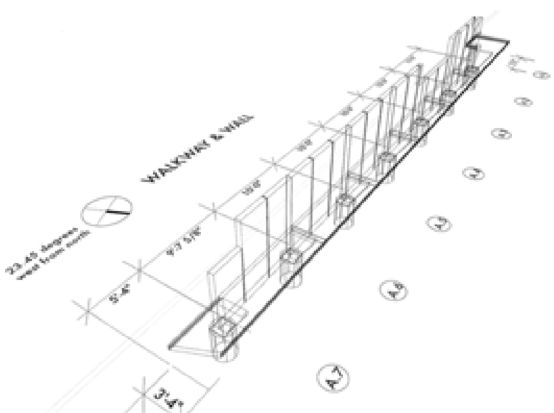


Fig. 8. Third year studio: "End of the Line" design-build project, Mobridge, SD (DoArch image).

Advanced Professional Coursework

As scheduled, fifth year students in architecture will again revisit their partner community as a site for a building proposal in Comprehensive Design studio. In addition to the familiar goals of this level of studio, the CLC will be scheduling public presentations of the work. The positive interest that partner communities have taken toward the DoArch CLC has provided a unique opportunity for students to learn about the municipal review process first hand. While the bureaucracy is fairly straightforward, the politics of public opinion remain an ongoing challenge.

Even the selection of a site and building type will have public repercussions. While student work for comprehensive studio will remain a proposal only, the site and building type may represent a critique or suggestion of a particular community shortcoming. A recent proposal for a partner community overlooked a heated, ongoing debate regarding the location of a new public swimming pool, sparking additional controversy and suspicion of the CLC "taking sides." Awareness of appearances or preference is monitored closely.

Additional Community Involvement

Opportunities to work with communities in a variety of ways beyond the established curriculum have already presented themselves. These include historic preservation, restoration projects, planning, event proposals and community development. Exposure to actual projects opportunities supports the DoArch mission preparing architects for the discipline. Both municipal and private interests have approached the CLC with potential work. Towns have also begun to contact the CLC inquiring about participating as a partner community, an indicator of initial success.

The CLC has not yet made successful connections with American Indian communities. The political, financial and cultural split between the native and white populations in South Dakota continues to be an alarming obstacle. Connections with communities in the western half of the state are emerging, and attention toward this particular kind of outreach is now our first priority. [4]

Urban and Rural

It is worth noting the distinctions and common attitudes of typical undergraduate students in the region, and to describe the connection to modes of design practice and economies currently in place.

Student sensibilities are largely "anti-urban." There exists a pride in the rural, agricultural composition of Mid-western culture, which often includes a dislike or distrust of cities and urbanism. Most new students have not visited the larger regional cities such as Chicago; suburban students often are ambivalent towards their home cities. And, despite the now long-standing commitment towards urban improvement in Sioux Falls and Rapid City (South Dakota's two largest cities), these sensibilities are only beginning to take root, usually supported only by a minority of city-dwellers and those in the "creative class." [5]

The anti-urban sensibility is a hurdle facing the region's design community as well. The term "urban" is associated with negative cultural types, rather than with commonly understood social and physical traits we largely acknowledge today, such as density, diversity, mixed-use, pedestrian scale, etc. This is *not,* however, to say that the state's small cities are lacking in "community," defined in the tradition of being neighborly, supporting established institutions like schools and churches, or working to generally improve economies and living conditions.

The vocabulary and connotation of both "city" and "urban" pose a continuing challenge in engaging students and communities in urban discourse and the role of architects beyond just designers of individual buildings. Thus, teaching the benefits of urbanism, or even assuming that the city is the natural habitat of the architect, becomes a "pre-foundational" lesson.

The DoArch CLC has argued that the condition of small towns in this region are actually quite urban, demonstrating clear patterns of infrastructure and economy, initial planning strategies that follow the Jeffersonian grid, and continued reliance on Main Street for commercial, civic and social activity. There remains a generally distinct physical edge between urban and rural. Populations have decreased, but only marginally, over the past 50 years since the decline of the rail industry. Maintenance and sustainability are the economic and demographic goals, more realistic than outright "growth."

Many of these small cities are also experiencing housing problems, including both a lack of senior housing and of modern housing for younger families moving back to these places. In addition, many of these cities have identified a lack of centralized recreational uses and are in the process of proposing new parks, trails, public pools and rec centers.

Resetting

One of the larger and longer term goals of the new SDSU Department of Architecture is to increase awareness and valuation of design culture. This applies to campus as well as the state as a whole. Small towns offer a (physically) straightforward laboratory in urban design, and deconstructing the social, infrastructural, economic, and historic trajectory of these places have provided students with an understanding of design complexities and how to better affect their maintenance and future. It is likely that many of our young architects will return to their hometowns and influence not only the physical landscape, but also the political and social one.

Having outsiders like the CLC identify the strengths of small communities has rarely been made explicit to residents. While the likelihood for growth seems small, there isn't evidence that these towns are dying either. "Maintenance" and increasing cultural awareness of the traditional strengths of Main Street are directly presented to these communities as stepping stones for new proposals.

The use of partner communities as sites for more ambitious design proposals will likely increase. Initial work during the first two years of the CLC has been largely focused on establishing curricular goals and building trust. As the CLC moves beyond these initial efforts, we hope that greater collaboration, more progressive design, and increased confidence will emerge.

Opportunities for community partners in larger cities such as Sioux Falls and Rapid City are also possible. It is still to be seen how successes with smaller towns could influence such projects, but basic lessons in the history of the region's cities are clear. Partnerships with *very* small towns (populations less than 1000) have been presented to the CLC by other SDSU departments, outreach centers and service programs. Here the challenge of rural and urban reemerges, as does the question "how small is too small," when simply considering just the physical size and extent of these towns.

Ultimately the CLC has established a structure within the DoArch curriculum, advocating community research and design, and introducing public service and outreach. The curricular goals of the department are not dominated by issues of community design, but have certainly taken advantage of the scaffolding that has been put in place. Design studio, history and theory, representation, technology and materiality are at the heart of architectural education, and the CLC addresses each of these in various ways. That students feel comfortable working in familiar locations is significant, and increasing the conversation of design across the region is a cultural necessity.

Notes

[1] United States Census 2010. Retrieved 09 Feb 2014. Currently there are only six South Dakota cities with populations larger than 15,000. The entire state population in 2010 was only 814,180.

[2] A fourth-year studio project for the design of a museum on a vacant lot in Aberdeen, SD quickly emerged and has led to an exhibition. A student led independent study has also been initiated, looking at the history and potential of downtown Beresford, SD.

[3] The first design-build project, located in Mobridge, SD, will be completed in spring 2014. The second will be located in Huron, SD. The first design build projects have been led by Assistant Professor and Department Head Brian Rex, and are supported by a grant from the Precast Concrete Institute, in partnership with Gage Brothers Concrete Products in Sioux Falls, SD.

[4] The CLC is assisting on a collaborative project led by the SDSU Department of Sociology and Rural Studies for the non-profit Rural America Initiatives in Rapid City.

[5] Florida, Richard. *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community, and Everyday Life.* Basic Books: New York. 2003.

Student work: McKenzie Wolf (wire); Emily Linn, Sharon Sanchez, Seth Varty (block model); Cassie Pospishil (drawings); McKenzie Hengel (Mobridge model).

Modulated Landscapes 2.0:
New Translations in Foundation Curriculum

Gregory Marinic, Jason Logan

University of Houston, Gerald D. Hines College of Architecture

Prologue

Building upon our previous report to the NCBDS at Temple University in 2013, this proposal for the 2014 conference revisits graduate curriculum development at the University of Houston, Gerald D. Hines College of Architecture. This essay documents a continued search for alternative approaches to foundation curriculum in a graduate architecture program that challenge the organization of discrete design problems executed in a linear fashion. The idea is that the education of an architect is not a linear process; rather than a series of discrete exercises that move from hand-drawing, to drafting, to digital modeling, or from basic architectural elements, to program, site, and material assemblies – projects are designed so that a complex range of skills and concepts may be developed in parallel. Here, we present continual refinements made during the Fall 2013 semester, focusing specifically on two projects that translate fundamental graphic and analytical techniques into material and spatial constructs.

Material/Immaterial

The built environment is generally perceived in regard to the solid and objectified—to physical matter—but what about the spaces and the sensory impulses that architecture ultimately evokes? Over the course of history, formal and material experimentations have inherently shaped the trajectory of architecture. More recently, technological innovations in materials and methods of fabrication, ranging in scope from emergent conceptual generators to advanced modes of production, have profoundly impacted the evolution of our discipline. Within this shifting discourse, the timelessly relevant significance of immaterial sensory conditions such as light, sound, and smell, as well as unseen systems and developments that technology may soon place within our reach, reveal the broadest interpretation of what *immateriality* means in contemporary design.

This foundation design studio sought to balance the simultaneity of the material *and* immaterial aspects of architecture. It formulated prevalent tendencies and coherences among foundational content groupings – translated from conventional means – into an inter-connected range of research-based projects that engaged trans-disciplinary affinities relative to ideas, process, tools, and architectural production. Considering the needs of career-change Master of Architecture students in their first semester of a three-year professional degree program, our curriculum proposes an alternative order of experiences and discoveries that speak to the core of architecture.

Acknowledging that buildings deliver solidity and permanence, we re-aligned the discourse at the foundation level with the *immaterial*, privileging concepts toward outcomes that contemplated the experiential aspects of designed space rather than prescribed objectivity. Engaging the body as object and spatial phenomenon as central to architectural discourse, we promoted trans-disciplinary awarenesses that fused immateriality with materiality by challenging preconceptions in regard to formalism, purposefulness, and usage.

Constructing Projective Space

Graphical Projections developed out of the search for a way to teach projective drawing techniques as a *design* problem rather than a *technical* exercise. Conceptually speaking, anamorphic projections create a spatially dynamic relationship between the viewer and environment, isolating a single moment where graphic legibility is attained. As such, constructing anamorphic projections provides an opportunity to utilize the techniques of projective drawing as a perceptual and spatial effect, through materials and making. This provides students with an opportunity to engage a broader range of fundamental design concepts through the construction and installation of an anamorphic projection.

Historically dating back to *Leonardo's Eye* (c. 1485), anamorphic projection has been used as a technique to construct images that may only be perceived from a single vantage point. This particular type of anamorphic projection – called *oblique* – has been used to create artificial depth in flat surfaces (Andrea Pozzo's ceiling at St. Ignatius' Church), or to conceal images in plain sight (the skull in the painting, *The Ambassadors*, by, Hans Holbein the Younger). In a more recent history of the technique, anamorphic projection uses the foreshortening of perspective depth to distort a two-dimensional graphic image into three-dimensional space, such that, at a particular location within a space the viewer perceives the effect as a flattened image (fig. 1). Students were required to use the latter version of this projective technique to design a graphic installation within the college of architecture building.

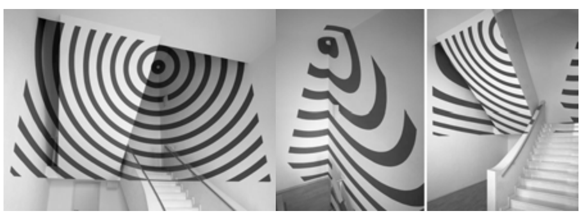


Fig. 1. *Anamorphic Projection* – Felice Varini

Orthographic, Perspective, Anamorphic

To begin the project, a series of exercises demonstrated the technique of orthographic projection as a form of parallel projection where the projection lines are parallel in relation to each other, while being orthogonal to the projection plane. Students are able to see that this produces a measurable or scalable representation, used in architecture as plans, elevations, and section drawings. A subsequent series of exercises taught one- and two-point perspective projections as a non-metrical form of projection, where distance was not measurable due to the effect of foreshortening.

Students were then asked to select a space within the college of architecture building to construct the anamorphic projection. A plan, with corresponding sections, and elevations of the space served as the basis for constructing one and two point perspectives. Once the perspectives were generated, a series of graphic organizational systems from their first project *Generative Pattern Finding* (fig. 2), were studied within the space. The students must ultimately select one graphic drawing based on its capacity to simultaneously confound the spatial reading of a place, while maintaining its legibility at the point of the anamorphic effect.

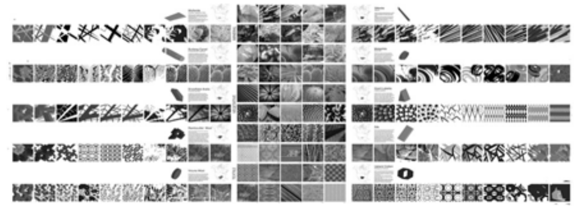


Fig. 2. *Generative Pattern Finding* – Dijana Handanovic

Anamorphosis

To properly develop the perceptual anamorphic effect, students were not allowed to use digital projective tools found in 3-D modeling software since "project to surface" commands are typically executed in orthographic viewports and therefore do not account for the foreshortening of projective space. Instead, by overlaying the selected graphic image on the perspective drawing that represents the point within the space where the anamorphic effect will be perceived, students were taught to "reverse-engineer" the anamorphic pattern by following the steps of generating one- and two-point perspectives in reverse.

Students were asked to think through the normal process of perspective projection (fig. 3), where the depth of an object is calculated by projecting a line from the Station Point (SP) to a point within the plan. In the location where that line crosses the Projection Plane (PP), a vertical line representing the *depth* of that point is projected down to the perspective drawing until it intersects the associated lines extending to the Vanishing Point (VP).

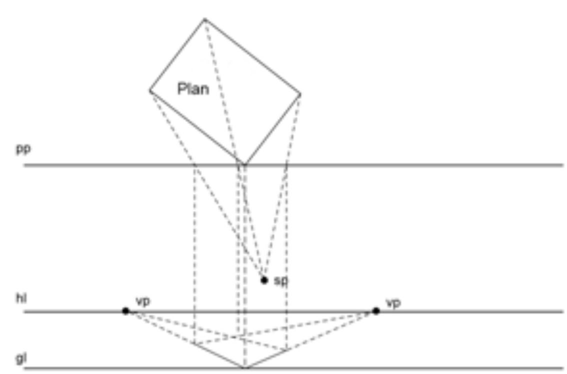


Fig. 3. Two-point perspective projection diagram

As a result, any point of depth that exists within a perspective drawing – in this case the points of their overlaid graphic pattern – may be located in the plan by projecting vertically from the point, to the PP, and then drawing a line from the SP to the intersecting point on the PP, extending the line until it intersects the corresponding surface of the plan. Similarly, the height of points may be calculated by projecting from the VP to the measurable point of the perspective. In case of a one-point perspective, it would locate the height in *section*, or in a two-point perspective, it would locate the *height* along the measurable corner of a space.[1]

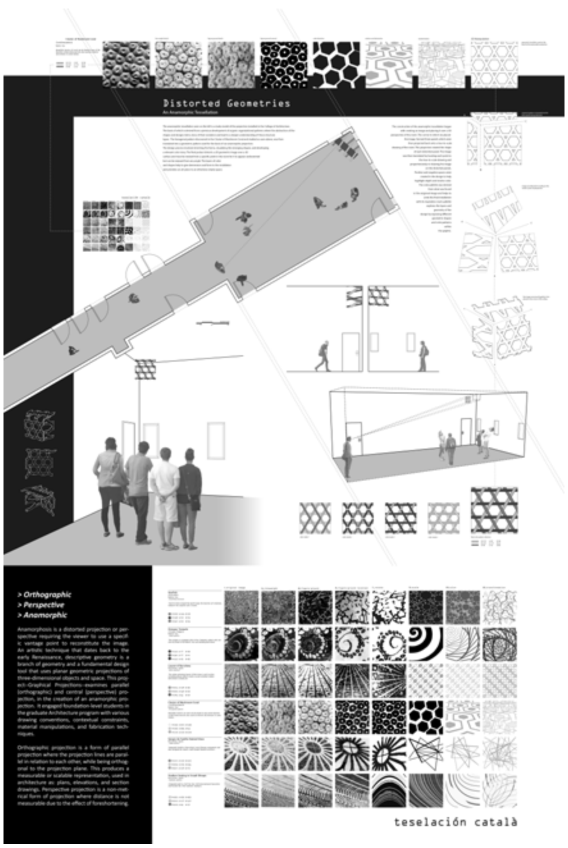


Fig. 4. Anamorphosis: final presentation board

After calculating the distorted anamorphic pattern from the perspective drawing, students began a series of material construction studies and color studies. These models informed the construction of the final installation within the actual space of the building for which they had designed the projection. The final presentation consisted of the physical installation of the anamorphic projection and a 36” x 36” presentation board of digital and analog drawing techniques placed next to the point within the space where the three-dimensional projection visually flattened into a two-dimensional image (figs. 4, 5, 6).

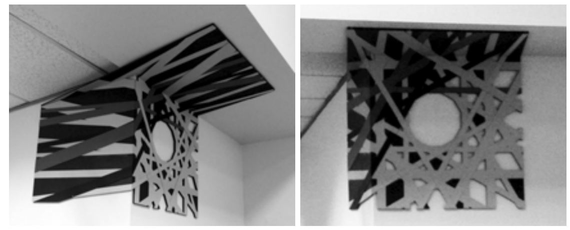


Fig. 5. Anamorphosis: projection installation

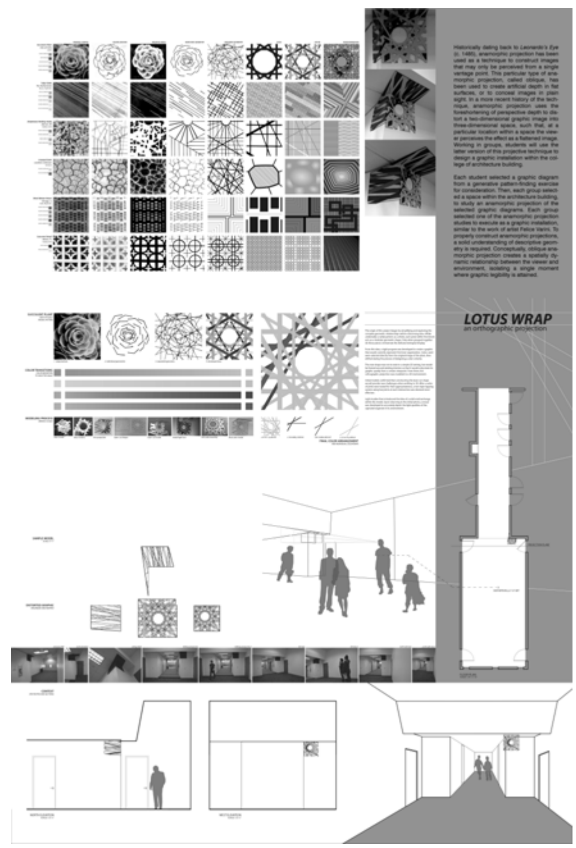


Fig. 6. Anamorphosis: final presentation board

Constructing Site Analysis

Architectural diagrams and maps, through graphic abstraction and representation, bring clarity to the conditions and constraints that circumscribe any design problem. In diagramming and mapping, choosing what *not* to draw, is often as important as what to draw. Diagrams and maps filter out unnecessary information, representing only that which is relevant to the idea(s) being communicated, while also having the capacity to articulate and manifest conditions that are not immediately apparent within a site. These drawings become the foundational tools that focus the priorities of a project and inform design decisions.

Systematic Landscapes continued the theme of constructing graphic techniques as a design problem by using site analysis as an opportunity to formalize the immaterial conditions within a site. Borrowing the title from Maya Lin's work in 2006, her installations demonstrate how material constraints are capable of providing new ways to understand a site. [2] The registration of a series of cuts across the land, when made with ½" MDF, abstracts entire strips of the actual geomorphology. Pulling apart the landform into a matrix of square samples, allows the viewer an impossible perspective of walking *between* the landscapes. A grid of bent wire is able to articulate the site in two directions, while positioning a person under the ground, as an assembly of 2x4s invites the viewer to appreciate a landscape that might otherwise go unnoticed.

Similarly, this studio developed models that reconstructed an analysis of downtown Houston within the constraints of a material system. However, the project departed from Lin's installations – which reconstitute observable landforms – as students formalized and constructed the latent conditions of a site, to expose alternative ways of understanding the area. In other words, what does it mean to *build* the pedestrian flows within a site? How could a model demonstrate the solar exposure across time? How could you build the wind patterns within a city?, etc. These otherwise unseen landscapes are used to inform how each student develops their final project.

Unlike conventional site analysis diagrams, *Systematic Landscapes* exist somewhere between data and a spatial construct. In addition to an awareness of place, students begin to understand how material constraints also impact decisions of formal organization and ways of making. By working with materials that are generally excluded from scale modeling, students have the opportunity to understand the techniques of flat materials (lamination, folding, joinery, etc.), liquid materials (casting, moulding, etc.), or mass materials (carving, milling, etc.). In the best cases, a traceable link from the constructed landscapes informs the design and making of the final project.

Conclusion

In both cases, *Graphical Projections* and *Systematic Landscapes* reflect the fundamental architectural challenge of realizing any built form within the constraints of a material practice, while acting as a technical and analytical tool that informs decisions in future projects. Likewise, both projects acknowledge that spatial design methodologies and environmental mapping techniques offer designers significant benefits in the conceptual phase.

Graphical Projections, introduced students to generative emergence and the notion that built spaces are activated by human movement. However, historically, Architecture has been more typically taught in regard to biased organizational methods, static drawing conventions, and objectified formalism rather than through the lens of temporality and spatial dynamics. Moreover, conventional perspectives and orthographic projection drawings are limited by their detachment from movement. By engaging the anamorphic, *Graphical Projections* simultaneously considers movement and questions the validity of static architectural drawings. However, the goal of this methodology did not suggest a radical departure from foundational principles, nor an entirely new architectonic aesthetic. Rather, for the beginning design student, this strategy addresses the potential for an increased awareness of physical space and of the human body moving through time.

In *Systematic Landscapes*, mapping as a method of teaching foundation design principles allows for the development of documentation practices and analytical skills alongside graphic visualization techniques. While still linked to the conventional curriculum pedagogies of composition and ordering systems, emphasis is placed on critical thinking as *the* approach to design rather than the pursuit of prescribed, formalist outcomes. Due to the multiplicity of see, unseen, and temporal conditions within an urban environment, self-directed exploration based on *finding* context, rather than assuming an obvious relationship of direct adjacencies, inspired curiosity, innovation, and choice. Furthermore, diagrammatic mapping offers students the ability to connect ideas directly to graphic translations using digital tools.

Additionally, *Systematic Landscapes* privileged analytical drawings and material investigations as a means of design communication. The project was built upon an intense material exploration, whereby students developed an intervention consciousness in regard to materials and their agency in architecture. This process promoted innovation among students with a very limited previous knowledge of "architectural" modeling materials. Students engaged materials through by developing a new language that would communicate a complex spatial idea that emerged from diagrammatic mapping. Spatial flows and situational analysis allowed for a more complex understanding of context to emerge. As a generative exercise, it operated on the premise that urban space is dynamic and continuously changing. *Systematic Landscapes* promoted more thoughtful understandings of the city as a socially, culturally, and organizationally rich environment where architects engage in extending its performance.

Over the course of the semester, beginning design students were guided through various conceptual processes that allowed them to question *how* and *why* they might realign their perceptions toward the design of *dynamic* spaces. We propose that these types of foundation exercises encourage beginning design students to engage in self-initiated design experimentation and innovative visualization—as well as more meaningful, performative, and critical Architecture.

Notes

[1] Andersen, Kristi. "Niceron's Construction of an Anamorphic Grid" " in *The Geometry of Art: The History of the Mathematical Theory of Perspective from Alberti to Monge* Springer: New York, NY. 2007. p 454-457.

[2] Andrews, Richard. "Outside In: Maya Lin's Systematic Landscapes" " in *Maya Lin: Systematic Landscapes* Yale University Press: New Haven, CT. 2006. p 61-75.

Immaterial Objectives of Design/Build Projects

Emily McGlohn

Mississippi State University

Abstract

Design/build projects are popular with students and an effective way to teach architecture through hands-on experience, team collaboration, and service-learning.[1] Clients instigate a program, provide feedback, and help to instill accountability in architecture students. The immaterial needs of the client, such as: the desire to feel safe, comfortable, and proud, become an integral part of the program, and students are encouraged by their own moral obligations to create thoughtful, highly functional, and beautiful architecture for their clients – all qualities that good architecture has. While the advantages of client based design/build projects are clear, this paper asks two questions: what are the immaterial needs of a client perceived by students in client based design/build projects and which immaterial objectives of client based design/build projects can be gleaned for use in non-client based design/build projects?

For the purpose of this paper, design/build projects are categorized into two groups: client based and non-client based. Both project types share positive learning outcomes such as: hands-on construction experience, teamwork training, and communication skills. However, projects without a client sometimes lack the service-learning aspect that some educators believe to be necessary for a successful design/build experience.

The first component of this study is a comparison of design studios that exemplify the two types of design/build projects identified earlier. Second, a survey of students who have participated in projects of both types will be conducted in hopes of identifying the immaterial objectives associated with having a client. These objectives may then be recreated for projects that do not have a client – enhancing the service-learning experience for the student.

Introduction

Design/build programs have increased in number and gained popularity in American architecture schools over the last 20 years.[2] It is estimated that there are at least 100 programs within the 123 NAAB (National Architectural Accrediting Board) accredited architecture schools.[3] These programs are popular because of the varied experiences provided by this method of learning. The value of a design/build education is sometimes criticized because of its perceived emphasis on construction, however, design/build projects often involve an aspect of service-learning and this "provide[s] an educational platform on which to present architecture as a complex structure of ethical position and actions" as stated by Scott Wing in his essay *Sore Shoulders, Bruised Ethics: The Unintended Lessons of Design/build*.[4] A student's experience is enriched by the immaterial objectives presented through meeting a client's needs. William J. Carpenter, author of *Leaning by Building: Design and Construction in Architectural Education* suggests four major points that a design/build education highlights: "Thinking and Making, Collaboration, Giving Back to the Community, and Communication Skills."[5] Of the four points listed above, one is related to technical skill, two are related to interpersonal skills, and one relates to service. A design/build project that includes all four points is ideal. Are learning outcomes different for students who participate without involving all four points? Not all design/build programs have the funding, time, and resources to accommodate a client, and some projects are simply focused on teaching technical and communication skills between students. Value exists in alternative forms of design/build projects but, assuming a client adds value, is it possible to infuse a non-client based project with the immaterial objectives associated with client based projects?

In an attempt to answer these questions an online survey was developed for two different groups of architecture students. The survey asked about a recent design/build project in which they participated, however, each group represented a unique experience. One project had a very involved client and the other did not. The groups were asked the same questions in hopes of determining the immaterial objectives of projects with clients.

Background

The concept for this study stems from my experience with student projects with and without a client. Currently I am an assistant professor at Mississippi State University (MSU) and teach a collaborative design/build studio that is named the Tectonic Studio. Two bus shelters were designed and constructed by this studio with limited interaction with the client. This project, which was completed in the fall of 2013, represents a non-client based project.

In comparison to my experience at MSU, I was an instructor at Auburn University's Rural Studio (2003 – 2006) where I worked with students to complete the design and construction of two single-family homes. Both of these projects had a client who was heavily involved in the design process and a major influence over the students. These types of design/build projects are ones I consider to be client based.

Fig. 1. Assembly of the Philadelphia, MS bus shelter.[6]

Both projects at MSU and Rural Studio were successful, however, after completing the bus shelters last fall I began to question how my MSU students' experience might have been different from my Auburn students' experience. My own background has suggested to me that the service-learning aspects of design/build projects are a major contributor to a meaningful project. Others, mentioned earlier in this paper, confirm my opinion. I developed three questions to attempt to determine how my MSU students' experience may have been different.

1. Are the learning outcomes different for students who participate in non-client based design/build projects?
2. What are the immaterial needs of a client perceived by students in client based design/build projects?
3. Which immaterial objectives of client based design/build projects can be gleaned for use in non-client based design/build projects?

I believe the learning outcomes are diminished when a client does not serve a critical role in a design/build project.

Mississippi State University Tectonic Studio – Two Bus Shelters: Fall 2013

The Tectonic Studio consisted of 35 second year architecture students and 14 second year building construction students. Together they designed and built two bus shelters. The majority of the construction occurred on campus and resulted in prefabricated portions of the shelters that were assembled on site (Figure 1).

Fig. 2. Assembly of the Tucker, MS bus shelter.[7]

Five professors taught this studio, including myself.[8] The Mississippi Band of Choctaw Indians funded this project and now use the shelters for their reservation's bus route around Philadelphia, MS. They were designed and constructed in one semester – August 19, 2013 – December 2, 2013. Although a client existed for this project, students only knew the client by name for approximately the first eight weeks of the semester. They were able to research the Choctaw culture but the client gave them no specific wishes and a site was not assigned. The professors developed the requirements for the bus shelters, including general site information, with assistance from the client. The decision to keep the client anonymous was intentional because the focus of the studio was collaboration between students and the technical aspects of design. After the designs were complete for both bus shelters, the students were introduced to the client and to each site. This project is one I consider to be non-client based. Architecture students who participated in this studio were asked to take part in the online survey developed for this study. They represent the perspective of a non-client based project participant and will be referred to as Tectonic students.

Auburn University's Rural Studio – Rose Lee House: Fall 2008 and Spring 2009

Auburn University's Rural Studio is an internationally known design/build program that operates in West Alabama. I am no longer associated with Rural Studio but they were gracious and assisted me with this study. With the faculty's help, I determined an appropriate client based project, Rose Lee's House in Footwash, AL. This project was designed and constructed by 33 second year architecture students during the fall of 2008 and spring of 2009.[9] Assistant Professor Elena Barthel and John Marusich instructed this studio. Rose Lee, the client, was involved in the process of design and according to Rural Studio website, "its design [the Rose Lee House] is driven by the client's priorities, necessities and lifestyle."[10] This project represents a client-based project and the architecture students who participated in this studio were asked to take part in the online survey developed for this study. They represent the perspective of a client based design/build project participant and will be referred to as Rural Studio students.

Survey and Analysis

To answer the questions posed previously, an online survey, hosted by SurveyMonkey.com, was developed and approved by MSU's Office of Research Compliance. The survey was entitled *Immaterial Objectives of Design/Build Projects*, and consisted of three multiple choice, four Likert items, and five rank order lists (ten questions in total.) Students were asked if they would like to participate in a drawing for one of two gift certificates to Amazon.com. Results of the survey were analyzed using SurveyMoney.com's analysis tools and Microsoft Excell.

Response Rate

A request to participate in the survey was sent by email to the 35 Tectonic students and 14 responded (41% response rate.) For the purposes of this paper, only the architecture students involved in the Tectonic Studio were asked to participate in the survey. With the help of instructors John Maruisch and Steve Long at Rural Studio, a request to participate in the survey was sent via Facebook to 32 of the 33 Rural Studio students. One student could not be contacted. Twelve out of 32 students responded (38% response rate.) Overall, 67 students were asked to participate and 26 responded (39% response rate.) The survey was open for two weeks time period for each group.

Results

Survey items are based on the research questions listed in a previous section. The results and discussion below attempt to answer these questions.

Influential Motivating Factors[11]

When asked, "What were the most influential motivating factors in your design/build experience?" Rural Studio students decidedly put all of the choices involving the client at the top of the list (see Figure 4 below.) Tectonic students rank factors related to design and construction higher than client's needs. Number one and number two on the Tectonic students' list is expected because they were strictly instructed to concentrate on how the bus shelter is assembled and how design is affected by methods of construction. Although a client was not a significant part of the project, Tectonic students still rank "the client's need for a well-built and sturdy building" as number three. Figure 3, below, shows Tectonic students top three choices. Interestingly, both groups of students rank "a good grade" and "my professor" lastly.

1	Good architectural design.
2	The desire to learn how to build.
3	The client's need for a well-built and sturdy

Fig. 3. Tectonic students' top three most influential motivating factors.

1	The client's need for a well-built and sturdy
2	The client's need for a secure and useful
3	The desire to learn how to build.

Fig. 4. Rural Studio students' top three most influential motivating factors.

Skills Important for an Architect[12]

When respondents were asked to rank a list of skills important for an architect, it was clear that both groups of students believe communication with a client is most important. Tectonic students clearly think many forms of communication to be important for an architect. This can be contributed to the nature of the studio. Tectonic students worked closely with teammates and building construction students to accomplish most assignments. See Figures 5 and 6 below for ranked lists.

1	Communication with a client.
2	Coordination between team members.
3	Compromise between designers.

Fig. 5 Tectonic students' top ranked skills for an architect.

1	Communication with a client.
2	An understanding of building materials and assemblies.
3	Coordination between team members.

Fig. 6. Rural Studio students' top ranked skills for an architect.

Skills Gained[13]

When asked "Which skills did you gain the most experience in during your design/build experience?" the same list of items from the previous question was given to the students. Both groups of students report gaining experience in communication and technical skills. See Figures 7 and 8 below for ranked lists.

1	Compromise between designers.
2	Hands-on construction skills.
3	An understanding of building materials and assemblies.

Fig. 7. Tectonic students' skills in which they gained the most experience.

1	Hands-on construction skills.
2	An understanding of building materials and assemblies.
3	Compromise between designers.

Fig. 8. Rural Studio students' skills in which they gained the most experience.

Qualities Important to the Client[14]

Tectonic students and Rural Studio students feel the same three qualities are most important to their client. See Figures 9 and 10 below.

1	Well-built and sturdy.
2	Secure.
3	Protective from the elements.

Fig. 9. Tectonic students' top ranked qualities they believe to be important to their client.

1	Protective from the elements.
2	Well-build and sturdy.
3	Secure.

Fig. 10. Rural Studio students' top ranked qualities they believe to be important to their client.

Qualities Important to YOU?[15]

In contrast to the question above, students rank qualities important to themselves differently. "Architecturally significant," "efficient," and "representative of culture" are now included. Both groups, however, feel that "well-built and sturdy" is the most important quality of their project. See Figures 11 and 12 below.

1	Well-built and sturdy.
2	Architecturally significant.
3	Efficient.

Fig. 11. Tectonic students' top ranked personal qualities.

1	Well-built and sturdy.
2	Protective from the elements.
3	Representative of culture.

Fig. 12. Rural Studio students' top ranked personal qualities.

Agree or Disagree?

In a series of Likert items, students were asked to respond to the statements in Figure 13. Figure 14 lists the results as a percentage of students.

A	A client is important to the success of a design/build studio.
B	Adequate time was spent with our client to be able to understand their needs.
C	Good architectural design was the most important aspect of our project.
D	The client's needs were the most important aspect of our project.
E	The client's input made our project better.

Fig. 13. Likert items students were asked to evaluate.

	Accept		Reject	
	Tectonic	Rural Studio	Tectonic	Rural Studio
A	86%	100%	7%	0%
B	0%	100%	86%	0%
C	64%	83%	0%	8%
D	71%	100%	7%	0%
E	29%	92%	43%	0%

Fig. 14. Response to Likert items by percentage of students.

Discussion

As expected, the learning outcomes for the two groups of students differed depending on the experience in which they were presented. Tectonic students, whose focus was on cross-disciplinary teamwork, reported they gained more experience with compromising between designers than anything else. Rural Studio students gained the most experience in hands-on construction skills. Communication with a client ranked seventh on the Tectonic students' list and only ranked fifth on the Rural Studio students' list.

Predictably, the results from the survey illustrate the influence a client has on a design/build student. One hundred percent of Rural Studio students reported the needs of the client were the most important aspect of their project. They also *all* reported that adequate time was spent with their client to be able to understand her needs. The client was clearly an important influence on the Rural Studio students. Conversely, 86% of Tectonic students reported *not* having adequate time with the client in order to understand their needs, however, 71% report that the client's needs were *still* the most important aspect of their project. The Tectonic students' desire to serve a client, even though client interaction was not required, is unanticipated. They were asked to concentrate on communication skills within teams and develop logic of assembly for each shelter. Although each shelter was required to satisfy the material program set forth, immaterial needs of the client were perceived by the students and they instinctively understood the importance. Interestingly, even with such different experiences, both groups of students came to the same conclusion about what they believe to be the most important skill for an architect to have – communication with a client.

Although respondents were asked "which qualities do you feel were most important to your client?" the results of identifying the immaterial needs of a client are not definitive. Both groups of students reported the same three qualities in different orders (see Figures 9 and 10 above.) It is inconclusive if these qualities were perceived by the Tectonic students or imposed by the Tectonic faculty. It is probably safe to say that Rural Studio students' perceptions were more accurate since they worked closely with the client. The qualities students find important are slightly different from what they believe to be important to a client. Tectonic students reported that being architecturally significant and efficient were important and Rural Studio students believe representation of culture is important. This could be explained through the nature of each program. Rural Studio students move to West Alabama for an entire semester to become immersed in the local culture. At MSU, students participate in Tectonic studio on a regular studio schedule, three days a week from 1PM to 5PM.

Conclusion

Looking at the intent of the study and the analysis of the results, it is difficult to determine which immaterial objectives can be gleaned for implementation into non-client based projects. The survey shows that students believe well-built structures are important to clients, but this is generally a requirement for all design/build projects. The survey revealed how important students believe clients are in design/build projects, and this supports earlier assertions that the service-learning aspect of design/build is equally important to the construction experience. In order to provide an educational experience for students that will prepare them to enter the profession, projects that include a component of client interaction are necessary. After all, each experience during an architectural education should contribute to the students' development as successful professionals. Design/build studio projects are one of the only opportunities a student will have to interact with a client in a meaningful way. This is not to say that projects without a client, or with a distant client are ineffective. I am suggesting that in studios like the Tectonic Studio, the client should be more present, and not held at arms length. This could be accomplished by an initial meeting with the client and students; the faculty could act as client representatives for the remainder of the project. If a client is involved, students seem to have a difficult time ignoring their responsibly.

In cases where there is no client and design and construction is the focus, I do not believe it is necessary to fabricate a client. For Example, in the fall of 2012 the Tectonic Studio completed a two-week project where students were given a restricted list of materials and a set of physical requirements to build a "pier" in the school's amphitheater. This project had no client and even at this scale, students reported that the hands-on experience provided them with a knowledge base of materials and methods.

The Tectonic Studio is ongoing and another iteration is planned for the fall of 2014. The primary focus will be collaboration between disciplines and assembly of materials, but students have expressed how important client interaction is to them, and this will be a consideration for the next project. If a client is initially presented to the students, it seems proper representation should be made throughout the process. Design/build projects are unique opportunities, and students understand that service-learning lessons are equally important to the design and construction aspects. It is difficult for students to divorce the client's interests from design/build projects and it is encouraging to hear beginning design students express their concern for the client's role in design. In the end, the educators' role and a significant intent of each studio project is to prepare students for their entry into the profession. Direct client interaction is a huge part of the Architect's role, and will be a significant component of most students' professional lives. We should do all that we can to prepare them.

Acknowledgments

I would like to acknowledge my colleagues at Mississippi State University for the team effort involved in teaching the Tectonic Studio. Before I arrived at MSU many hours had been spent envisioning this innovative studio and I am happy to be a part of it. I would also like to thank the faculty at Rural Studio. Without their support this study would not have been possible. War Eagle!

Last but certainly not least, thank you to all of the students who participated in this study. I should also acknowledge both groups for tirelessly working to design and build each project. I understand the amount of energy and dedication it takes.

Notes

1 Geoff W. Gjertson, "A House Divided: Challenges for Design/Build Programs in Architecture Schools" Paper presented at the 2011 ACSA Fall Conference, Prairie View A&M University, and Texas A&M University, Oct. 6 -8, 2011, accessed February 11, 2014, http://www.acsa-arch.org/docs/emails/house-divided.pdf.

2 *Ibid., 23*

3 *Ibid., 23*

4 Scott Wing, "Sore Shoulders, Bruised Ethics: The Unintended Lessons of Design-Build," in *From the Studio to the Streets: Service-learning in Architecture and Planning*. eds. Mary C. Hardin. Richard Eribes, and Corky Poster, (Sterling, VA: Stylus, c2006., 2006), accessed February 11, 2014, http://books.google.com/books.

5 William J. Carpenter and Dan Hoffman, *Learning by Building: Design and Construction in Architectural Education, (New York: Van Nostrand Reinhold, c 1997., 1997), accessed February 11, 2014, http://books.google.com/books.*

6 Image provided by students participating in the fall 2013 Tectonic Studio.

7 Image provided by students participating in the fall 2013 Tectonic Studio.

8 The collaborative studios at MSU in the fall of 2013 were taught by Lee Carson, Hans Herrmann, Alexis Gregory, Tom Leathem, and the author, Emily McGlohn.

9 "Rose Lee House," Rural Studio, accessed February 12, 2014, http://www.ruralstudio.org/projects/rose-lee-house.

10 Ibid.

11 Rank order list included: the client's need for a well-build and sturdy building, a good grade, the desire to finish the project, the realization of the design, the desire to learn how to build, good architectural design, the client's need for a secure and useful building, and my professor.

12 Rank order list included: compromise between designers, hands-on construction skills, communication with a client, an understanding of building materials and assemblies, coordination between team members, and understanding of architectural spatial relationships, empathy for a client, and effective documentation through drawing.

13 Ibid.

14 Rank order list included: secure, architecturally significant, protective from the elements, well-built and sturdy, representative of culture, sustainable, representative of self, and efficient.

15 Ibid.

Architectural Deceit Revisited

Mark McGlothlin

University of Florida School of Architecture

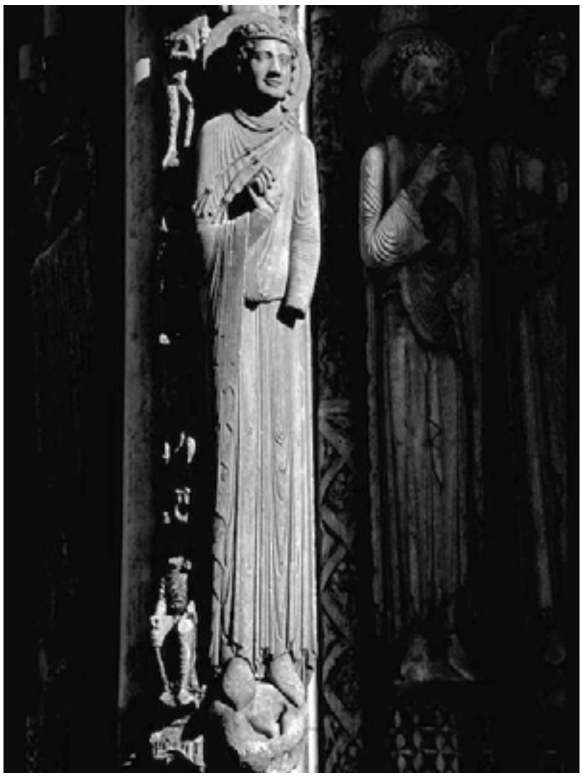


Fig. 1. Figures of Chartes Cathedral

Introduction

But in architecture another and less subtle, more contemptible, violation of truth is possible; a direct falsity of assertion respecting the nature of material, or the quantity of labor. [1]

John Ruskin penned his *The Seven Lamps of Architecture* as a lengthy polemic operating in a two-fold manner; first, as a reading of the value of architecture through seven tenets, or lamps; and second, as an indictment of three architectural deceits, themselves the product of both the growing pressures of industrialization on the building arts and the faltering moral character of architecture in society. To Ruskin, these deceits were omnipresent in contemporary architectural discourses and needed to be vanquished, replaced by the structural clarity and honest materiality of the gothic. Following its printing in 1849, *The Seven Lamps of Architecture* quickly grew as a dominant architectural treatise, foreshadowing Ruskin's more expansive book *The Stones of Venice*, which would serve as the foundation for the Arts and Crafts movement. Ruskin's dismissal of industrial methodologies offered a powerful, if momentary voice, that was quieted by the Modernist zeitgeist's broad intellectual reach and its openness to the new tools, techniques and materials afforded by industry.

Though the *Seven Lamps* remains as one of several canonical architectural essays, its significance in current architectural discourses is more of an antiquated polemic and while some still value Ruskin's impassioned resistance, more are likely to be content in casting him to the dustbin. Yet, his three deceits seem to have reappeared as a synthesized specter rekindled by material thinking in the digital realm. Of particular concern is the rapid acceleration of digital tools in the design studio, wherein the emphasis on novel techniques have displaced more conventional material inquiries, and beguiling suggestions of finished materiality through constructed imagery mask startlingly unresolved architectural ideas. Prompted as much by the tool as by the project, students fixate on simply making things appear to be complete without concern for the materials and techniques being represented, or more so fetishizing these materials and techniques for their own ends. Material has simply become the wallpaper of an unknown assembly, infinitely interchangeable and without consequence – or in Ruskin's words, an unacknowledged deceit.

The Three Deceits

Rather than jumping feet first into turbulent digital waters, it is important to first examine the contextual origins of Ruskin's *Seven Lamps*, and more so the portions of his essay directed to the concerns of materiality. The *Seven Lamps* emerged during a time of remarkable transformation. The industrial revolution was already well underway and the full potentials of its burgeoning industrial might were quickly displacing earlier methods of building, and with them the societal fabric that supported that production. Karl Marx and Fredrick Engel's *Communist Manifesto,* published just one year prior to Ruskin's *Seven Lamps,* served as an agitating voice to these chaotic times, wherein the socio-political fabric of Europe was upended, exposing the palpable tensions between the social classes. Ruskin, equally sensitive to the growing pressures for social reform in response to this accelerating industrial prowess, used the aesthetic dimension of architecture as his muse, and through this medium directed his attention to the broader relationships between buildings and society, and more so the focused relationship between architecture and man.

In penning his essay on the "distinctly political art of Architecture"[2], Ruskin offered the following statement as his broader intent:

I have long felt convinced of the necessity, in order to its progress, of some determined effort to extricate from the confused mass of partial traditions and dogmata with which it has become encumbered during imperfect or restricted practice, those large principles of right which are applicable to every stage and style of it. Uniting the technical and imaginative elements as essentially as humanity does the soul and body, it shows the same infirmly balanced liability to the prevalence of the lower part over the higher, to interference of the constructive, with the purity and simplicity of the reflective element.[3]

Ruskin sought to offer the clearest and most honest definition to his seven lamps, wherein each lamp stood "for a direction in which it is considered well for a beholder's associative trains to wander."[4] Of these seven lamps, the Lamp of Truth was distinguished as being the one most bound to the material realities of construction.[5] Ruskin understood these realities and conceded that the disparities between actuality of construction and its material expression did not interfere within the greater architectural deceits as he saw them, namely that of structure, surface and operation.

Structural Deceits

For Ruskin, structural expression was at its most noble state when "an intelligent eye discovers the great secrets of its structure, as animal form does, although from a careless observer they may be concealed."[6] Though Ruskin acknowledged the architect's discretion in revealing or concealing a building's structural logic, Ruskin offered no latitude to an expression of structure "other than the true one."[7] In this regard, Ruskin's position was clear, as any expression that could be visually interpreted as structure but played no such role could only be seen as dishonest, and thus deceitful. More so, the materials of structure were narrowly defined and strictly determined, to the extent of limiting the role of iron to that of "*cement* but not as *support*."[8] For Ruskin, the honest expression of structure was rooted in materiality, a position that binds the notion of structure to the second deceit, surface.

Surface Deceits

Ruskin's position on material surface paralleled that of structure, accepting certain concessions between the appearance of and the actual means of construction. In contrast, any attempt to beguile the beholder with the representation of a material as being something other than itself could was deceptive in intent, and this proffered a falsehood. The most explicit demonstration of surface deception occurred when a material was painted to appear to be a different material, a practice that had become commonplace in 19th-century architecture. In Ruskin's eyes, this practice was merely the proffering of an architectural illusion and could not be justified. "Touching the false representation of material, the question is infinitely more simple, and the law more sweeping; all such imitations are utterly base and inadmissible."[9] Ruskin was careful to distinguish the expression of materials through veneers, gilding, and plaster with frescos as honest, citing that these surfaces remained genuine to the noble character and intent of the material, and as such offered no attempt towards deception. With this, Ruskin preserved the skills of the painter, carpenter or mason, particularly in contrast to those of an anonymous common workman, as being valuable in retaining truth in the material. This sense of value, in turn, led to Ruskin's third deceit, wherein the character of the material and its associated labor was displaced by the onslaught of industrial materials and techniques.

Operational Deceits

Ruskin showed no remorse in expressing his disdain for industry and the materials associated with it. Ruskin's narrow focus on cast iron ornamentation merely served as a vehicle for his two-pronged critique, one directed to the inherent weakness in terms of craft in cast and machined ironwork, and the second to the depleting effects of industrialized processes on the intrinsic sense of labor within the work. To Ruskin, this latter depletion was "the grossest kind", offering "sufficient reason to determine absolute and unconditional rejection of it."[10] Ruskin was abundantly clear on this point, dismissing the products of industrial processes as crude and unbecoming in terms of material refinement. More so, Ruskin lamented the loss of craft in this work. The absence of the hand of the maker left it empty, and thus detached from its associative meaning of the labor invested in making it.

For Ruskin, the high gothic period in architecture represented the greatest balance of detail, material and craftsmanship, demonstrating "how nobly it unites fantasy and law."[11] More so, the architectural decline that followed was born of material falsehoods that substituted "the *line* for the *mass,* as the element of decoration,"[12] leading to a disintegration of the broader rules of gothic architecture. "So fell the great dynasty of medieval architecture. It was because it had lost its own strength, and disobeyed its own laws – because its order, and consistency, and organization, had been broken through – that it could oppose no resistance to the rush of overwhelming innovation. And this, observe, all because it had sacrificed a single truth."[13]

Tilling the Dustbin

To look back to Ruskin for insight into the evolving role of digital tools in architecture of may seem an absurd stretch. Ruskin's rejection of industrialized materials and methodologies can hardly be seen as useful by contemporary standards, nor can his retreat to the high gothic as the primary source for architectural meaning. That being said, Ruskin's concern with the role of technology in architecture aligns surprisingly well with current debates regarding the influence of digital tools on the design process, and more so within the bounds of design pedagogy where the critical discourse regarding the tools, methods and materials of architecture remains vibrant.

Before agitating the architectural dustbin, it is important to make two clarifications. First, the primary focus will remain within the bounds of contemporary architectural pedagogy. By narrowly bounding this reconsideration to the academy, the focus is directed to the critical formative moments in an architect's training, where the speculations on Ruskin's specter may offer the greatest resonance. More so, though contemporary practice makes immense contributions to the breadth and depth of architecture thinking, the academy "remains the crucial site where the discourse of architecture is formulated and disseminated," [14]

Secondly, and more directly, this examination takes to heart the undeniable influence of new technologies on the design fields, and does not mean to indulge in an academic exercise of resurrecting Ruskin to simply perpetuate Luddite traditions. Rather, the concern will be on the long shadows that Ruskin's deceits may cast, and more so how these deceits have remerged in new variants caught up the turbulent "rush of overwhelming innovation."[15]

Structural Deceits – The Appearance Of Standing

Ruskin's concern regarding structural deception was directed to tectonics masquerading as structure, and in this light, this deceit should retain its critical potency. Contemporary architecture is just as likely to be critiqued on its structural merits and as will be scrutinized for any structural falsehood that may be offered. That being said, the understanding of what is structure, in contrast to what is given the appearance of structure, has become increasingly mired in architectural rhetoric, and subsequently further divorced from the real obligations of structure in building. As an example, the tenets of the International Style, which argued a transparent and unornamented expression of structure, become questionable when held to the light of the realities of construction.[16]

In this regard, Ruskin's initial definition of structural deceit remains true at its core, but is too narrowly defined to withstand the pressures of contemporary design issues, particularly given the geometric complexities afforded by a digital realm devoid of gravity. Any argument to employ digital analysis as a means towards establishing structural integrity must be understood to contribute to this deception. The student, and their critics as well, may be satisfied with perpetuating this falsehood, not out of spite for the role of the engineer, but more so for the beguiling images before them.

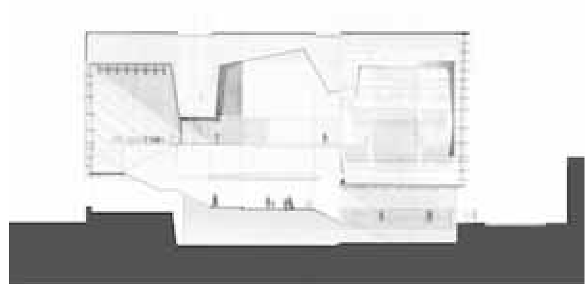


Fig. 2. The Impression of standing absent structure – student work: Peter Sprowls

Surface Deceits – Paper Thin Walls

Ruskin, in his effort to reconcile material intentions in architecture with the reality of construction, conceded that the a rigid interpretation of materiality was not essential in order to maintain the truthful expression of material.[17] This concession, however, relied on the genuine expression of that material, even if it was a veneer thinly wrapped over a more crudely defined substructure. Ruskin's rejection only applied to those moments where material deception was intentional. To bring this deceit back into play, the same kind of concessions need to be addressed. Though critics may debate the honest expression or use of material in the specific images provided by the student, the particular concerns of materiality within these images are quickly reframed and placed in service of a larger discourse about the role and meaning of material in contemporary culture. Unlike Ruskin's time, where the architectural apprentice was likely to be in direct contact with the materials with which he worked, architecture students are increasingly unfamiliar with the multifaceted role of materiality, and thus unaware of the larger implications of materiality in design, particularly when the digital realm allows them to apply materiality to indistinct tectonic systems without consequence.

The notion suggested by Ruskin, whereby *line* displaces *mass,* is not simply continued, but expanded to even higher levels of material illusion. Unlike Ruskin's line, wherein material thinking may have lingered ever so faintly, the digital line carries no such residue and as such can be understood as being in perpetual material flux. More so, the digital environment provides no means of resistance relative to the determination of material; the monolithic weight of in-situ concrete can be placed with the same ease as the transparent and reflective qualities of glass - and more so, both can be exchanged without consequence to either system. This approach to material thinking is as immaculately thin as Ruskin's layers of faux-paint, and equally deceptive. Insofar as materiality in the digital realm is as shallowly applied as Ruskin's marble-painted wood, so too is the perception that materiality matters in architecture beyond its painterly impression within in image.

Operational Deceits – Means and Ends

Ruskin reserved his most abrasive critique for the products of industry, which, in his eyes, were vulgar representations of both the characteristics of materials and the labor involved in their production. Ruskin admired the value of labor as evidenced in the work itself, and as such appreciated the physical imperfections of handwork as a testament to the efforts of craftsmen. Ruskin's larger tome *The Stones of Venice,* written just four years after his *Seven Lamps,* codified this position:

> *You can teach a man to draw a straight line, and to cut one; to strike a curved line, and to carve it; and to copy and carve any number of given lines and forms, with admirable speed and perfect precision; and you find his work perfect of its kind: but if you ask him to think about any of those forms, to consider if he cannot find any better in his own head, he stops; his execution becomes hesitating; he thinks, and ten to one he thinks wrong; ten to one he makes a mistake in the first touch he gives to his work as a thinking being. But you have made a man of him for all that. He was only a machine before, an animated tool.*[18]

Ruskin's dogged resistance to industry was rooted in this kind of insistence, for if industrial procedures emptied of imperfections within the work, so to did it strip it of its meaning.

By today's standards, this position would likely be considered quaint, born from sentimentality and antiquated values. That being said, the operational deceit to which Ruskin devoted such attention, remains viable, albeit in a variant form that holds technology at its center. Ruskin, in defining *operational deceit*, defined two deceptive characteristics as critical, the crude quality of the object of casting or machinery and the subsequent devaluing caused by the visible loss of labor. Unlike these technologies, digital tools offer no easy means to find such a division, nor does any effort to re-establish such divisions prove useful. Rather, the increasing availability of digital production, in both the creation of imagery and the extension towards material fabrication, has made the relationships between process and product clouded, interwoven, and teetering on the tautological.

It could be argued that Ruskin's concerns should be washed away and any new concerns, if any, formed in their stead. This posture, likely to be favored by technophiles, may use at its base the rising ability of the designer to leverage greater control over production and more opportunity to articulate a higher level of sophistication in terms of both artistry and performance within the work, without additional labor, and more so without the problematic trappings of preordained aesthetic judgments or referential dogma. Michael Meredith noted of the growing influence of parametrics within the design fields:

To the extent the profession has utilized parametrics today, there is very little instigating complexity other than a mind-numbing image of complexity, falling far short of its rich potential to correlate multivalent processes or typological transformations, parallel meanings, complex functional requirements, site-specific problems or collaborative networks. When something supposedly looks "parametric" today, it's aesthetic (re)production – the repetition of quality and taste. The mastering of hi-tech engineering software is ultimately used to produce ornate architectural decoration.[19]

Meredith's comments, directed to the range of emerging parametric strategies within the digital realm, are refreshingly self-critical and curiously mirror with those of Ruskin. Ruskin harbored no aversion to architectural ornament so long as it was born through material restraint, wherein the inherent character of the material was celebrated in both its shaping and the labor involved in making it. Ruskin depicted this concept, and its corresponding corruption, within the shift from mass to line, which was born from the transformation in the development of stone tracery, wherein the expression of carved stone drifted away from mass and its inherent strength in favor of more slender forms that broke away from their material origin to explore the fragility and elasticity of line; "The flexible traceries were often beautiful, though they were ignoble; but the penetrated traceries, rendered, as they finally were, merely the means of exhibiting the dexterity of the stone-cutter, annihilated both the beauty and dignity of the Gothic types."[20] In other words, the shift from mass to line replaced the original intent of material with the fascinations of process, and as such allowed the self-referential potentials of innovation to eclipse the more humble, but noble material intent – or even more simply, the means justify the ends.

Meredith's concern regarding the use of parametrics is precise, and in doing so he illuminates both the potentials of parametrics in advancing architecture in more complex and productive ways, and the inherent limits that these tools and processes carry. "Architecture is primarily a cultural socio-political form, not technological determinism; it's super vague, it's inclusive, relational, it's parametric, but it's far more complex than any of us could singularly map out within the computer and totally understand because it's out of our grasp."[21]

Meredith's recognition of architecture's "socio-political form" recalls Ruskin's early acknowledgement of architecture as "distinctly political art,"[21] and in doing so sheds light onto the heart of the operational deceit. If architecture is to advance meaning in itself, then its cultural context needs to be central. Self-referential processes, however, offer no quarter to these concerns, accommodating only those parameters that reinforce and extinguishing those that prove inconvenient. More so, its most egregious variant appears when the design process is fueled solely by digital technologies that rely on their own self-referential justifications as a means of defense for the architectural inadequacies that they produce – which is to say, ""it has to be that way because of the geometry or form, or "the software did it.""[22]

Ocular Deceit – Between Images and Words

In reference to drawing, Le Corbusier was quoted as saying; "I prefer drawing to talking. Drawing is faster, and leaves less room for lies."[23] His thoughts, precise and meaningful to a profession reliant upon the visual senses as a primary means of study, may have rung loudly years ago when hand-drawing remained the primary method of architectural study. The exercise of drawing still offers truths about design thinking that cannot be found elsewhere. The challenge, however, is not in regards to the act of drawing, but its waning significance as a critical part of design inquiry. Ruskin could not have anticipated the digital revolution that has overwhelmed the architectural discipline, nor could he have imagined the degree to which these tools would reshape the design process. Meredith's anecdotal quip, "the software did it," resonates loudly in this regard. Digital tools afford students the ability to consider their work in three dimensions, at full scale, and without the limitations that handwork would incur. More so, digital modeling offers the potential to confront the joints, seems, folds and corners that two-dimensional drawing would otherwise leave undisclosed. That being said, the digital realm equally encourages the conscious avoidance of these material intersections, as the design process shifts away from the larger tectonic and spatial concerns of the project as a whole in favor of privileged perspectival views that purport to represent a larger architectural vision that is grossly incomplete, masked by thinly painted facades (Fig. 3).

In fairness, this ocular deceit is an extension of Ruskin's concern with industry, but only loosely so. The falsehoods of digital imagery are not directly the result of the tool, but rather are tied to the seductive powers that these tool supply. The impression that digital tools can quickly bridge between the imagined and the real is in itself deceptive. Regardless of suggestive imagery or the veiled promises of digital fabrication, there is an undeniable gap between the architectural imagination and the realities of material making. Many within the academy accept this distance, and celebrate it as critical in separating architectural invention from the conformist pressures that the profession can impose. There are others, however, who are content to fill this gap with verbose and impenetrable rhetoric, and in doing so reinforce the ocular deceit by constructing an intellectualized mask bound up with words.

Fig. 3. Buildings with no backs – student work: Reid Caudill and Kirsten Ackerman

Coda

In reconsidering Ruskin, the paradox of identifying deceptive design practices while remaining free from excessively narrow dogmatic positions is apparent and troubling. As previously noted, Ruskin observed architecture's growing dishonesty "respecting the nature of material, or the quantity of labor,"[24] and in response developed his perception of three deceits within both built work, and more so, in anticipation of work yet to come. In this light, it may appear that Ruskin's arguments in petitioning for a more honest approach towards material and methodology would stifle the imagination. Quite to the contrary, Ruskin was abundantly clear; "For it might be at first thought that the whole kingdom of imagination was one of deception also. Not so: the action of the imagination is a voluntary summoning of the conceptions of things absent or impossible; and the pleasure and nobility of the imagination partly consists in its knowledge and contemplation of them as such…"[25] Ruskin championed an ascetic design process that would be insufferable in today's complex and multilayered design culture. That being said, Ruskin's desire to keep distinct the truthful and the deceptive remains use, as the alternative will only perpetuate the accumulation of discarded and fleeting falsehoods that appear to be truthful.

In a world that really has been turned on its head, truth is a moment of falsehood.[26]

Notes

[1] Ruskin, John. *The Seven Lamps of Architecture.* Illustrated Library Edition. New York: James Clarke and Company, 1885. Print. p 38.

[2] Ruskin, p 10.

[3] Ruskin, p 10.

[4] Baljon, Cornelis J. "Interpreting Ruskin: The Argument of the Seven Lamps of Architecture and the Stones of Venice," in *The Journal of Aesthetics and Art Criticism.* Vol. 55, No. 4 (1997). http://jstor.org/stable/430927 (accessed March 1, 2014). p 401.

[5] Baljon, p 402.

[6] Ruskin. p 40.

[7] Ruskin. p 39.

[8] Ruskin. p 45.

[9] Ruskin. p 50-51.

[10] Ruskin. p 55.

[11] Ruskin. p 61.

[12] Ruskin. p 63.

[13] Ruskin. p 68.

[14] Ockman, Joan, and Rebecca Williamson. Eds. *Architecture School Three Centuries of Educating Architects in North America*. The MIT Press: Cambridge, MA. 2012. p 35.

[15] Ruskin. p 68.

[16] Daniel Schodek, in discussion with William LeMessurier, analyzed Le Corbusier's Carpenter Center from the point of view of the structure, contrasting the intentions of the architecture to express specific structural principles visually against the realities of the structure in both material and construction. For more information, refer to: Schodek, Daniel. "Structural Reminiscences: Carpenter Center at Harvard," in *Form, Modernism and History,* Alexander von Hoffman, ed. Harvard University Press: Cambridge and London, 1997.

[17] Ruskin was clear in his preference for the honest expression of material, particularly thickness, but understood that the broader implications of this attitude would run counter to the expectations proffered in the Lamp of Sacrifice. More so, Ruskin accepted that the use of veneers and gilding, though not representative of the larger assemblies that supported it, were not dishonest, as the material expression, such as marble, was genuine. For more on this, see *The Seven Lamps of Architecture,* "The Lamp of Truth, XVIII", Ruskin. p 53-55.

[18] Ruskin, John. *The Stones of Venice. The Sea Stories*. Vol. 2. New York: John Wiley & Sons, Publishers, 1878. p. 178.

[19] Sakamoto, Tomoko, and Albert Ferré. *From Control to Design: Parametric/Algorithmic Architecture*. Barcelona: Actar-D, 2008. p. 6.

[20] Ruskin. p 64.

[21] Ruskin. p 10.

[22] This is a fragment of a larger statement by Michael Meredith, which is as follows; "The parametric is a totalizing aesthetic built upon the legacy of American formalism, an ideology which has since transformed from an important critique of functionalist dogma as a positivist and naively utopian discourse into its own positivist position ("it has to be that way because of the geometry or form" or "the software did it.") Sakamoto, p. 6.

[23] Le Corbusier. BrainyQuote.com, Xplore Inc, 2014. http://www.brainyquote.com/quotes/quotes/l/lecorbusie 115261.html, accessed March 7, 2014.

[24] Ruskin, p 38.

[25] Ruskin, p 37.

[26] Debord, Guy. *Society of the Spectacle*. Trans. By Donald Nicholson-Smith. New York: Zone Books, 1994.

Guiding Beginning Design from the Outside In

Lauren Mitchell, PhD

University of Hawaii at Mānoa, School of Architecture

Introduction

In *Architecture from the Outside: Essays on Virtual and Real Space*, Elizabeth Grosz sets up several philosophical experiments, carefully imagining new conceptual starting places for the study of space and architecture. She is interested in opening up trajectories for radically diverging from unproductive aspects of the discipline, and from stagnant conceptions of space.

I have drawn upon three of the essays specifically, "The Future of Space: Toward an Architecture of Invention," "Architecture from the Outside, and "Architectures of Excess," in the development of a beginning design studio. I will briefly outline the significance of these essays for this beginning design course, and how they have influenced the course curriculum. In April the course projects will have mostly been tested, at which point substantive conclusions may be presented.

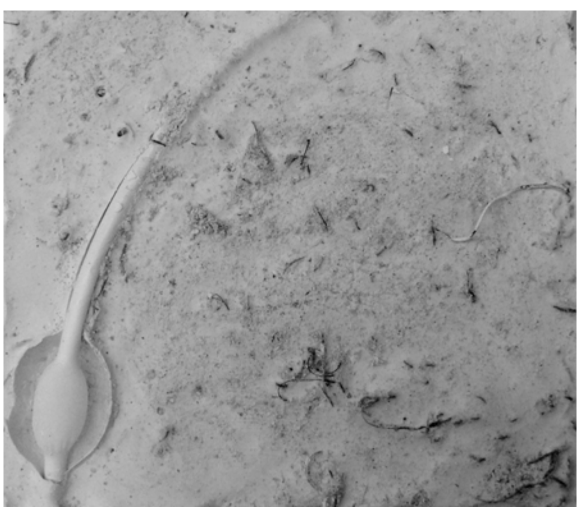


Fig. 1. Exaggerated Tactile Transition (P1.2)_ Priscilla

Grosz' essays have been influential in my approach to teaching ARCH540, *Threshold to Architecture*. This studio course is a transition for UH Manoa's incoming architecture grads holding degrees in areas outside of architecture into a professional, NAAB accredited architecture program—into a community. These "non-professional degree holding" students (often called "boot-campers" at UH) are perceived and perceive themselves as coming from outside in. Last fall I found myself, for example, eager to mine the applications of this particular group, which I have come to refer to as threshold students, in order to find out "from" where each has come "into" architecture.

Grosz asserts, the outside "is paradoxical insofar as it can only ever make sense, have a place, in reference to ... an interior," (xv). The majority of the threshold studio effort surrounds the groups' capacity to "enter" the graduate architecture studio sequence the following fall. At this point they join studio courses with students holding pre-professional degrees in architecture and continue together for the duration of 3 more years (a typical scenario in many schools of architecture). Discussions during the faculty review of each studio last semester revealed instances in which UH faculty found "boot-camper" performance distracting due to a lack of one or more particular skill sets, such as section drawing and site analysis.

I am perhaps overly sensitive to this paradox of the outsider's position, having recently completed a PhD in Rhetorics, Communication and Information Design. With my focus now reoriented again more centrally on architecture, I find this particular beginning design studio ripe for disciplinary expansion and productivity. My primary question, considering the pedagogy of this studio, surrounds whether we should continue to expect the group to quickly assimilate to the many visual communication and design skills needed (hence the boot-camp mentality). Or, should we conceive of this group differently altogether? Grosz' essays help to tease out why I believe the latter.

Grosz also posits the outside as perverse. She explains, "for while it (outsider) is placed always relative to an inside, it observes no faith to the consistency of this inside," (xv, parenthetical insertion mine). The perversity of the threshold students' exteriority lies in the reality that they can communicate from a position of authority on some related topic, and generally have thoughtful insights about the profession of architecture as a result. Using this class of 10 students as an example, they collectively hold a few decades of experience in other professional, and even military arenas. To what degree is it possible for us to write into the curriculum opportunities to celebrate their experiences toward the betterment of the field of architecture? Would architecture be better served if we began to conceive of these student perspectives as opportunities for the field to diverge from the status quo?

Grosz' collection of essays address the notion of community from a perspective that this mixture of graduate students are able to uniquely grasp (whether they choose to or not). Joe, a local practicing engineer, and Kaili a native Hawaiian who holds an MFA and is a successful sculptor/art professor, each have more experience in their first field than myself. As a result of the fresh perspective their added area of professional experience provides, I see Kaili and Joe as capable of leading architecture from the outside in, but I believe this requires a shifted perspective.

Within the essay "The Future of Space: Toward an Architecture of Invention," Grosz speculates about what philosophy can bring to architecture and vise versa. The conclusion surrounds opening up new conceptual starting places—a proposed logic of invention conceived to supplement the dominance of Aristotelian logics of identification. Grosz asserts, "The virtual is the realm of productivity, of functioning otherwise than its plan or blueprint, functioning in excess of design and intention," (130).

Though Grosz is speculating here about how architectural modes of thinking/making can accelerate philosophical experiments and vise versa, I extend her project to the threshold student's position of outsider. Teaching this group requires opening up oneself to surprise and veering off of one's course. Grosz continues:

"This is the spark of the new that the virtual has over the possible: the capacity for generating innovation through an unpredicted leap, the capacity of the actual to be more than itself, to become other than the way it has always functioned," (130).

Fig. 2. Exaggerated Tactile Transition (P1.2)_ Priscilla

In summation, I have approached teaching this class with the hope of discovering repeatable strategies that may be used in order to celebrate the unique gifts of these individuals coming into architecture from the outside. Rather than to approach their first semester as a boot camp, or as time for assimilation, I have decided to regard their choice to come into the program as a valuable opportunity for the school to become more than itself. If handled with more care, I feel the *virtuality* of the threshold students may help us to understand more expansively what the gifts of architecture are?

What do we teach and why do we teach it?

Arch540 has in most ways been conceived as a basic design course. The preexisting curricular map/guideline asks for two main items, which are body and space mapping, and a focus on tectonics/making.

Beyond a general theoretical premise, Grosz' essays and the outsider subject position has helped to guide the pedagogical agenda of

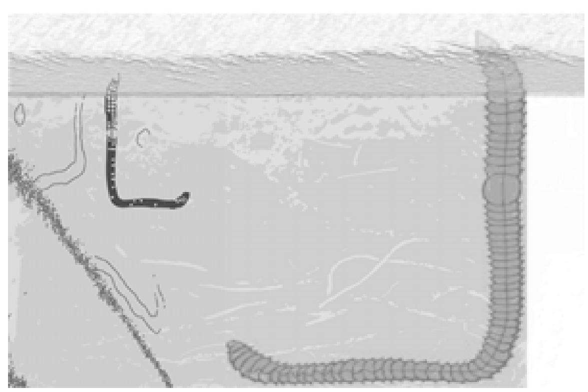


Fig. 3. Atmospheric Threshold (P1.1)_ Priscilla

ARCH540 as well. In the last two sections I will focus more directly on how Grosz has helped me to alter this sequence subtly for the threshold students, toward the above aims. Below I have simply outlined a fairly predictable sequence of basic design projects, which I have used as my template. The projects are an aggregate of ones I have previously taught to undergraduate beginning design students.

The semester has been broken down into three phases outlined as follows:

Domestic Section: Folding Inward (6 Weeks)

Key terms: Thresholds, transitions, moments (doors, windows, stairs) always as these relate to and are contextualized by the body.

- Terminates with a tectonically specific and fragment model driven by student led spatial narrative fictions.
- Final work is constructed at 3/8" scale to help with model making skills as well as to become intimate with conveying atmosphere with materiality.
- Successful spatial compositions are ensured by way of provided kit of parts.
- Deals with Vertical section as primary spatial determinant.
- Introduces light as a medium.
- Focus on body in context/as context
- Focus on relationship between body and space as well as body and tectonics.

Domestic Field: Folding Outward (2 Weeks)

Key terms: Space/object in field, matrix, urban, context

- Terminates in one map/analysis drawing.
- Body within a larger context.
- Emphasizes understanding of spatial itineraries and the role of time and sequence.
- Local urban condition in Honolulu.
- Focus will be on sectional ribbons in an urban setting rather than plans/patterns.
- Section drawings from first project are superimposed into a larger contextual section.

The Desert/The Sublime: Body + Context + Program Synthesis (7 Weeks)

Research Phase1: Context_ The Great Thar desert of Gujarat.

The Thar Desert in Gujarat is the most densely occupied desert in the world. The students will be asked to research this context, producing cultural, physical, and material data about this sublime context.

Research Phase 2: Program + Tectonics Integration_ The Step wells of Gujarat region

The Step wells are essentially an ancient sustainable device, which collect and make available ground water throughout the year. As the level of the groundwater drops about 40 feet during the course of the year, the vertical section of these wells are used for shelter and social/cultural purposes during the hottest seasons. These deeply ritualistic and culturally layered spaces will act as an exaggerated example by which the students will begin to understand context + program/tectonic synthesis.

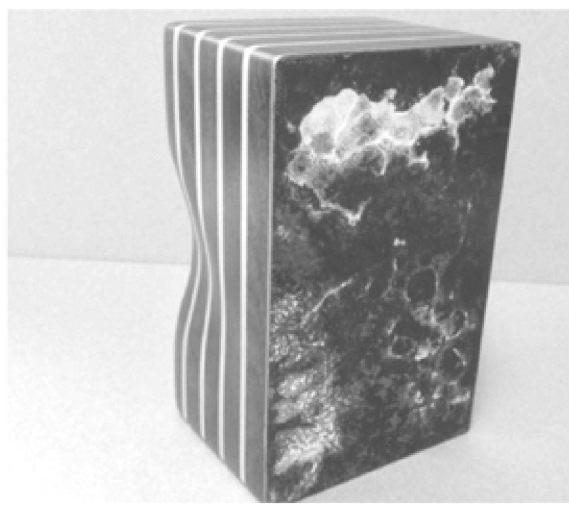


Fig. 4. Exaggerated Tactile Transition (P1.2)_ Kaili

Building Project Phase: The selected site is the Big Island, Hawai'i (Lava zone 1). The program will be a rehabilitation facility.

What are the material objectives of design education?

Grosz has helped me to customize the project sequence outlined above with the subject position of the threshold student in mind. In this section I will touch on two customization strategies I have conceived of as a means to accelerate the potency of the above projects, distilling what seem to be the most vital skills and project deliverables within an accelerated beginning design path. For the purpose of time and space, I have only focused here on the first project in the above outlined sequence, where the final section focuses more on the third project of the sequence.

Aleatory (Chance) Procedures

Architect peter Zumthor provides a launching point for the first project of the semester. His mastery of materiality and tectonics offer examples of architecture that are in “excess″ or “more than,” while coming from an authoritative and accomplished position within the disciple. In 2013, during his Royal Gold Medal lecture at the RIBA in London Zumthor states that form matters little to him throughout the design process of a given project. He is more interested in the "condensation of emotion" and/or the "atmospheric” conditions of spaces,[1] asserting that form can easily arrive at the very end of a project.

After watching Zumthor’s 2013 Royal Gold Medal lecture, I asked each student to select an “atmospheric input” randomly from a paper bag. The inputs come directly out of Zumthor’s lecture and project oeuvre, and are listed below.

Atmospheric Inputs:

- Sound of architecture: Angular
- Sound of architecture: Breathy
- Temperature of architecture: Warmth
- Temperature of architecture: Cold
- Tension in architecture: inside-outside
- Tension in architecture: compression- release
- Seduction and architecture: pulling-pushing
- Intimacy and architecture: hand
- Intimacy and architecture: resting
- Mood of architecture: Excited
- Mood of architecture: wary

Light and architecture:
Shadow Design projects typically originate out of some combination of three elements: the site or “context,” the program, “function” or “use,” and the intentions of the architect, his/her “project.” If architectural procedures are reducible to one of these starting places alone, the full ecology, and therefore, potential of generating designs through alternative methodologies becomes lost. Grosz articulates this sentiment below:

I simply want to argue that the gift of architecture is always in excess of function, practicality, mere housing or shelter. It is also always about the celebration of an above-sociality, a cultural excess that needs elevation, not diminution. (165)

Beginning with site and/or program alone restricts the designer’s agency, by reducing creative action to a means-ends attitude wherein the act of design becomes mere problem solving—spatial, ecological, or otherwise.

Drawing from current rhetorical terminology, the identification of a beginning, or new juncture, first requires the recognition of a hiatus, or a break, from known (disciplinary) *stasis* points. Stasis, here, refers to articulated or unarticulated norms in architectural education in which the site/program or “design problem” founds the only legitimate architectural approach. In order to explore projects in line with Grosz’ thinking, more attention must be placed on aleatory (chance) methodologies at the start of projects.

I believe this will result in a much-needed hiatus, opening up possibilities for new beginnings. In both rhetorical study and in architecture pedagogy, I hope to encourage instructors to utilize methodologies that are chance-based, directing students beyond comfortable starting places that they are confident will guide them toward a single or, at least, narrow range of solutions. This lesson seems most critical for the threshold students who may come to architecture with more typological conditioning and preconceptions about buildings than undergraduate students.

Finally, aleatory methodology encourages the design of discourse as a significant ecological practice inherent in any creative act.

Potent/Efficient Representation_ Scale and Fragment

Rather than placing emphasis on formal and compositional strategies first, I directed the students through a sequence of fragmented exercises culminating in a physical model that itself is fragmented in nature. The assumption is that the formal and compositional skills will arrive, albeit potentially more slowly, when needed.

The final product of project 1 is intended to be atmospheric in nature, an object commanding attention and presence within the room, all while communicating clearly the assigned 3/8" scale information. I have mapped out the most critical stages of the project sequence below.

P1.1, *thresholds and bodies* focused on conceptualizing a body through a section drawing at 1/8" scale. The students were prompted to "develop an atmospheric threshold with a specific body in mind," using the random input/prompt provided. Key terminology for this stage included: intersection, episode, and moment. The targeted skills building areas included: section, collage, composition, representation, line weight and type, scale, and the development of design thinking.

P1.2, *transitions and bodies* continued to elaborate on each randomly selected atmospheric input. Here students were prompted to "create an exaggerated tactile transition," this time working in a fragment model that represented two scales simultaneously. The artifact was to simultaneously act as a 1:1 object, conveying the atmospheric condition to our actual bodies and represent the exaggerated tactile transition at 3/8" scale. Key terminology here included: rhythm, measure, connection, link, and sequence. The targeted skills building areas at this step included: modeling/physical representation, scale, further development of design thinking, material investigations, and tectonics.

P1.3, *bodies in pause* focused on spatial proportion, narrative, circulation, bounds/edges and moments. In this stage the objectives of the previous exercise became more distilled as a result of contrasting transition with the idea of a pause. Students were instructed to shift scale to 1/16," and work in a more abstract representational language.

Students are currently assembling the final model of project 1, *Domestic Section*. In the final stage a kit of parts, abstract programmatic parameters, and a spatial boundary were provided in order to ensure a certain level of success with regard to spatial composition. The contextual bounds of 32' x 32' x 48' at 3/8" scale and shared kit of parts, for example, have helped to provide enough consistency from student to student for accelerated learning to occur across the studio.

This final assemblage stresses body as context, architect as director of a spatial narrative fiction, and mastery over materiality and atmosphere. I have attempted to weave the most critical skill sets into the project, while ensuring focus be placed on why they are learning these skills. That is, it has been my intention to allow the threshold students to focus as much on the design and construction of discourse (visual and/or textual), from which new cultural practices of invention might grow, while building their design skills. This approach allows for a more potent or "efficient" representation. Becoming skilled at fragmentation and clever strategies for communicating between artifacts and drawings will allow these students to keep up with peers who may initially be quicker at visualization and representation tools.

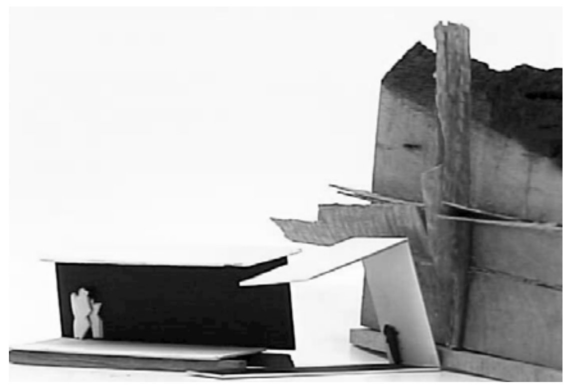


Fig. 5. Exaggerated Tactile Transition (P1.2)_ Joe

What are the immaterial objectives of design education?

Emphasizing the dialogue about how each of the iterative projects steps cleverly communicate with the others provides a level of articulateness that is rare in the architectural studio. I have found that this emphasis on dialogue has helped to develop this group's confidence about design, and will allow them to potentially assert leadership among the fellow design students within the pre-professional track next fall. To provide one example, I have inserted evidence by way of of an extended excerpt from Kaili. She writes:

As Russell Ferguson quoted Virginia Woolf, 'A masterpiece is something said once and for all, stated, finished, so that it's there complete in the mind.' That is what my initial expectation was...to fully realize and find comforting resolve in the 'complete.'

However, having the opportunity to work within the parameters of the "fragment," I pleasantly found myself in a larger world, entering the macro through the micro. Possibilities and potential for expanded thought arose through the exercises that would not have entered into my mind, had I continued on my initial path. ... I suppose this is *where I am currently treading—not quite knowing enough to clearly state the objective, but knowing enough to remain dedicated to the pursuit.*

The excerpt comes from a short writing assignment given during P1.3, and reveals a deeper awareness and interest in pedagogy than is typical in my undergraduate beginning design students. I believe this offers an example of the "spark of the new" Grosz is searching for.

With more fostering, I feel that this surprising outcome has the potential to influence future studios very positively. The usefulness of this group's handle on pedagogy and potent or "efficient" representation, however, will only positively influence their peers if faculty at UH M□noa's School of Architecture are open to viewing the threshold student track as unique and decidedly separate from—outside of—the norm. I advocate for extending and exaggerating their differences, rather than assimilating them into the group as quickly as possible.

Architectural theorist Sanford Kwinter has suggested that a major challenge of contemporary design is finding ways to approach the incorporeal, what Grosz refers to above as the virtual. In the design and compositional process, Kwinter suggests we must first be able to conceive of "...the space from which forms are launched and filtered not made."[2]

I will touch very briefly on one more aspect of the project sequence outlined very briefly above. As noted, the final project for the semester is a rehabilitation facility sited on Hawai'i within a lava zone. Drawing again from Grosz, I wish to overlay the threshold student's subject position onto the subject position of their future "clients." Grosz suggests:

Architecture is ... the anticipation and welcoming of a future in which the present can no longer recognize itself. In this sense, architecture may provide some of the necessary conditions for experiments in future living, experiments which those excluded, marginalized, and rendered outside or placeless will also find themselves. (165-166).

Students will work to develop their own program, loosely framed as a rehabilitation facility. Here, focus is again placed on the body, the outsider, and culturally disregarded. In addition, the intentionally potent programmatic and site prompts reinforce the importance of architectural excesses and/or architectural and architectonic gifts as theorized by Grosz. Using the research phases about the Gujurati step wells (mentioned above) as relays, I anticipate compelling context plus program and program plus tectonic synthesis.

I look forward to reporting on how the threshold students' perspective and accelerated capacity to communicate will positively impact the outcome of the semester's final project.

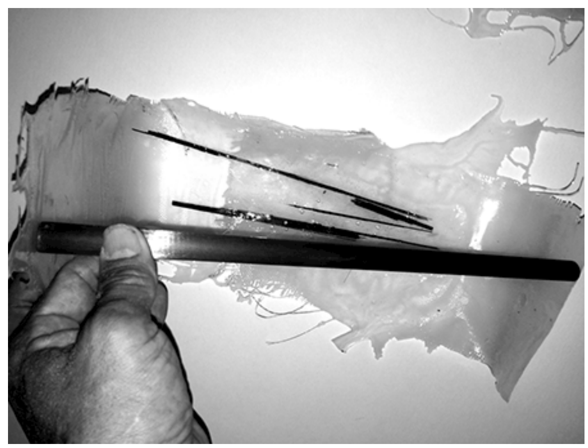


Fig. 6. Final Production, Domestic Section_ Joe

Notes

[1] As a class we watched Zumthor's lecture and read the blog post below: <http://www.dezeen.com/2013/02/06/peter-zumthor-at-the-royal-gold-medal-lecture-2013/>

[2] See Sanford Kwinter, "The Hammer and The Song", in *OASE* 48

Chicken and Egg?

Hentagon, Icosa-Coop, and Two Types of Experience

Mikesch Muecke and Peter Evans

Iowa State University

Introduction

In an essay with the title *Experience and Poverty*,[1] Walter Benjamin writes about the lack of traditional experience (*Erfahrung*)—a kind of acquired knowledge—that could be handed down to younger generations through story-telling and hands-on instruction. Benjamin reads this experience as a cipher for modern architecture where one material—steel—stands in for a cultural perspective toward traditions, while glass represents a new virtual existence expressed in a short-term event-based experience—in German the word is *Erlebnis*—both of which, we think, can be transmitted through contemporary pedagogy. In our paper we argue that effective teaching of beginning-design students requires a hybridization of a material focus and an emphasis on immaterial modes of production.

Benjamin's dialectic reading of the two experiences articulates well the differences in the two apparently opposite, yet coordinated, courses we taught in the fall semester of 2013 in the College of Design at Iowa State University. The two courses, Arch 201, an architecture design studio, and its complement Arch 230, a computation-heavy design communications course, are both required in our professional BArch degree. In the history of the department there was never a very close connection between these two courses until recently, when we realized that students might benefit from a more explicit communication across the classes that makes use of the long durée of *Erfahrung* and the shorter impression of *Erlebnis*. This realization came about not only because we share an office but also because our research areas tend to overlap. Aside from teaching studios and digital communication courses Pete also takes courses in our Human Computer Interaction program dealing with cognition and augmented reality, while Mikesch usually teaches studios, history/theory seminars and digital fabrication courses, but has also taught Arch 230 several times. In other words, discussing the content and delivery of both courses seemed inevitable, and discussing pedagogical topics and problems now allows us to imagine a different future.

Figure 1. Intermediate review of Chicken Coop project in College of Design Forum

When students enter the first year of the BArch program at Iowa State, after having completed the one-year long Core program shared between the seven different programs in the College of Design, Arch 201 is the first proper architecture studio they encounter. The studio consists of three projects: the first is an introductory precedent study where students understand through physical modeling and drawing that there are buildings, designs, and environments already created by other designer in history that precede their own burgeoning world of architecture; the second project is a team-based full-scale design and construction of a chicken coop (in its first iteration this last fall) where students learn about inhabitation, gravity, wrestling with physical tools, and the translation of two-dimensional drawings into a three-dimensional materiality [see Figure 1]. The last project is the design of a boat-house through two iterations where each student works individually to develop their ideas. In Arch 230 students are introduced to design communications techniques, including conventional 2D and 3D hand drawing techniques, digital applications such as Sketch-Up, Bonzai, and Revit as well as more advanced hybrid modes of manipulating and visualizing architectural designs using augmented reality. Parallel to Arch 201 and Arch 230 the students take a history survey and a building science & technology course. Our goal in this paper is to explore one section/intersection between Arch 201 and Arch 230, namely the design, construction, and visualization of the chicken coop project. We chose to study this project because it requires students to shuttle effectively between both courses by asking them to address inhabitation (at two different scales: chicken and human), the virtual projection of an idea (in German design means *'entwerfen'*: a throwing forth of an idea into the world), the making of something physical from drawings, and finally its re-presentation through text, drawings, and augmented reality projections that combine representations of physical and virtual presences.

Context

Both of us focus in our research on the sensory aspects of design, and here we mean the multi-sensory exploration of our designed and natural environment that is based on olfactory, auditory, ocular, haptic, and gustatory perception. Through these senses design intersects with cognition and memory. In the 2009 biography about Robert Altman by Mitchell Zuckoff, the director is quoted as saying: "I don't think anybody remembers the truth, the facts. You remember impressions."[2] If we consider what students take away from our courses, what they remember after the semester has ended, individual memory in the form of impressions plays an important role.

From cognitive psychology we know that working memory holds both verbal and visio-spatial information. Beyond that, long-term memory — internalized knowledge — describes comprehension. And here we can differentiate further: hierarchical memory is constructed through a combination of 1. arbitrary things, 2. meaningful relationships, and 3. explanations, moving from the 'what' of declarative knowledge to the 'how' of procedural knowledge [see Figure 2].[3]

We argue that between the immaterial (the internal thought stream of words, images and spaces) and its material expression (external knowledge and physical experience) a hybrid bridge can be built that links both the immaterial and the material modes of production. We believe that this hybrid bridge is critical for today's design-student experience, in that it follows through perceptual analysis, unitization, and on

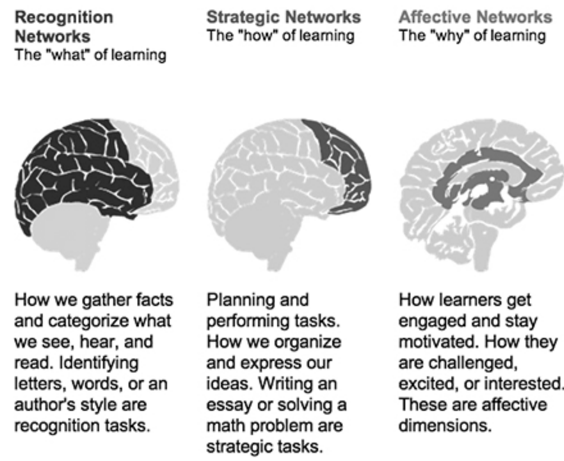


Figure 2. Hierarchical memory http://www.cast.org/udl

to comprehension[4] while tapping into work modes students are already familiar with, such as conventional drawing and modeling techniques as well as more advanced screen-based augmented-reality applications.

Through a case study that we used as an assignment in both of our courses we explore a project in which students in groups of three or four designed and built working chicken coops. The students employed initially both cognitive and intuitive approaches to learn about the real-world needs of chickens living in urban backyard chicken coops. After several design proposals advanced through small-scale modeling and drawing (both in sketch and hard-line form) the students constructed a full-scale cardboard mock-up where scale (reinforced by ocular, olfactory, auditory, and haptic perception) leads eventually to decisions about construction materials, detailing, and finally full-scale assembly of parts [see Figures 3 and 4].

Figure 3. Full-scale assembly and inhabitation

Arch 201 Design Studio	Arch 230 Design Communications
Physical Design (poly-sensual coordination) Drawings (paper, pencil, charcoal, pen) Analog Scale and Full-Scale Models (using rulers, knives, cardboard, glue, tape) Analog Full-Scale Models (using hammers, saws, cordless drill, screws, nails, wood, metal)	Computational Design (predominantly visual but also hand-eye coordination) Digital Models (using SketchUp, Bonzai, Revit) Movies (analysis through documentation) Graphic Design (digital posters) Immersive Technologies (augmented reality)

Table 1: Dialectical Pairing of Studio and Communications course

On one hand the designs are ostensibly about habitation but stretch the students' material/immaterial toolkit by asking them to explore the difficulty of material joinery, iterative thinking and making, by using saws, hammers, and cordless drills while learning about material resistance, connection and gravity through tactile perception. On the other hand they are about projecting into the future using virtual/digital technologies such as 3D modeling to not only redraw but also draw ideas from what is created digitally. Parallel to this studio work the students created digital models to study optimal orientation of their coops based on environmental factors (sun, wind, exposure) and they modified their designs in the communications course. A one-hour Arch 230 lab component reinforces the joint between both courses by placing the space of instruction physically in the studio which students identify already with designing and physical making.

We might say initially that the studio deals with making while the communications course addresses representation, but the reality is more complex. While the simple dialectical pair of material/immaterial production in both studio and communications courses might look like [Table 1]...

..we prefer for the table above to grow a third column that joins the apparent opposites of material/immaterial realms with hybrid tools of representation and design [Table 2].

However, rather than see the joint between material and immaterial realms as the sole focus of attention we believe that offering students of diverse backgrounds a broad spectrum of learning opportunities provided by the range of tools presented above, will potentially lead to a more comprehensive and effective level of learning. Given the complexity of teaching design to beginning students it seems appropriate to recall the set of principles laid out in the Universal Design for Learning (UDL) initiative[5] that acknowledges three brain networks involved in effective learning. They consist of recognition networks (the 'what' of learning), strategic networks (the 'how' of learning), and affective networks (the 'why' of learning) [see Figure 2].

These three networks can be addressed respectively through curricula that facilitate learning

Material	Material + Immaterial	Immaterial
Physical Design (poly-sensual coordination) Drawings (paper, pencil, charcoal, pen) Analog Scale and Full-Scale Models (using rulers, knives, cardboard, glue, tape) Analog Full-Scale Models (using hammers, saws, cordless drill, screws, nails, wood, metal)	Augmented Reality (visual overlay onto physical reality) Hybrid Drawings and Collages	Computational Design (predominantly visual but also hand-eye coordination) Digital Models (using SketchUp, Bonzai, Revit) Movies (analysis through documentation) Graphic Design (digital posters) Immersive Technologies (augmented reality)

Table 2: Modified table showing additional third column with Material + Immaterial content.

Figure 4. Full-scale assembly

through multiple modes of representation, multiple means of action and expression, and multiple means of engagement, combining knowledge, skills, and enthusiasm for learning. Innovative instructors in design studios have been following these principles perhaps intuitively, given the collaborative design environment that encourages learning by iterative doing and collective evaluation. In addition bringing UDL principles consciously into the design curriculum may also create more complex evaluation from the students' perspective (analagous to cognitive processing), which in turn might allow more resonance and/or more opportunities for some students to gain more profound insights into design processes. Consequently we see UDL principles as a fundamental means to strengthen the multimodal/sensory delivery of design understanding at the beginning student level.

UDL's holistic and inclusive approach to learning also takes into consideration the phenomenological dimension of perception. In a recent article Alberto Pérez-Gómez makes a case for the inseparability of time and space from a phenomenological perspective, arguing for a perception that involves all senses in a unified whole. His assertion that "meaning is not something merely constructed in the brain" but that it "is given in our normal, bodily engagement with things, things that we recognize [...] instantly as the embodiment of an idea, word, or category[6] resonates potentially with both the physically and the digitally constructed world surrounding us. The tenor of the article is at times defensive, as if digital technology with its claims of bodily immersion presents a threat to the phenomenological perception of the world through our senses, and yet Pérez-Gómez provides the very logic that allows us to change how we teach our students through both advanced technology.

He admits as much when he describes how in this awareness of that immediacy of perception "reside both the possibilities and the limitations of digitally generated images as potentially contributing, as a form of architecture, to a meaningful lived environment."[7] While we agree with the author's assessment of the limitations of conventional architectural representation, i.e. that "architecture is not what appears in a glossy magazine, buildings rendered as 2-D or 3-D instrumental images on the computer screen, or even to a comprehensive set of precise working drawings" Pérez-Gómez fails to address a third possibility that involves generating designs through a hybrid of both conventional architectural perception (dwelling in an environment using all of our senses holistically) and augmented reality where the design works as an overlay of what exists already.

Figure 5: Arch 201/230 student working with AR Media.

Augmented reality (AR) can be defined as the "fusion of digital information with...the viewer's real environment.[8] In Arch 230 Pete started using the mobile app AR Media, in addition to many other digital and physical drawing tools, as an instrument for students to evaluate a live view of their chicken coop designs in a physical context, such as the backyard of a house in town, or alternatively in their studio environment after the coop had sold in a public auction [see Firgure 5]. In this case AR offers a conceptual joint between the material and the immaterial modes of design, allowing students to visualize and evaluate a live version of their project, before, during, and after its transformation into a physical presence. AR could also play a role in the revised version of Bloom's learning taxonomy by joining so-called lower order skills such as to remember, understand, and apply, with higher order thinking skills, i.e. analyze, evaluate, and create.

Figure 6. Arch 201/230 student Ahmed Al-Othman working with his design in AR Media through a mobile viewing device

In a recent book in which Harry Mallgrave explores the relations between neuroscience and architecture, he unpacks how memory works in our brains. In a chapter on memory he refers to the work of Eric R. Kandel who, in the 1970s, began to "relate memories not to neurons but to neural circuits"[9] which made possible an "understanding that all forms of learning (invariably a process of memory) result in synaptic changes."[10]

Figure 7: Student reading drawings of his group's Chicken Coop project during the intermediate review while sitting in the project. Different modes of representation overlap.

Expanding the students' toolkit of learning about design using multi-sensory methods that include AR likely reinforces their comprehension of important design concepts in their early design-learning phase, especially with intentional integration and extension into immaterial media at full scale which AR provides. After acquiring initially a how-to experience in a material sense in

Figure 8: Full-scale construction of Chicken Coops

studio, students continue to explore further iterations digitally, extending the idea of making into the immaterial realm—with the intention to have them learn modeling and hone their digital communication and representation skills. In this process of shuttling between material and immaterial realms the tools we teach our students become complex instruments that enable fast-track learning.

Conclusions

While we are asking fundamentally what we can do to improve the effectiveness of our teaching and the students' learning, we still have to evaluate if our hybrid approach is effective or not. The proof won't be noticeable until later in the students' career. However, we think it is important for beginning designers to develop a project all the way from initial concept to its final built form, including all the in between stages, because traversing this vast terrain of iterative design using many tools parallels the UDL principles of multi-modal learning. When students work iteratively, they learn from what works, and what doesn't work. They don't discard their mistakes but make them part of their learning process, part of their memory that affects their design knowledge, and they appear to learn faster than students who only do part of one project, or only work through a single iteration. While we don't have quantitative data yet we plan to poll students' experiences through several surveys during the upcoming fall semester when we will teach another iteration of both courses. If this collaboration into the material and immaterial realms proves to be successful we may project it as a pedagogical model for the following semesters, with the proviso that, in consideration of the range of studios and electives offered in the upper semesters, our approach might work only for early education.

In his book *Immaterial Architecture* Jonathan Hill points out the difficulty faced by architects—who struggle to maintain a solid, objective, and respectable profession—to develop an immaterial practice that exhibits qualities such as subjective, unpredictable, porous, and ephemeral. This weakness of immaterial practice, and by extension architecture, is perhaps also a strength in that it requires us as designers of architecture and as educators of future architects "to be fluid, flexible and open to conflicting perceptions and opinions."[11]

In summary, by the end of the semester the students' toolkit consisted of conventional drawings done by hand, hybrid drawings that emerged out of a shuttling between analog and digital work, physical models made by hand and/or machine, immaterial thought structures expressed verbally, 2D and 3D digital work that existed only temporarily in pixels on screens, and finally augmented-reality hybrids that closed the loop between analog and digital visualization. This conceptual circle of multi-modal learning now includes both the experience of the long durée (*Erfahrung*) and the shorter event-based insights (*Erlebnis*), creating a longer-term knowledge base that makes it possible for students to become better designers.

Figure 9: Full-scale construction and inhabitation

Notes

[1] Benjamin, Walter, “Erfahrung und Armut,” in section “Metaphysisch-geschichtsphilosophische Studien” in *Gesammelte Schriften*, Band II (Suhrkamp, Frankfurt am Main: 1991): 213-218.

[2] Zuckoff, Mitchell, *Robert Altman: The Oral Biography* (Knopf, New York: 2009): ix.

[3] See Wickens, Christopher, *Introduction to Human Factors Engineering* (Pearson: 2003).

[4] See Norman, Donald, *The Design of Everyday Things* (Basic Books: 2002).

[5] For more information go to the National Center on Universal Design for Learning site at http://www.udlcenter.org, accessed 15 February 2014.

[6] Alberto Pérez-Gómez, "The Gift of Architecture and Embodied Consciousness," in *From the Things Themselves: Architecture and Phenomenology*, edited by Benoît Jacquet and Vincent Giraud (Kyoto: Kyoto University Press and École Française d'Extrême-Orient, 2012): 462.

[7] Ibid: 462.

[8] Paul Sim in lecture Augmented Reality in Experiential Learning (with Steve Jackson and Pete Evans), Fall 2013 HCI 521 Research Presentation, cited from Hamilton, Karen E., Augmented Reality in Education, http://augmented-reality-in-education.wikispaces.com/Home accessed on 15 February 2014.

[9] See Eric R. Kandel, *In Search of Memory: The Emergence of a New Science of Mind* (New York: Norton, 2006).

[10] Mallgrave, Harry Francis. *The Architect's Brain: Neuroscience, Creativity, and Architecture* (Wiley, New York: 2010): Kindle Locations 4981-4982.

[11] Hill, Jonathan. *Immaterial Architecture* (Routledge, New York: 2006): 75.

Weaving Words:
Promoting the Integration of Architectural Ideas

Glenn NP Nowak

School of Architecture, UNLV

Association(s)

This paper presents a method for teaching students to construct conceptual connections about architecture, even before crafting a model or creating a drawing. It chronicles the creation of a precedent publication whose text distills complex information into manageable content and whose layout invites interactive reading while insisting on discussion of alternative perspectives and integrations. An overview of the subsequent foundation studies' first year experience course reveals how design exercises that interrogate the material of books, libraries, and media create a structure for achieving specific learning outcomes and a framework for engaging interests beyond a prescribed curriculum.

Manifesto in a Flip-book

Pedagogically, thinking about architectural thinking comes before thought about teaching. While in school, I recognized my peers and I (in architecture) thought differently about things than our friends in other disciplines. We were taught what architects were taught. Urban planning students were taught to think like planners, art students to think like artists. Occasionally it seemed the further we progressed in our majors, the more we drifted apart from alternative perspectives in areas outside our own.

Association, a publication of Cornell AAP, sought to bring students, faculty, and alumni from different disciplines together for the purpose of constructing ever more meaningful connections between ways of thinking about our world. Illustrations and author statements about the ideas in their work became the material of the project. Serving as the founding editor of Association, it was to be my challenge to create a publication that did more than record and even comment on works submitted for presentation. The objective was to generate the potential for infinite readings of the works and their relationships to one another.

ART

David Todd | det25@cornell.edu

Movements Through Space
Stereographic Winter, Ithaca, NY (Photo 16)

The sum of these photographs can be placed under the title, Movements Through Space, based on the overarching ideas behind them. All of the images are recordings of space, different spaces, street scenes, interiors, and peep-holes, and at the same time recordings **of my** movements through these spaces, traveling **physically, mentally**, or **visually**. Photograph 16 is BW 120mm film taken with a stereographic camera I built, meant to be viewed with full 3-D effect through an antique stereo-viewer.

ARCHITECTURE

Yoonchun Jung | yj36@cornell.edu

Ghost Catching

I did an experiment called "Ghost Catching" which focused on **analyzing human** movement. Then, I defined "Ghost" as personal history, which can be shown through a person's habit or *gait*…
I made the skeleton-like accessory out of wire to fit to my left arm. Then, I attached small mirrors on every joint. I used a projector, projecting a beam of light onto my body. **I wanted the audience to see the movement of a** performer **and the** reflection/projection **of the movement at the same time**. The audience will experience the meaning of being in the **present** by the performer's movement and the meaning of being in **past** and **future** by the reflection/projection of the movement.

PLANNING

Marcel Ionescu-Heroiu | mi48@cornell.edu
Bjorn Markeson | bom3@cornell.edu
Nathan Kalaher | nsk26@cornell.edu
Sudeep Gupta | sg346@cornell.edu

The ULI Gerald D. Hines Student
Urban Design Competition

Magna is located on the western periphery of the Salt Lake City metropolitan area. Connecting Places: Our primary goal in our proposed scheme is to *promote* Magna as *a hub as* opposed to a terminus. The resident of Magna can connect **to** people throughout the city by car, light rail, bus, rapid transit, or bicycle. Within Magna nodes of activity are connected in a variety of ways. Connecting Ideas: The Cineplex, Main Street, the Transit Hub, the Copper Golf Course, and the Webster School/Community Center are all accessible by foot, bicycle, and car. The signature feature is the pedestrian/bicycle path that connects all major destinations and incorporates a number of parks and wetlands.

Fig. 1. Association 1, 1, 1

Not too unlike a children's flip-book with pages cut into thirds allowing for the imaginative reader to contemplate an animal with a fish's head, a dog's body, and elephant's feet, Association invited its audience to mix-and-match art, architecture, and planning works based on theoretical connections. Super-sized pagination enabled suggested starting points for discussion, but conversations amongst readers and authors most surely evolved as unique readings were shared. Occasionally, starting heated debates.

An artist reveals his naked soul in his work - and so, gentle reader, do you when you respond to it.
–Ayn Rand

ART

David Todd | det25@cornell.edu

Movements Through Space
Stereographic Winter, Ithaca, NY (Photo 16)

The sum of these photographs can be placed under the title, Movements Through Space, based on the overarching ideas behind them. All of the images *are* recordings *of* space, different spaces, street scenes, interiors, and peep-holes, and at the same time recordings **of my** movements through these spaces, traveling **physically, mentally**, or **visually**. Photograph 16 is BW 120mm film taken with a stereographic camera I built, meant to be viewed with full 3-D effect through an antique stereo-viewer.

ARCHITECTURE

Nathaniel Kalaher | nsk26@cornell.edu

ALVIS

'…Although there is certainly a fair amount of fiction in Iceland's historical record, most of the fictions carry a **basic truth**. And as such there is a strange mix of fact and fiction in Iceland's historical **development** in which even fiction translates into the physical world of here and now… The primary reasoning behind my object is to be **a** thing **and a** nothing. It is about that which could be called solid and the void that defines it. It is about space that is **lit**, and the space that is **not lit**. It speaks metaphorically to issues of anthropomorphism, the fact and fiction found in sagas, and also in the knowledge of myself gained by making something that is ambiguously myself and not myself…'

PLANNING

Matthew P. Drennan | mpd12@cornell.edu
Jose Lobo | bom3@cornell.edu
Saurav Dev Bhatta | nsk26@cornell.edu

Spatial Income Inequality Among Metropolitan Areas of the United States, 1969 –2000

'…we directly address the issue of income **inequality** among spatial units by treating metropolitan areas as individuals in a population and by **calculating** a spatial variant of the Gini coefficient. Our data and methodology do not permit any inferences about income inequality within metropolitan areas. Our approach is **empirical** and **exploratory**. Our goal is to complement current studies by providing facts about trends in income inequality among metropolitan areas. The spatial Gini G_s, measures inequality among spatial units - metropolitan areas - rather than people. Using a trapezoidal approximation for the area under the Lorenz curve, we obtain the following formula for the computation of G_s…'

Fig. 2. Association 1, 4, 13

The Association editorial staff's metacognitive approach to designing a reading experience: one that requires analyzing, contextualizing, and critiquing, is similar to the modus operandi of our word-weaving efforts in teaching beginning design students. We wanted students' sense of connection to be strong with their work, and that sense had to be rooted in a studious understanding of their work and its link to scholarly sources… never just a subjective preference for their own "creations".

Concept(ion)

When asked about the material of foundation studies, some may point to building materials: wood, concrete, earth, light, etc. Others may note various means of representation to start covering: pencil, ink, clay, CAD, etc.. Still more might mention specific introductions to _______fill in the blank (famous architects, iconic buildings, career paths, related disciplines, etc.)

With a sense that any single direction leaves out several other legitimate routes, an ambition to bring awareness of the interconnectivities between the many facets of architecture drove the cognitive mapping of lessons in the historical, theoretical, social, technical, and environmental forces that shape the design professions.

Survey of theories

Here, an alternative sense of material arises out of the intricacies of the intangible world of ideas found in architectural literature. Faculty in all three disciplines of our school (architecture, landscape architecture, and interior design) were queried for their short lists of seminal texts. A list of nearly fifty books emerged. Several came with notes describing the travesty that was when students could graduate without having been exposed to ____________ (fill in the blank). The first year experience evolved with earnest effort to put all of the texts on everyone's radar.

Architecture will no longer be the social, the collective, the dominant art. The great poem, the great building, the great work of mankind will no longer be built, it will be printed.
–Victor Hugo

In an interdisciplinary beginning design survey course, opportunities for complementary studies inherently present themselves. Yet when the synergy of multidiscipline instruction yields to least common denominators of technical skill (learning tools for representational purposes) without addressing objectives of the representation, opportunity for greater appreciation of peers'/colleagues' thought processes, later, is lost. So instead of delaying exposure to concepts of theory, research, and the real world application, which most schools place at the very end of their four or five year curricula (as does UNLV), we sought to bring those elements forward in this survey course. Through frequent readings and focus on environmental concerns, the class's understanding of design would be shaped and reinforced by their increasingly intensified story-telling of what they had read between the lines.

Integrat(e/ion)

It is not even enough to claim the intellectual content of particular books as the material of foundational studies but rather the illuminating connections between ideas of one source and another as discovered by individual students which becomes the stuff (material) of a psychological foundation for design education.

Among the first steps in developing a course, an introductory lecture or seminar is often the selection of a textbook. Yet, whatever is picked potentially sets up what was previously described, a predetermined way of thinking. While valid, it runs the risk of prescribing solutions instead of inviting alternative answers.

Timely Text

Mostafavi's Ecological Urbanism served as a key component in the introductory class in focus, not merely as course textbook but as conceptual anchor. Required readings are manageable selections from the tome. Associations with it are made amongst a large body of texts (over twenty books) from which a basic working knowledge is an aspiring goal. The onus or opportunity to make tertiary associations with any other scholarly (and occasionally popular) source is with each individual as they navigate the milieu of the university's learning communities, libraries, and social media.

Reading is often a function of having the time. The architectural world of document production and site supervision is very time consuming, so you inevitably read less, or rather you read with a specific goal in mind, rather than as a free-ranging explorer.
-- Bernard Tschumi

The following flow diagram show how students were encouraged to be that free-ranging explorer (while still delivering on challenges of curricular redevelopment, ever-evolving university initiatives, NAAB Criteria, and a desire to marry teaching styles to the myriad of learning styles).

Detailing the Connections

Each of four semester foci (theoretical, social, technical, and environmental) were woven throughout several weeks of presentation and discussion on some of the most influential texts pertaining to the focus in design professions including but not limited to: architecture, landscape architecture, and interior architecture. Each week's lecture launched that week's research and development period. Students were expected to bring certain deliverables and drafts to each week's lab-like component in order to receive participation credit.

First, an in-depth discussion or presentation surrounding an article or chapter (assigned from the required course text: Ecological Urbanism) would take place in the lecture. Then (in lab/library discussion groups), students would share summaries/analysis of seminal books assigned from the list of supplemental texts. Students then conducted further searches on one or more of the presented texts in order to uncover a tertiary text that could serve as a conceptual link between two sources focused upon in lecture and lab (ex. similar subject, shared time period, same author,

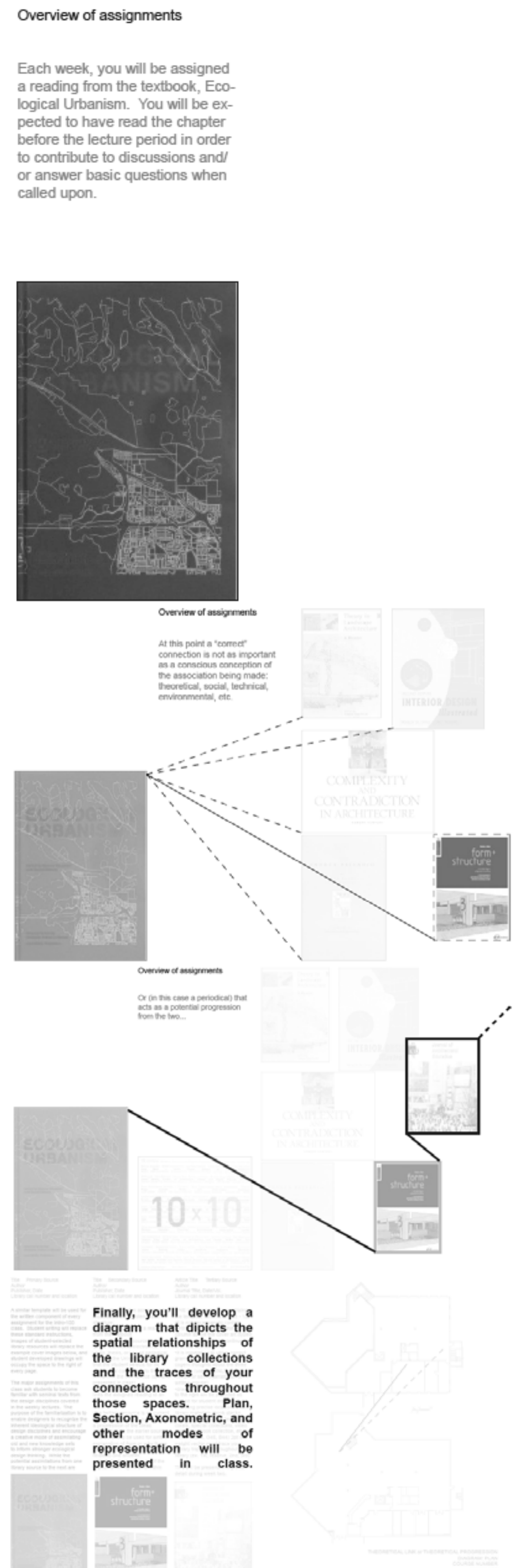


Fig. 3. Constructing Conceptual and Literal Linkages

comparable style, more recent critique, texts that reference the presented book, etc.) ...one that could be explained through its relationships to the primary and secondary texts. The tertiary text could be either a periodical (scholarly journal, conference proceedings, industry magazine, etc.) or a book (reference, non-fiction, fiction, etc.). Tertiary periodicals had to have been more recent publications than Ecological Urbanism and serve to associate all three texts by looking toward the future. Tertiary books had to have been published between the dates of the primary and secondary sources and serve as a suggestion of ideological link or causal factor between the two.

In class demonstrations equipped students to describe the conceptual links between all three sources through written word and the spatial relationships among them through graphic convention. Students were encouraged to discuss their individual design interests with their lab instructors. Assignments were designed to allow for specific interests to be further explored while simultaneously introducing broad overviews of widely relevant design ideas.

In essence, connections drawn by students between assigned readings, suggested readings, and elective readings were the material of the course. Thinking, writing, drawing, and modeling were in substance ways of communicating how similar so many ideas were, and simultaneously how information was interpreted and extrapolated in unique ways. With one anchor text, fifty-three recommended books, eighty-five students, fourteen thousand volumes in the Architecture Studies Library and countless other elective readings (for now, left out of the following equation), the combinations of potential linkages approach 4.27e+69... or four with about seventy zeros behind it. Moreover, the number grows as students gain access to more information. More interesting, however, is the more diverse the association of an elective reading back to the suggested readings and the conceptual anchor text, the greater the collective and individual understanding of the primary and secondary texts become. Even with a single starting point (Ecological Urbanism) and a common choice among secondary connection (group of four or five books on reserve), no two assignments were the same, but every submittal reinforced a weekly theme. The plot might have taken unusual twists after inviting students to find a common thread with any scholarly source of their choosing, but the conflict always resolved.

This is why at first glance, equally plausible connections between Bank of America in NYC and Tallinn Town Hall on one hand and BoA and Frank Gerhy on the other seems unlikely, but through careful selections in intermediary texts, compelling arguments emerge.

Drawing is always important, even for those like me who are not skilled draftsmen. Ideas emerge through drawing, ideas are tested through drawing, and ideas are represented through drawing. The least important function of the drawing is to show others "what it will look like."...take care to place those means (methods of representation) in the service of ideas.
–Henry N. Cobb

Reinforcing these connections in multiple ways always brought the foundation studio back to questions of representation. Diagramming and drawing not merely the lines traversed amongst the book stacks or the physicality of the libraries spatial relationships but questioning the method and inherent meaning of the drawing relative to the content of the ideas explored became the higher level lessons in this first year experience. Drawings never traced an image, they traced a thought process, and the building material was *the idea*...

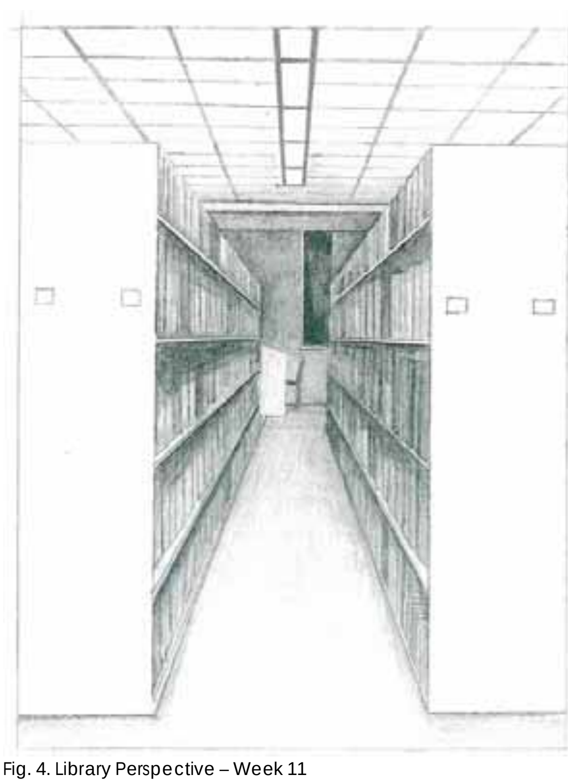


Fig. 4. Library Perspective – Week 11

Notes

[1] Nowak and Sherbany, Association Volume 1, Cornell University 2005.

[2] Mostafavi and Doherty, Ecological Urbanism, Lars Muller 2010.

Images 1-3 by author

Image 4 student drawing by Lindsey, Abigail

Printed Matters:
Or Why Architectural Education May Also Include the Making of Books

Sneha Patel

Tyler School of Art, Architecture Department, Temple University

Fig. 1. Student-Produced Books, "Show and Tell" Event, Tyler School of Art, Philadelphia, PA; Fall 2013

The Age of Electronic Textuality

When we speak of architecture we may mean either something built or a body of knowledge – a collection of experiences that may be transformed into models or rules that continues to exist only if these are recorded, accumulated, and transmitted. Recording and transmission are dependent on the instruments, vehicles, and media used to carry them out. Such mediating techniques change over time, and as information science has shown us, no means of communication is either universal or neutral.[1]

Published in 2001 and referring to the technical invention of a 'typographic culture' born of the Renaissance, architectural historian Mario Carpo portends the ways in which rapid and significant changes in communication technologies play a crucial role in the ever-evolving body of architectural knowledge in *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory.* Architectural education often addresses the roles and techniques of representation within the discipline, particularly at the foundations-level, as it relates to transforming digital platforms and processes. This digital materiality also has parallel significance within expanded, or not exclusively visual, modes of communication within architecture. Reflecting on languages, books, and reading, historian Roger Chartier describes this as 'the age of electronic textuality'[2] and asks the often-raised question about the future of printed publications or texts as confronted by new forms of computer-based media, transmission, and dissemination.

This paper will expand upon the ways in which beginning design education may address these larger questions of digital and physical materiality through an exercise in book-making. Here, the term *book* is used loosely, to include publications of all shapes and sizes, from zines and pamphlets to journals and what is often described as the *book as object.* Associations will be drawn between the ways in which organization, narrative, fabrication, and communication are developed in book form, but have relational structures and metaphors within space-making and architecture. The paper will expand upon how digital and analog processes of production are problematized in architectural representation and how they are linked to the ways in which we *read* electronic and printed texts. Finally, it will conclude by offering insight into how the act of making a book serves as a means of expanding the often introverted acts of design for a beginning design student into a collaborative space (Fig. 1.) of collective thought.

A World without Differences

Architects have often referenced Argentinian writer and poet, Jorge Luis Borges for his imaginative and fantastical descriptions of space. A common theme identified in his short stories, such as "The Garden of Forking Paths" and "The Library of Babel", is the idea of 'infinite texts' that Borges characterizes through spatial descriptions of paths, labyrinths, and vast, endless rooms. These stories have also been cited by new media theorists[3] who suggest Borges's early 1940s predictions about a world of infinite texts are linked directly to our contemporary culture of electronic communication, hyper-reality, and digital materiality.

Furthermore, Borges has often written about the idea of communication and the quest for a universal language or linguistic unity, both in utopic terms and as an expression of loss. In the short story "The Congress" published in the collection *The Book of Sand* (1975), a search for a shared, universal language by its characters was proven futile because "the world [was] already there, made up of an insurmountable diversity of places, things, individuals, and languages. To attempt to erase that multiplicity is to design a disturbing future."[4]

Parallels have been made regarding the potential loss of *difference* suggested by Borges in his short story and the communicative devices of electronic media. Here, one can argue that there is a fundamental difference between the variability offered in printed media, from the materiality of the book itself (for example, the size of the page and the type of paper used), to the form of language (for example, the typography and the opportunity for multiple translations). Electronic modes of reading and digital forms of writing have in many cases universalized the experience of books and other forms of publications. Despite a global acceptance of digital communication, the primary mode of dissemination through electronic means remains English-based and even utilizes a specific characterization of the English language referred to as 'electronic English'.[5] Thereby multiple translations of books and texts are only slowly being recognized in digital formats, and often omit specific nuances of non-English languages such as tildes or accents. Similarly, the interface of electronic media is both limited and dictates the way in which the text is read. The design of the book relies on its ability to remain viable across multiple platforms and devices and be able to remain useable through engine and software updates. These additional considerations are perhaps less troubling when identifying texts that are focused solely on the written word, but become more important with publications within which the text and image are critically linked and therefore are especially notable within the art and design disciplines.

In the digital world, almost all texts, regardless of their genre, are produced or received through the same medium and in very similar forms. Referring back to Borges, this *world without differences* marks a shift in knowledge transmission and the experience of the text. It is further complicated by the fragmentation of digital reading, typically a discontinuous process that utilizes or preferences only a portion of a publication's entirety. This fragmented process changes one's relationship with both a body of knowledge and the book as an object in and of itself; it can reduce the reader's ability to develop synthetic relationships between expressed discourses and limit the interpretative ability for a reader to make choices in how one may experience and digest information.

While content may be identical, the experience of both creating and consuming books as physical objects verses electronic forms can be marked by scholar Donald Francis McKenzie's simple statement, "forms effect meaning."[6] Roger Chartier argues, "A text is always conveyed by a specific materiality: the written object upon which it is copied or printed; the voice that reads, recites, or otherwise utters it; the performance that allows it to be heard. Each of these forms of publication is organized in its own unique fashion, and each form, in different ways, influences how meaning is produced. Thus, looking only at the printed text, the format of the book, the layout, the divisions of text, typographic conventions, punctuation, all are invested with an expressive function…different intentions…[are] guiding the reader's – or listener's – unconscious, they govern, at least in part, the process of interpreting and appropriating the written word."[7]

Fig. 2. Student-produced book; Linear Narrative Format; produced by Jennie Li (2013).

Parallels between Space-making and Book-making

If one accepts that a book presents a specific form of materiality then beginning design pedagogy may begin to draw parallels between acts of space- and form-making and acts of book-making. In an assignment given to first-year architecture students, the exercise of making a book was shaped by the idea of a *collection* or a *catalog*. While still broad enough to produce a diverse range of products, this theme served to introduce the value of structure and organization within any communicative or experiential device.

Students were asked to think about the ordering of content and if this followed a linear progression of narrative information (Fig. 2.), or was purposely structured to be read in multiple ways. These differences alluded to structures of architectural organization at the most schematic level, whether directed by a strict and ordered sequence of spaces or a layered, folded, or overlapping spatial order.

Narrative content was focused on the question: What story are you trying to tell? The general theme of *collection* or *catalog* by nature set up narratives that most typically communicated comparisons, either similarities or differences among the elements included. This exercise of identifying and presenting qualifications of *sameness* and *difference* was reinforced in a concurrent course on architectural representation. Visual literacy skills emphasizing the spatial relationships between figure and ground, object and field, solid and void, foreground and background, and so forth paralleled the students' studies of comparative relationships in the book-making project.

The book's narrative was also meant to communicate an overall idea or theme through its content and graphics, which required students to be selective about whether they were interested in communicating something humorous, personal, political, textural, historical, time-based, and so-forth (Fig. 3.). This required a sense of intentionality in terms of its legibility and understanding, tied to its referential content. For beginning designers, opening up the conversation about the referential, assisted in linking their work and their world to a larger context and cultural history. Exposing the myth of isolated creativity and pure invention, the exercise encouraged selective and thoughtful appropriation (Fig. 4.), working with and within existing contexts. Again this methodology of appropriation was also utilized in the architectural representation course, which required students to move from exercise to exercise by "reworking" or altering previous work rather than starting anew.

Fig. 3. Student-produced books focused on Historical Information (top) and Textural content (bottom); produced by Maria Gwynn-Samblas and Jessie Cummings (2013).

Furthermore, the act of constructing or fabricating the book was a central part of the project. As a physical thing, it was unable to be distanced from its own materiality. Similar discussions about joints, assemblage, material choice, and craft were had between early exercises in architectural design and book design. The book's size, material, binding, and layout were open-ended aspects of the assignment. They were all understood as critical to its communicative abilities and its success as an artifact. Students were introduced to simple ways to produce bindings and were able to use a school-wide shared resource, a perfect binding machine. The material and fabrication choices opened up possibilities and limitations, not unlike decisions made for architectural representation – from lineweight, to type of media, to modelling material or to choice of software.

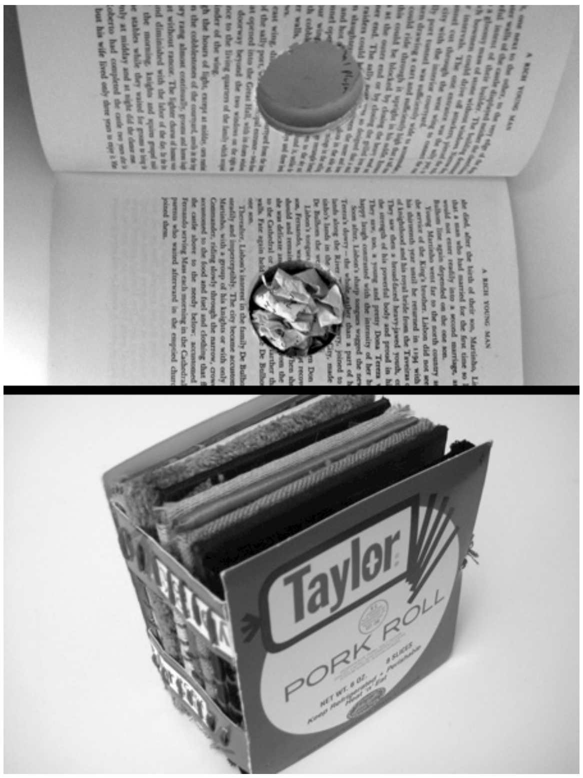


Fig. 4. Student-produced books appropriating existing content (top) and material (bottom) and creating *books as objects*; produced by Johnny Folliard and Hannah Thomases (2013).

Critique and feedback given to students highlighted the connection between idea or concept and made object or artifact, neither operating in isolation nor valued exclusively. The ability to discuss the book as an artifact that communicated essential relationships both in terms of constituent parts or details as well as a complete form or body further underscored the parallels between the experience and design of the book and that of space.

While the book was an exercise in mental occupation (as opposed to physical occupation), the parallels of reading content and reading space were highlighted through the book's form (Fig. 5.). The materiality of the book as an object became a

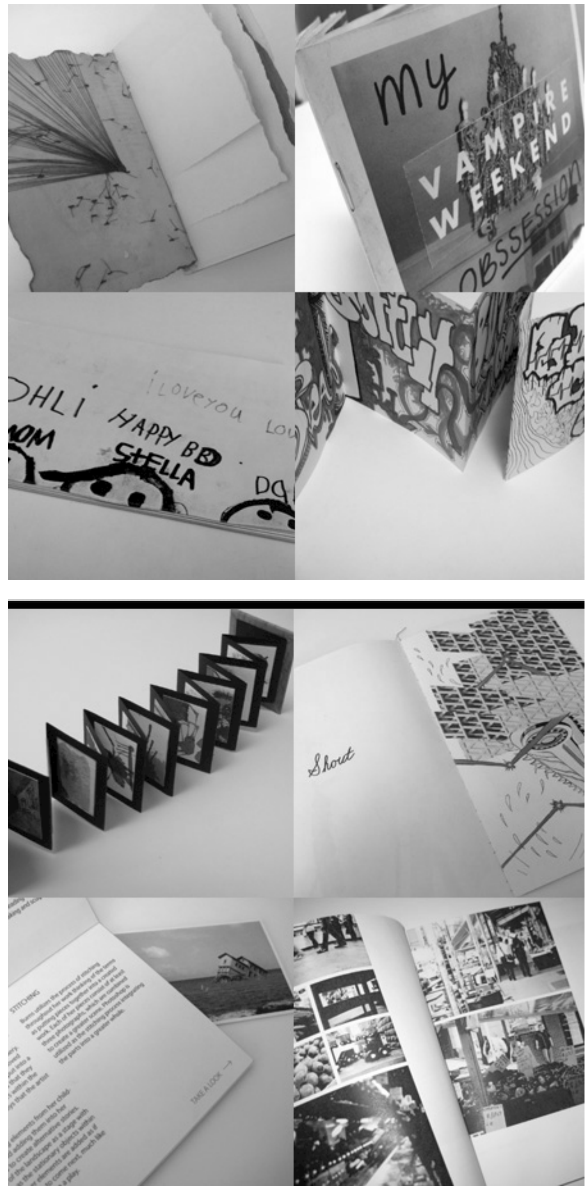


Fig. 5. Student-produced books; designed and created by (counterclockwise from top left): Carley Reed, Francesca Crivelli, Julia Lewis, Joseph Fretta, various students from Foundations 1501, Julia Cauller, Joshua Hallquist and Jennifer Sanders (2013).

tangible registration of decisions in ordering, hierarchy, narrative, communication, tactility, notation, and assembly, all terms and concepts understood as fundamental within beginning design education.

Material/Immaterial: Qualities of *Time* in Physical and Digital Forms

In September 2012, architect Michael Graves's article titled "Architecture and the Lost Art of Drawing" was published in the op-ed section of *The New York Times*. In it, he describes how the computer, with its expansive capabilities in organizing and presenting data, has been targeted as complicit in the 'death of drawing'[8] within the architectural field. Graves, not necessarily presenting a new argument, insists that in fact hand-drawing is still a valuable and valued part of architectural practice and that while digital processes of representation are ubiquitous, they become problematic when used exclusively.

Graves describes that "our physical and mental interactions with drawings are formative acts."[9] In other words, they mark beginnings, but also carefully implicate the inter-connectedness between hand, mind and speculation. This bodily sense of drawing might serve to viscerally remind us of the physical actions of the body that make and shape space. Graves celebrates the fragmentary and selective nature of the hand-sketch, and its ability to quickly express a short-hand notation, a reminder of non-linear thoughts.

In contrast to the argued efficacy and incompleteness of the sketch, computer-based drawing has often been described as a means towards alleviating the tedious nature of hand-drawing in a world where the demands of speed are evermore-increasing. Technology could theoretically abbreviate the time required to communicate a design, but often the efficiencies that are gained are negated by the need for the intimacy of labor. This idea is of particular value when thinking not solely of the architectural discipline at-large, but when considering beginning design pedagogy. For young designers, the qualitative experiences of production (processes) need to have a clear sense of connectedness to the resultant forms of communication (products).

Three years prior to the publication of Michael Graves's article, book editor David Ulin wrote of his own experiences with reading in the 21st century in the *Los Angeles Times* article, "The Lost Art of Reading." His writing parallels Graves's insight into the differences of digital and physical forms of communication not only in title. Ulin describes an over-networked culture in which the ability to focus is rendered difficult due to the constant exposure to technologically-focused distractions. To concentrate singularly on one act is evermore elusive. Within this context, the act of reading becomes a conscious decision of slowing down, more easily attainable, Ulin argues, when it is disconnected from the device. The expectation of immediacy when reading electronic texts can parallel young designers' frustrations when they realize that digital forms of representation also demand labor, rigor, and focus. Here, the stigmas associated with technology and time, acculturated through our everyday lives, must be expressly overcome in design teaching.

Ulin describes picking up a physical book as *real reading* because "it demands...space, because by drawing us back from the present, it restores time to us in a fundamental way."[10] This restorative quality may well serve to balance the complementary skills of analysis and intuition necessary to introduce to students of design in a fast-paced and ever-connected world. In other words, when one *really* reads (or similarly, when one *really* draws), he or she is both engaged in the present and physical moment and escaping to alternative mental spaces simultaneously.

Hybrid Forms of Drawing and Reading

To portend a dismal future when physical books are only memories and architects no longer use pencils is unrealistic. In fact, arguments that separate the hand-made and the digitally-made at either end of an analog-digital continuum are becoming less and less favored, and hybrid forms of making are more typically utilized and taught in schools of architecture and design. Similarly, our consumption of texts in our everyday lives is rarely purely digital or printed, but most often a flexible and fluid combination of both. As is often the case, the more digital materiality and technological interfaces become commonplace in our culture, the more effort is placed on not only restoring, but also reshaping, the nature and form of the so-called lost arts. These hybrid forms are often inventive and architectural representation, not unlike textual language, can celebrate the richness of differences in communication and techniques.

To that end, it is a mistake to understand digital design processes as wholly immaterial as they interface directly with devices that produce physical, material output. When reading an electronic book, the screen serves as an interface between the reader and the content; it is argued here that this interface, or *form*, matters in regards to communication, experience and understanding. When teaching techniques of digital representation to architecture students when they are first introduced to the discipline, this *form* must combat the tendency for standardization and uniformity that is calculated and explicit in the tools themselves. Perhaps no different than any other tool, digital or analog, creative experimentation is paramount to elicit variability in material forms. For the book exercise, a diversity of forms were created, shared, discussed and most importantly, valued, allowing the students to creatively surpass their perceived limitations of standard givens, types, and formats.

The Agency of Book-making; Extending the Discipline

...in contrast to an abstraction of text, which reduces it to its semantic structure...the status and the interpretations of a work depends on its successive forms...it emphasizes the role that the author can play, along with others (the publisher, the printer, the typesetters, the editors) in the always collective process that gives texts their materiality.[11]

While the exercise in making a book was not issued as a group project, it was an opportunity to celebrate shared dissemination through the exhibition (a "show and tell") of the books, both within the class and to the school at large (Fig. 6.). Each student was required to develop an author's note which included his or her name, book title, and a short summary of its content or approach. These author's notes were printed and exhibited along-side each book providing a place where peers could share their written thoughts, critiques, and feedback on each other's work. The exhibition showcased the value placed on the diversity of forms, from small, intricate illustrative books, to quickly but carefully assembled zines focused on cultural or political content. The book-making exercise also introduced the students to other "makers" in the city at large who either create, edit, curate, or display self-produced book collections through a panel discussion and a gallery talk. Students signed up for visits to the University Library's Special Collections Room, which houses a series of artists' books, zines, and non-conventional publications. This extended the context of the work for the students and allowed them to share their work beyond the classroom or even the university, in order to establish connections to expanded audiences.

Architecture's Discursive Space

In the article, "Showing Work," architectural critic Sylvia Lavin describes how 1960s poststructuralist literacy and critical theory permitted "architecture to be distinguished from building, to become also drawing, which became text, texts which in turn became constructions, and so on. The "work" of an architect could...take many forms, not just the conventional ones of drawings, models and buildings, but also books..."[12] In our current era of digital textuality, one may go one step further to consider how publications, both printed and virtual, serve as an extension of the discipline. The popularity and desire for architects to create "small magazines," to start blogs, and to make publications, reflects a desire to shape the materiality of architectural discourse and to frame the creation of discursive space as a form of architectural design in and of itself. "Whether new 'little' publishing ventures are handsewn or hand-coded, material or virtual, custom designs or mashups, they need to acknowledge both the risk of and the necessity for material experimentation – not for its own sake, but as a means of questioning architecture's and its publications' position in 'the relations of production of [their] time.' And because that time is ever-advancing, this question must be continually re-posed."[13]

For the first-year design student, to make a book is an act of agency; it is a platform where the potentially idiosyncratic preferences of the individual are valued and voiced over the exigency of universal skills and mere technique-building. This "lesson" might serve to better establish the role of writing, reading and publications broadly within architecture for the students such that they see printed matter as not only a *mechanism* for presenting and distributing information, but also as a *site* of production for ideas and discourse.

Notes

[1] Mario Carpo, "Prologue: Architectural Culture and Technological Context," in *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory,* trans. Sarah Benson (Cambridge: MIT Press, 2001), 12-13.

[2] Roger Chartier, "Languages, Books, and Reading from the Printed Word to the Digital Text," *Critical Inquiry* Vol. 31, No. 1 (Autumn 2004): 133.

[3] Lev Manovich, "New Media from Borges to HTML," Introduction to *The New Media Reader,* ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge: University of MIT Press, 2003), 5-8.

[4] Roger Chartier, 135.

[5] Geoffrey Numberg, "La Langue des sciences dans le discourse èlectronique," in *Sciences et langues en Europe*, 254.

[6] D.F. McKenzie, *Bibliography and the Sociology of Texts* (London: Cambridge University Press, 1999), 13.

[7] Roger Chartier, 147.

[8] Michael Graves, "Architecture and the Lost Art of Drawing," *New York Times,* September 1, 2012, accessed February 1, 2014.

[9] Ibid.

[10] David L. Ulin, "The Lost Art of Reading," *L.A. Times,* August 9, 2009, accessed February 1, 2014.

[11] Roger Chartier, 148.

[12] Sylvia Lavin, "Showing Work," *Log* 20 (2010): 6.

[13] Shannon Mattern, "Click/Scan/Bold: The New Materiality of Architectural Discourse and Its Counter-Publics," *Design and Culture* Issue 3 Volume 3 (2011): 347.

Speed Design:
Invigorative Design Pedagogy

Peter S. Raab

The University of Texas at Austin

Abstract

For the last twenty years at The University of Texas in Austin, an intense five-week Summer Academy in Architecture has been offered to invigorate the beginning design student's architectural senses. This paper describes the Academy's main pedagogical goals of full immersion within the study of architecture to awaken haptic awareness and sensitivity. It explores the Academy's coordinated trajectories and calculated exposure to methods and techniques through project-based prompts that have been developed as a way to introduce a broad architectural scope within the abbreviated framework of a summer program.

Instigations

How do you successfully introduce the practice of architecture to the curious student...within a limited timeframe? Can architectural schools create a low-risk, low-cost, compressed design program that thoroughly introduces and excites students about working in the field, even in a time when the press has suggested that architecture degree is not worth the expense?[1] One approach has been the expansion of exploratory summer design programs, ranging in length from a few weeks to a couple of months. Architecture schools across the globe have organized such programs, not only to expose future design students to a comprehensive foundation of skills, but also as a testing ground for how to best utilize rapid-paced, short classes to instigate architectural education as a whole.

Aspirational architecture intrigues nearly everyone, but few people have an awareness of the wide skill set required and the complexity of the creative process. Within these intense, condensed summer programs participants are thrust into the studio setting and confronted with the inherent complexity of design decisions and their subsequent ramifications. Utilizing the open summer months between academic years, short programs immerse students full-time into the realm of architecture – five days a week, eight hours a day, and sometimes nights - with lectures, workshops, studio, reviews, and field trips. Within these programs, it becomes essential that students be exposed to both the pleasures and pains of architectural study so they can properly determine if the profession is right for them.

Harvard is credited with creating the first summer design program forty years ago. Since then, the pedagogical utilization of the summer architecture "crash-course" has gained steady popularity increasing from roughly 20 in the 1980s, to almost 100 accredited programs in the summer of 2013.[2] As diverse as the architecture schools they represent, these summer programs differ greatly due to region, design foci, facilities (some more digital or technologically driven), time length, and intensity. Before committing to the investment of an undergraduate or graduate education, these summer programs offer a laboratory for interested parties to assess their architectural ambitions while determining if the school would be a right fit for those interests.

The Academy

The Summer Academy in Architecture has been developed to provide a venue for the architecturally inquisitive to discover realities of the design studio, theory, practice and the larger profession. Students, ranging in age from sixteen to sixty, are immersed into a series of fast-paced and evocative design problems to excite and educate the novice designer within. Through the introduction of studio culture, architectural skills, and conceptual methods, the Academy attempts to expand the student's understanding of the practice of architecture beyond their set of predefined ideals. What they quickly learn is that architecture is demanding work, a truism of any architecture program. If, however, this initial design program successfully inspires, they may discover that this work, both intellectual and physical, can be more satisfying and engaging than they ever imagined.

Full Immersion

This program is driven by a individual-to-group repeatable process – experiencing design first-hand through making, then engaging in self-observational critical analysis, and then exchanging phenomenological experience through discussion of the work of peers. These personal yet shared experiences provide a broader dialogue for the students, and have considerable impact in their design thinking.

While the location of the studio is where students primarily synthesize spatial, material, social, contextual, and structural ideas, and "bring things together", it is well understood that an architectural sensibility is developed through a variety of diverse experiences.[3] Real-life architectural experiences give students confidence, visual and haptic memories, and theoretical underpinnings to draw upon for their architectural investigations. In tandem with the studio-based curriculum, a series of programmed events happen throughout the academy: professional lectures, a film series, office tours, design theory lunch forums, and field trips to realized architecture. These experiences offer tangible aspirations of finished works, and visits to architectural offices expose the students to active design environments and evidence of the path from theory and concept through iteration and execution of built work. Students complete Summer Academy with a deeper understanding of the practice of architecture and the skills, methods, and level of commitment required.

Fig. 1. Students participate in an Academy-wide demonstration within the courtyard. Summer Academy in Architecture, UT-Austin, 2012.

Who Comes Together?

With a wide variety in age level and experience in making, the goal for each student is different. High-schoolers are considering career decisions for college, undergraduates are developing portfolios for grad school applications, and still others are simply looking for a challenging adventure in architectural design. A proven way to excite the beginning design student is through interaction with young, dynamic, and talented instructors. The Summer Academy has the advantage of selecting from a large accomplished crop of recent or current graduates from the Masters of Architecture program at The University of Texas at Austin - all who have demonstrated exemplary design and communication skills accompanied with an interest in teaching. Although coordination with the individual instructors regarding the overall schedule, main projects, and the presentation of required skills occurs on a bi-weekly basis, the studio instructors establish all the day-to-day assignments. This allows each instructor to provide specific feedback and to steer exercises relevant to the needs of their group while also giving each a sense of agency regarding the studio content, resulting in an excitement and engagement that is communicated to the students.

Haptic Iterations

The Summer Academy in Architecture at The University of Texas enlists the iterative process as the fundamental teaching technique. A series of circular processes of testing and retesting, sometimes producing several iterations in a single day, is paramount to conceptual advancement and project development. As Donald Schön mentions in a 1988 article, students learn not by assimilation but by trial-and-error practice, or using his term of "reflection-in-action" - design not as problem solving, but as a "reflective conversation with the materials of the situation."[4] Through iteration, students learn that "failure" is a welcome step of discovery, as it flushes out weaker ideas, and proves how working quickly rather than preciously allows for a more immediate and productive feedback loop.

In order to ensure the celerity of iteration, emphasis is placed upon hand-making – both models and drawings - to reduce the distance between the student's ideas and their physical manifestations, and to awaken his or her haptic sensibilities and awareness. The stuff of architecture is the material world, and the goal of the Summer Academy is to cultivate curiosity in that world.

BRIDGE – The Crossing

The Academy starts off with a bang! On day one, after studio assignment and brief introductions, the students are immediately plunged into the first project – to design and build a structure to span the courtyard fountain while allowing a person to cross without getting wet. With a short structural and material explanation, the students are assigned into groups of four or five and begin developing a design strategy before lunch.

Each group generates multiple strategies, which range from the intuitive and poetic to the more practical and purely structural. These designs are presented to instructors and teaching assistants through sketch, diagram, and small model. Each group is then asked to re-think and re-design their schemes through iterations into a concise, convincing strategy that conveys understanding of structural performance and material construction. Upon final approval, materials are handed out, and the full-scale bridge construction begins in earnest.

Fig. 2. Full-scale structural testing of BRIDGE, an annual academy-wide event, happens on the second day. Summer Academy in Architecture, UT-Austin, 2012.

Over the next 18 hours, with some teams working well into the night, the student groups build their bridges. In addition to the set timeframe, each team is limited in material palette – they may use only five sheets of 6’ x 8’ corrugated cardboard, eight hundred and sixty feet of string, and five 30” wooden dowels. The fountain’s dimensions are 9’x13’, and since a cardboard sheet is 8’ at its longest, the mechanics of joining are an immediate consideration. Without access to the use of glue, nails, or tape, students are forced to grapple with material properties and innovative ways of joinery.

On day two they descend from the studios with a remarkable variety of bridges in hand. The craft and complexity with which the materials are woven together - some using braided string, or suspension solutions, others folding, rolling, cutting, and bending the cardboard – are executed in often surprising and imaginative ways. Gathered in the courtyard, each team briefly presents their concept and then predicts how their bridge will perform underfoot.

The testing is a cheerful celebration – ninety students, ten instructors, twenty bridges - and culminates with the collapse of each structure [whether it takes one person or three]. Discussion of structural analysis, led by the instructors, occurs during the testing, and continues after through a dissection of each waterlogged assemblage to determine why it failed and what could have been done to strengthen the construct. The best bridges utilize each of the materials for their individual strengths [cardboard in compression, wood in bending, and string in tension] to create a composite structure.

BODY – A Space for One

Building on this newfound knowledge of the iterative process and the experience of empirical testing, the studio prompt now shifts to explore space as a consequence of human occupation. Project two begins with a measured investigation of the human body in motion, and its relationship to its surroundings. What is the actual volume a body occupies, and how does this differ from perceived space or zones that are only visually inhabited? As these measurements are translated into a series of orthographic plan and section projections, or “body mappings,” and then physically modeled in three-dimensions, students are compelled to think reflexively regarding the body and its surrounds.

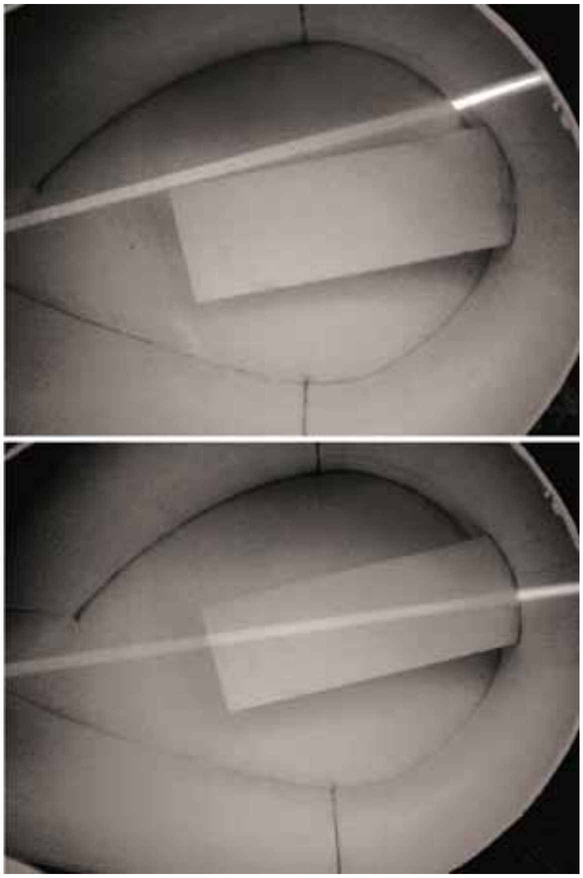


Fig. 3. Sarita Damania, Physical model light exploration of a sleeping pod. Summer Academy in Architecture, UT-Austin, 2010.

From these studies, students design a two hundred and fifty cubic-foot volume for a singular activity. By requiring the students to think volumetrically, rather than in square-feet, section and plan are developed simultaneously through drawing and model. Using the human body as the generator also de-emphasizes the importance of the exterior appearance while focusing on responsive spatial qualities. This project liberates students of possible pre-conceived notions of architecture they may have arrived with, forcing them to work from the inside-out rather than from the outside-in.

As this exploration is only a week long, students are required to work rapidly – moving from model, to drawing, to writing and back again – to create a series iterations which reconfigure their limited volumetric space in response to the demands of their specified occupation.

Considerations of aperture are folded into the project through discussions of how natural light can be used to activate the space and bolster the activity. The final prompt requires three apertures, with one incorporating an adjustable shading device to control light and create privacy. Students utilize large scale models [1”:1’-0”] to physically test their apertures using several different solar orientations. These experiments happen midway through the project to allow time for redesign, and photography is used to capture these effects and demonstrate the spatial significance.

Fig 4: James Rosinbaum, Sound mapping. Summer Academy in Architecture, UT-Austin, 2011.

LANDSCAPE – Designing for Multiplicity

The third project introduces the idea of contextual relationships and the impact of architecture within a landscape. The chosen campus site is rife with existing connections and activity, and bound by complex relationships of urban infrastructure on three edges with a fourth edge sloping dramatically toward a creek below. Across the street is the Art School, which the prompt – an open-air sculpture display space and adjacent artist’s studio – must engage.

Paralleling this design exercise is the exposure of students to the realm of architecture theory. Mapping once again begins the conversation, this time at the scale of the campus, and aids an understanding of the existing relationships within the site and campus. Discussion is complemented with readings from Stan Allen’s “*Field Conditions*.” The students learn vocabulary which allows them to posit how an insertion can strengthen, change, or divert contextual relationships, and initiates a discussion of the role of architecture within a landscape.

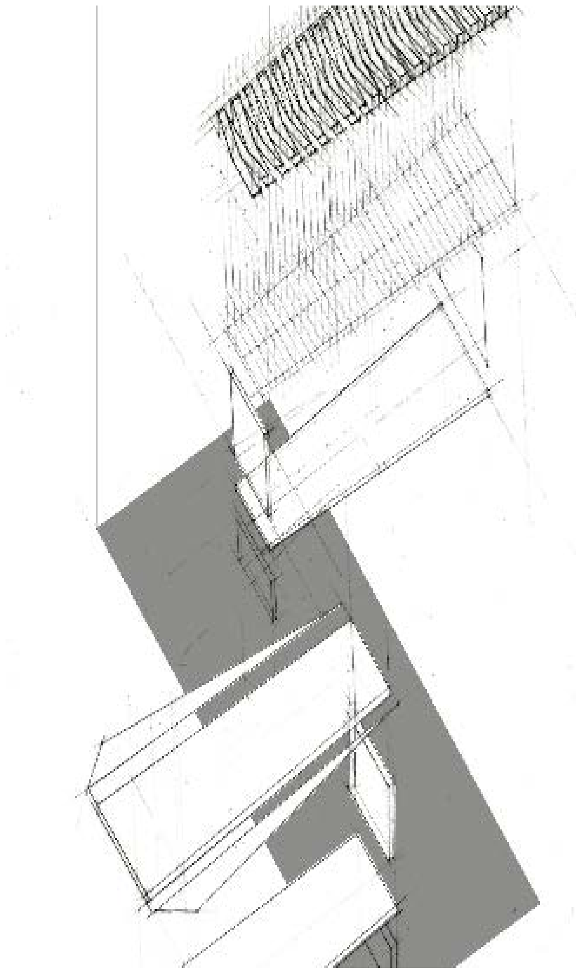


Fig 5: James Rosinbaum, Exploded axonometric drawing illustrating tectonics. Summer Academy in Architecture, UT-Austin, 2011.

Next, the students are introduced to the tectonic components of "hearth, enclosure, roof and earthwork" as theorized in Gottfried Semper's *Four Elements of Architecture.*[4] They are then prompted to insert a roof to shade, filter, protect, and control views. Once this demarcation within the landscape is established, students then tether the roof to the sloping ground. From this point students begin to suggest enclosure and hearth by defining a spatial sequence by employing walls and establishing a ground plane.

This project tends to be the most challenging in the sequence, as students must grapple with a scalar jump and often become worried with what the thing looks like. More successful projects utilize light to reinforce and organize movement through their design. Consideration of the thresholds between the outside and inside, as well as passive design strategies for day-lighting, shading, directing wind flow and viewshed strengthen the project's response to the site. A final challenge is the dramatically sloping site, which demands consideration of the ground plane and its relationship with the project. With only one week to develop, students learn to edit and refine their ideations through iteration to create a new order within the landscape.

URBAN – Architecture and the City

The final project is of civic nature, examining the relationship of architecture and the city. With a considerably larger scale, the students consider multiple components and their aggregation impacts the urban environment. The vertical nature of this final project introduces a new set of questions to be asked. What is public? What is private? How can these components be expressed, or concealed? How can multiple spatial hierarchies be composed within a singular vertical site? Provocations of architectural ramifications acting within the social realm demand that students consider the influence of design decisions at a city scale.

An investigation of the site and its surrounds requires the students to assign qualitative [from light to dark / public to private] and quantitative [volume + footprint] identities to both program components and the building as a whole. Simultaneously, the students formulate relevant organizational relationships for the building based on their readings of the site. Iterative drawing and model establishes an arc of investigation, fabrication, and testing – repeating as time allows in an effort to "narrow to a solution."[6] This formal and spatial analysis reinforces the student's stance on site and architecture's relationship to the public.

Students relish the longer, two-week timeframe to explore the final project, as it is necessary to grasp the complexities of the city and articulate a multifaceted componentry of a public building. This extra time also allows the students to use a formal mid-review where a jury of professors and local architects act as a sounding board to test ideas and receive constructive criticism on their progress. This feedback arrives at a crucial point for their spatial organization and catalyzes the students for the final week of development. During these final days, details of construction, materiality, and space are investigated through sectional models and building skin explorations.

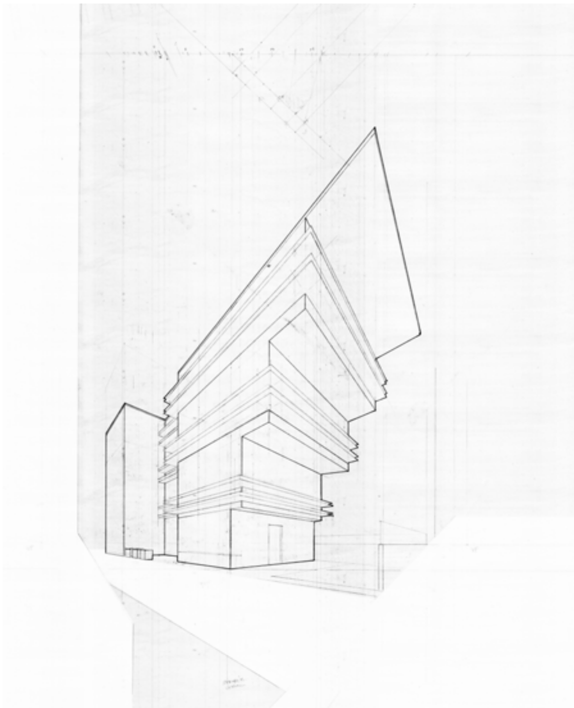


Fig 6: Curtis Nguyen, Constructed perspective study for URBAN Project. Summer Academy in Architecture, UT-Austin, 2010.

Pedagogical Breadth

Within the first 24 hours of the academy, the program capitalizes on arriving students' initial excitement to introduce a condensed start-to-finish design process, emphasizing *making* and *construction*, through rapid *iteration,* while establishing the idea of failure as an important aspect in the design process. As students execute BRIDGE, they are invigorated by immediate feedback and a sense of agency available in *studio practice*, and now a high bar of energy, engagement, and commitment, necessary for the following five weeks, is established.

BODY shifts the discussion towards *space.* It introduces *body as measure* and investigates *occupancy* as a spatial generator. It begins with a measured investigation of the human body in motion, and then implements the body as carving tool through *stereotomy*. Through the added prompt of *light* as a spatial activator, concepts such as *threshold*, *solid and void*, *poche*, and *materiality* are layered into the discussion to evolve a measured mapping into a space with experiential and phenomenological effects. Notions that human activity generates space, and is supported reflexively through architecture, asks the students to re-analyze the world around them, from the inside-out.

While LANDSCAPE continues the previous investigations into the effects of light and aperture as parameters for space-making, the student is also required to additionally consider architecture embedded within its *environment*, and challenges the student to use *site analysis* and response as a point of departure. The discussion introduces questions regarding *forces* - how does an object disrupt or invoke *flow* within a site? *Tectonics* are introduced as a way of breaking down the complex nature of architectural constructions through their assemblies.

URBAN is a true synthesis of the previous three weeks, and an opportunity for students to culminate their Academy with a large-scale project in downtown Austin. Building on the smaller, inwardly focused BODY and the more horizontal, outwardly focused LANDSCAPE, the URBAN project tests notions of how architecture should relate to the community. By merging inwardly / private functions with outwardly / public functions in a vertical site, students are asked to engage at a completely different scale while iterating on their newly formed design skills. How should the design of architecture with a strong community aspect speak to the public, and how will this alter the urban infrastructure that exists?

Fig 7: Final studio exhibition and walk through with friends and family of the students. Summer Academy in Architecture, UT-Austin, 2013.

Conclusion

At the end of this intense, five-week program, student work is displayed for an-end-of-academy exhibition. Students and their parents are amazed at the amount of work and the pedagogical complexity possible in only five weeks of instruction. It is a rewarding experience to visit with the student at the end of the academy and see the glimmer in their eye about their future dreams for a career in architecture, the possibilities now clearer. Programs like these can offer thorough exposure to the wide scope of architectural investigations for the searching student.

The goal of the Academy is to educate and excite about the wondrous field of architecture, in a non-competitive manner. Students do not receive grades, but rather only a certificate of completion to accompany their hard work. At this early stage, their enthusiasm for the process, rather than the product, is key. As the Dean of Pratt, Olindo Grossi points out in his paper, "If students in architecture cannot communicate their excitement to others, it is idle for us to try." [7]

It is so important, in this beginning studio, to fully immerse the student in architectural practice to garner excitement and a notion of what architecture might be. As exemplified by BRIDGE, design is about more than simply getting from one side to the other, but must also engage the senses while solving both the pragmatics and the experience of crossing to the other side. These students, now armed with tools and knowledge of what the future might hold for them, are much better off in making those difficult career decisions. And, if the final decision is to not pursue architecture as a profession, at least this brief experience opened their eyes to the breadth of application of architecture and design to give them a sense of agency towards the world in which they live.

Notes

[1] Rampell, Catherine. "Want a Job? Go to College, and Don't Major in Architecture." *New York Times*. 5 Jan 2012. Web.

[2] Kolson Hurley, Amanda, Edward Keegan, and Ian Volner. "Design Camp." *ARCHITECT: The Magazine of the American Institute of Architects*. N.p., 16 Sept 2010. p 1-3.

[3] Attoe, Wayne, and Robert Mugerauer. "Excellent Studio Teaching in Architecture." *Studies in Higher Education* 16.1, 1991. p 41-51.

[4] Schön, D.A. "Toward a Marriage of Artistry and Applied Science in the Architectural Design Studio." *Journal of Architectural Education*, Vol. 41.4, 1988. p 4-10.

[5] Frampton, Kenneth. "Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture". MIT Press: Cambridge, MA. 1995. p 5.

[6] Ledewitz, Stefani. "Models of Design in Studio Teaching." *Journal of Architecural Education* 38.2 (1985): 2-8. JSTOR. Web. 6 Apr. 2013.

[7] Grossi, Olindo. "Considering Architecture?" *Journal of Architectural Education* 19.4 (1965): 56-58. Print.

Generative Spatial Processes

Georg Rafailidis

State University of New York at Buffalo

Introduction

This paper describes and documents beginning design student work which emerged from a syllabus based on "generative spatial processes" and contextualizes the work within larger questions about materiality and representation in architectural education. The studio ran for two consecutive years as the second semester of the first year core design studio. The course, which introduced students to architectural space, presented space as an incredibly complex and multifaceted entity. With each assignment, the investigative lens was shifted to focus on the subject of space from a different perspective, to uncover a new distinct spatial dimension.

To undertake this elaborate investigation of architectural space, the studio employed two main strategies: rooting spatial description and analysis in the direct experience of a kind of "case study" everyday space, and fully integrating the scope of representational skills that the students needed to develop with their design tasks.

The first strategy emphasized the direct, personal experiences that students had with a chosen, everyday space. The emphasis on working from a personal reading of space was deliberate, since, in this early stage of architectural education, students are not yet immersed deeply in the discipline. Personal readings are therefore a better source of knowledge. Working with everyday surroundings was also meant as a perception-sharpener for the students. They worked from their experience of a space, which meant that they had to become more self-aware of their experience of spaces. Personal experience, analysis of personal experience, careful observation of everyday lived-in spaces and finding unexpected qualities was the main mode of production. From this experiential starting point, students were asked to make very careful, deliberate observations and critical interpretations of their given situation. The discovery and description of formal and spatial qualities, which might otherwise go unnoticed, was key to the way of working. The syllabus aligned itself, in this regard, with the work practitioners such as architect Sigurd Lewerentz and artist Rachel Whiteread. Lewerentz's investigations on fundamental, everyday architectural elements like the window opening gained their power from an unusual rigor in observing and rethinking of these elements. Colin St John Wilson wrote about Lewerentz's skill to observe in his essay *Sigurd Lewerentz and the Dilemma of Classicism*[1]:

> *It is said that he could sit for a long time just looking at a common nail and asking himself how many ways it could be used – for out of the simple question a surprising answer could come. And we read also of his instruction to a despairing metal worker: All I know is that you are not going to do it the way you normally do. It is not that we have to contend with perversity: what is at issue for Lewerentz is the search beneath conventional appearance for the shock of a renewed truth.*

Whiteread's work also offers an example of how to interpret everyday situations in radically new ways and charge them with new meaning. Her most noted work, *House*[2], transforms an ordinary London terraced house, slated for demolition, into a powerful sculpture by simply using it as the formwork for a cast of its entire interior. Whereas the methodology of casting, producing a solid-void inversion, was a controlled decision and act, the resulting forms were inherited by the existing house.

Similarly, the approach of this studio created a balance between design control and chance, as architectural design oscillates between control and chance. Students worked to make sense out of random constraints and qualities stemming from their given situation, to assemble them into a new whole/intention. Being able to work within a set of predetermined constraints seemed important in the discipline of architecture, where so many parameters are out of the architect's control, e.g. financial constraints, short-lived programs and site restrictions. This relates also to the contemporary condition of architecture where the life span of architecture is much longer than the ever shortening lifespan of client briefs and programs. Architects have to make do with existing structures and charge them with new meaning and use. The ambition was to apply this mode of working also to the design of ground up structures.

The second strategy of the studio involved a full integration of the required media courses and their deliverables into studio work. Unlike previous models of first-year design, where media was taught as a separate course with content unrelated to the design studio, this course tied particular media to design tasks, to encourage students to see and explore space using different media. Each introduced media skill was employed to investigate space from a new, media-specific angle. Media were not only taught, they were employed to investigate space and generate form. This strategy required students to flip between an experiential, a representational and a performative reading of materials and artifacts. Students started by working with a single, full scale space, and continued to develop a composition of several spaces that eventually turned back into the full scale fabrication of a single space. During this process, students learned to use numerous techniques and media for architectural design. With the introduction of each technique, students investigated space from a new angle, understanding that architectural space is not a clearly defined entity but a rather complex conglomerate of numerous different properties, readings and perceptions. Space can relate to us in endless ways. Each assignment and media offered a new perspective on the subject of space while simultaneously revealing the specific potentials and constraints of each design technique. Through each assignment, students investigated the relationships between techniques, generative processes and the resulting spatial typologies. Media was used as a backdrop from where students could find spatial qualities in their generated artifacts instead of inventing them from scratch on a blank piece of paper. In the section *assignments*, I will describe this aspect in reference to each project assignment.

To summarize, in this course, two main tactics were used to help students see, understand, and begin to explore the multifaceted nature of architectural space. The first tactic involved making the large and vague theme of space concrete and physical; students were asked to find and work with a full scale space that they had access to in their everyday lives. The second tactic exploited the investigative and generative potential (not just representational potential) of architectural media for different design techniques. Five media-specific assignments created a continuous design process which had a cumulative increase in complexity:

1. Experiential Assessment of Space
2. Survey of Space
3. Positive-Negative Inversion of Space
4. Inhabiting Space
5. Structure and Space

The course exposed beginning design students to a wide range of materials and fabrication techniques and set-up processes where making and the critical thinking necessary for design were integrated.

Assignments

In this section, I will describe the sequence of assignments and their relationship to the overall studio theme.

1) Experiential Assessment of Space. Media: Field trip, Photograph, Text (1 week)

This first step involved a physical encounter with architecture. Being tuned-in to our own direct experience or perception of space is one of the best ways of learning about architecture. The objective of the first assignment was to encourage students to learn about space through empirical observation and experience. Students were asked to leave the studio space and roam the city with a heightened awareness of the physicality and materiality of the spaces and the effects that they have on them. Students were tasked to find a space to which they related in an immediate way. It could be a space in which they felt suddenly comfortable or that triggered their sudden interest, a physical curiosity. The relationship between the student and the space was described in personal, experiential terms. Students were explicitly asked not to choose spaces according to images and representations that they might have seen. The authorship of the space – whether or not it was designed by an architect – was irrelevant. The objective of the task was very elemental; it was meant to foster an intense encounter with the physical presence and affect of buildings and spaces.

The students were then asked to take one photo of the interior of the space. Using the photo-documentation of the space and their immaterial, experience-memory, they were asked to analyze how the space achieved the strong impression that it had on them in text form. What about the space lead to the particular experience that the student had? This exercise focused on translating a personal experience of a space into both a text and a photograph, which could communicate that experience to others. Apart from the compositional and technical photographic skills learned, this deliverable required students to use editing skills to be hyper-deliberate about the content of their single photo.

For the text, students were given a letter-sized text template. They had to fill the page with a text describing how the space achieved the particular bond with them. This deliverable caused students to shift from an intuitive understanding of space to an analytical one and opened yet another layer of spatial reading. It also increased their verbal repertoire for spatial description.

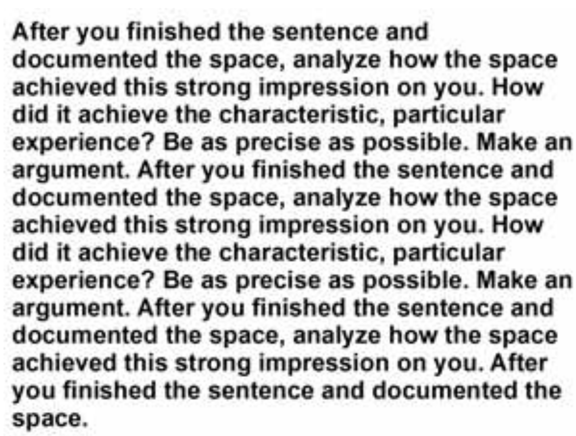

After you finished the sentence and documented the space, analyze how the space achieved this strong impression on you. How did it achieve the characteristic, particular experience? Be as precise as possible. Make an argument. After you finished the sentence and documented the space, analyze how the space achieved this strong impression on you. How did it achieve the characteristic, particular experience? Be as precise as possible. Make an argument. After you finished the sentence and documented the space, analyze how the space achieved this strong impression on you. After you finished the sentence and documented the space.

Fig. 2. Letter sized text template handed out to the students to insert their verbal description of their space.

In the first task, students were able to compare how the media of photography and text had their own distinct potentials and limits as they addressed the same space. Students were asked to describe how their first-hand experience altered as it became enriched by two new layers of representation.

2) Survey of Space. Media: Survey drawing (1 week)

Fig. 1. Photographic documentation of a space chosen by student A. Misenas, 2012.

Architecture is, on one level, a graphic language. Measuring buildings and drawing them as they are is one way that architects understand them and appropriate them into the language of architecture for further investigation and use. In this assignment, students were asked to conduct a comprehensive survey of their chosen space, translating and abstracting it into the graphic language of architecture and developing an understanding of the concept of drawing scale in AutoCAD. Students started to learn from comparing the different media that they had applied to the same spatial experience; they started be able to see how the different media revealed different aspects of the same space. Documenting the space through survey drawings focused on the straightforward, dimensional aspect of the space and added a new layer of understanding about that space. This time, the medium revealed and focused on aspects of size, dimensions and geometry. At the same time, it created a new artifact with its own aesthetic qualities and logics. As a rudimentary technical drawing, students began to see how, by adhering to drawing conventions, drawings – and therefore their space - became widely legible and understandable. The deployment of line weights, line types and paper types were some of the elements that the students were asked to control.

3) Positive-Negative Inversion of Space. Media: Foam mass modeling, Multi-part plaster mold (4 weeks)

Learning to think abstractly and at various levels of abstraction is a continual challenge in architectural design. We are constantly trying to imagine the form and potential experience of spaces which are fundamentally void and immaterial. Inverting space from void to solid, sometimes referred to as positive-negative, is a helpful tool in being able to look at, evaluate, and further work with spaces. The objective of this task was for students to handle a space in both its positive and negative forms.

In a first step, from the survey drawings that students completed in the previous assignment, students had to build a precise mass model out of foam of their space using a hot-wire foam cutter. The mass model, although geometrically true to the original space, offered a radically new reading simply because it was a void-solid inversion. This was another instance where students realized how the media skills they learned where also generative in nature, how they related not just to how they represented space, but more fundamentally, to how they could explore and try to understand them.

In a next step of solid void inversion, students were introduced into the traditional craft of making a multi-part plaster mold. They invested their foam mass model in a mold with a minimum of five parts. They were instructed in detail about the material behavior of plaster and the strict rules that need to be followed for a multi-part

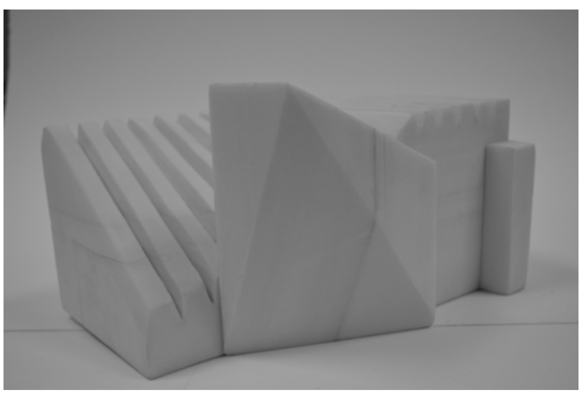


Fig. 3. Foam mass model. Student: A. Misenas. Photograph: G. Rafailidis, 2012.

mold to function. Establishing the parting-lines for the multi-piece mold required students to analyze the geometry of their mass model from another point of view. They gained an intimate understanding of the form in order to resolve undercuts, venting issues and the sequence of pouring each mold piece. This was an intense, hands-on material exploration which resulted in five or more mold pieces which all related to the original space and demonstrated to students the form generating potential of rigid mold making.

Fig. 4. Multi-part plaster mold with foam original. Student: J. Costello. Photograph: G. Rafailidis, 2012.

In a further analytical step of the solid-void inversion process, students drew each solid mold piece as a void through the introduction of perspective drawing and stippling. This step generated five spaces which were all distinct but still closely related to each other and to the original space they encountered in their first assignment. The sequence of assignments so far created a multi-layered project comprised of distinct media, materials and artifacts offering representational, performative and experiential readings.

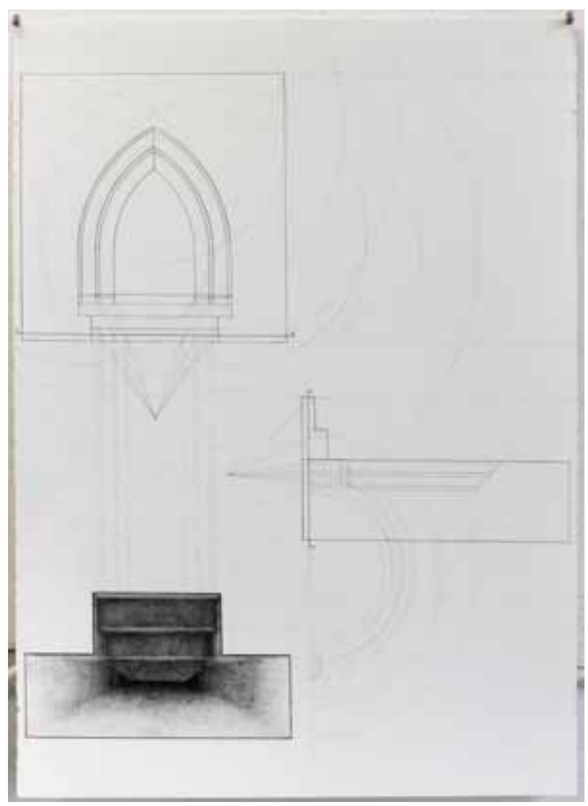


Fig. 5. Solid void inversion through perspective drawing. Student: Matt Rosen. Photograph: G. Rafailidis, 2012.

4) Inhabiting Space. Media: Perspective drawing, Paper mache (5 weeks)

The relationship between the multi-part plaster mold and the original, invested form, illuminated further the geometry of the original space, and resulted in a set of forms which were related to the original geometry, but still different. Therefore, casting became understood not only as a medium for representation or repetition, but also, as a formally generative process. The studio made use of this family of self-similar plaster pieces by viewing them as potential spaces and re-arranging them in relation to one another. To create a new assembly of these five spaces, students were asked to consider not just their original mass model as a volume, but all of the masses of the mold as space-entailing volumes. Each mass became a room of a house they designed for themselves. The program consisted of a living area, sleeping area, cooking, washroom, working area and storage. Students were asked to lift one side of the base board which they used to cast their mold against, to create a slope of 25 degrees. This became a site condition at the scale of their first foam mass model. The high point faced East. Along this high point, a street was situated from which the site could be accessed. Based on the findings in the previous exercises and the students' own spatial preferences, they were asked to develop a clear idea and spatial concept for their spatial reconfiguration and house proposal.

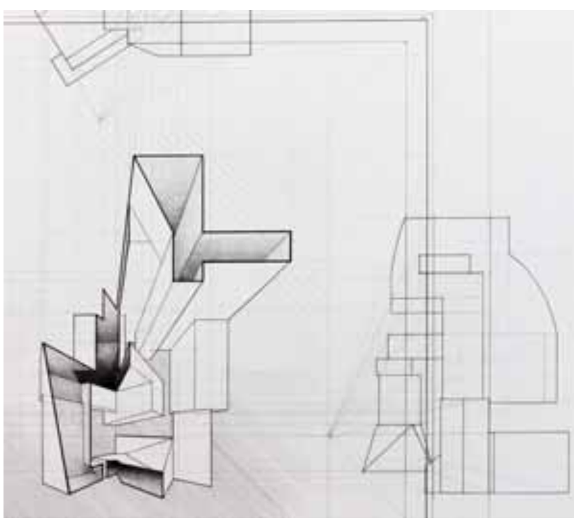


Fig. 6. New mold assembly proposal. Student: A. Misenas. Photograph: G. Rafailidis.

To model design options of the reconfiguration of the mold pieces, a new technique was introduced: students used their plaster masses as building blocks to assemble their spatial arrangement and envelop it with a thin skin of plaster bandage. Afterwards, students developed a language of cutting and folding to create integrated furniture, openings and circulation elements in the resulting monocoque thin shell structure. This exercise emphasized a balance between found forms and new design intervention, between chance and control.

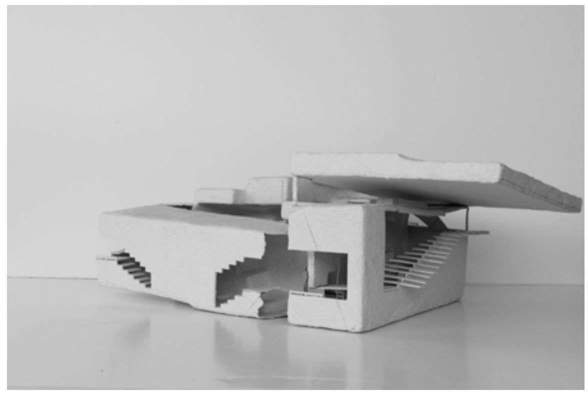


Fig. 7. Paper pulp monocoque model. Student: A. Barkhouse. Photograph : G. Rafailidis.

5) Structure and Space. Media: Full scale structure. (4 weeks)

The final assignment expands upon the thin shell structure created in the previous assignment and closes the loop in the entire process by connecting the model to the very first exercise, *experiencing architecture*.

In this final assignment, students formed groups of seven and investigated the structural potential and performance of thin shell structures as a generative process at full scale (1:1). By working at 1:1, students were able to investigate the relationship between material behavior, structure and space/form. Structural logics generated form and space.

Students were asked to cast a thin shell of an existing part of their actual, physical environment – their studio spaces - at 1:1 (e.g. corner, wall, niches, arch, I-beam, window, etc.). The existing space acted as form work. Then they removed the shell and repositioned it (flipped, rotated, moved, etc.) to create a space where the entire team could be accommodated inside or underneath the structure. The development of a clear strategy about how the cast (the recording, the copy, the negative) was positioned in relation to the original (the real space, the formwork) was emphasized. Space was created by the specific

Fig. 8. Thin shell concrete cast against the studio walls with planned fold and reinforcement creases. Students: V. Bui, C. Canfield, J. Costello, J. P. Lauricella, C. Narvaez, J. Salton, H. Tanner, E. Zeffiro. Photograph: G. Rafailidis.

Fig. 9. Thin shell concrete folded out. Students: V.Bui, C.Canfield, J. Costello, J. P. Lauricella, C.Narvaez, J.Salton, H.Tanner, E.Zeffiro. Photograph by the student group.

relation between cast shell and original building part.

Similar to the first assignment, students roamed their everyday studio spaces for forms which seemed to provide both a specific spatial experience and structural performance (certain forms obviously performed better structurally than others). Students had to think spatially and structurally at the same time. Thin shells acquire their structural strength through deformation of their surface. The less “flat” a surface is the more stiff it gets. This is a principle about which students developed understanding empirically. While the exterior surface of the formwork was “found”, the surface facing the students could be designed in a materially specific manner to enhance the structural performance of the shell. The size and the form of the border of the cast were also critical.

Fig. 10. Thin shell concrete released from the wall. Photograph: G.Rafailidis.

Each of the twelve student groups received one of the following six materials: hydrocal, twine, paper pulp, paper mache, latex and wax.

Fig. 11. Wax thin shell stood for 40 minutes before collapsing during final review. Students: C. Maier, N. St John, J. Ding, A. Tong, W. Van Deusen, Z. Boucetta. Photograph: G. Rafailidis.

Each material has its own specific properties, suggested or implied fabrication techniques, processes and appearances (such as transparency, thinness, etc.). The understanding and utilization of these aspects were of utmost importance. Students were able to compare the work of the other groups with different materials and expand on the question of how materials influence form, structural behavior and space.

Fig. 12. Folded paper pulp thin shell.. Photograph: G.Rafailidis.

The task to create such a large span with such weak material in such a short time forced students to focus solely on the relationship between structure, form and space and not get sidetracked by external concepts. The full scale model was not a representation anymore, but rather, a full scale physical product, offering a performative dimension (span, sag, failure, etc.) as well as an experiential dimension.

Fig. 13. Thin shell concrete cast. Photograph: G.Rafailidis.

Conclusion

This course[3] allowed students to develop critical beginning design skills which were all anchored in their reading and response to an everyday space. The various media assignments resulted in multiple readings of the original space, and revealed multiple dimensions or aspects of it. The main focus of the studio was to avoid a common tendency in design studios - the simplistic dichotomy between material and immaterial, between the real and the represented. Instead, the overall work produced in this studio suggested that space is a complex conglomerate of first-hand experiences, memories, representations and subsequent materializations and artifacts generated from it. The original, represented, and performative aspects of materiality and space were dissected and reassembled into a new whole.

Notes

[1] St John Wilson, Colin. "Sigurd Lewerentz, The Sacred Buildings and the Sacred Sites" in Sigurd *Lewerentz, 1885-1975: The Dilemma of Classicism* Architectural Association Publications: London, UK. 1989. p 7-29.

[2] *Rachel Whiteread: House* Phaidon Press: London, UK. 1995.

[3] The studio ran as the first year, second semester design studio. It was organized around 3 faculty and 7 teaching assistants. 2012 faculty: Georg Rafailidis (coordinator), Matthew Hume, Chris Romano. 2013 faculty: Georg Rafailidis (coordinator), Matt Hume, Jen Wisinsky-Oakley.

Texture as a Parti for Light and Form

Robert W. Tango AIA, LEED AP, NCARB

Southern Polytechnic State University School of Architecture and Construction Management

Where do I start?

Despite the resources now available to a student in the palm of their hand, the question of a starting point still on how to begin a design still perplexes most of the students. Throw in the request to "come up with a parti" and any look of confidence quickly diminishes. Texture as Parti creates a type of approach to kick start a project with the study of materiality. 2D & 3D exercises interplay sequentially to move the student into deeper exploration. Awareness thru observation is amplified and reinforced by sketching.

Southern Polytechnic State University offers a five year professional degree of Bachelor of Architecture. The project described within this paper was given to the second year, first semester students although it could be introduced in first year curriculum. Monitoring of student skills and weaknesses by studio coordinators gives insight to strengths and weaknesses of the current students. Curriculum is then developed to best suit the need. Hence this project formed to address the weakness of parti/concept evolution and additionally to add a component of the qualities of light.

Seven phases are involved for a period of four weeks. Instructions are given for each phase separately so the student is not aware of the next step or the final goal. Unencumbered by a preconceived solution frees the mind to concentrate at the task at hand without trying to bias it towards a final solution. Normally the tendency of the student is to not allow oneself to get into too complex of a thought pattern which proves cumbersome to transform into a physical solution. The objective is to create sensitivity, vision and awareness of texture, later for use as a project parti. This approach of materiality is not presented as the sole way to develop a parti, but as a suitable plausible option. The texture of a material – its materiality, becomes the seed to water and sprout.

Thinking Freedom

A component of success in my studios is infusion of an attitude at the beginning of the semester when I outline the studio culture expectation. "Scarcity/Abundance Mentality" is the cornerstone concept. Author and acclaimed business effectiveness consultant Dr. Steven Covey explains this characteristic in his book *The Seven Habits of Highly Successful People*[1] as part of the chapter on Habit 4: Think Win-Win. Scarcity Mentality is where people feel ideas are scarce and limited therefore must be carefully guarded and certainly not shared. The natural reaction of individuals (and students) can be to hoard information and not let fellow students "steal" them. The opposite attitude is the "Abundance Mentality" where people feel there is an abundance of information for everyone. They welcome sharing ideas and start thinking along win-win principles. The "Abundance Mentality" attitude in studio promotes thinking freedom making daily experiences between students fruitful as they freely brainstorm in a collaborative effort to advance the skills of everyone. Most critiques are full class pinups where interaction and idea exchange between the students is facilitated.

Phase One: 'Swatch" sketches

Materials: A sketchbook, High quality Strathmore heavy weight sketch paper (18" x 24"), ink pens, pencils, eraser and charcoal for drawing in grey/back tones. The paper should be sturdy enough to draw on in the field while attached to an 18" x 24" clipboard or other portable drawing surface. With removable masking tape a grid of four 5" x 5" frames is created on one vertically oriented sheet, locating the four frames in the center of the sheet separated by 1.5 inches in both directions.

Phase one is observation and documentation in the form of freehand drawings. Students are instructed to locate textures within close proximity of the architecture building so they can be easily revisited. The texture can be on an object like rust on a pole or can be a field of material like brickwork or metal grating. Objects outside are encouraged so they can be observed under strong sunlight conditions with distinct shadowing. The student is to look for a range of light conditions, color, and materials. The viewport for each object should be limited or confined in some way so distinctness of texture is focused upon. Four distinctly different textures, two of natural materials and two of man-made materials are required, looking for textures that might otherwise go unnoticed at a quick glance. It is best to select textures that are highly three-dimensional. Three-dimensionality awareness is enhanced with strong sunlight producing noticeable shadow characteristics.

Scale is carefully chosen by zooming in on the object so the intricate nature of the texture can be drawn. It is not necessary select a drawing window that will allow clear identification of the object since the emphasis is on texture.

Begin the process in a sketchbook, sketching the textures at different perspectives and "zooms" before selecting the final version for each of the four textures. In addition, diagramming is required as part of the sketchbook study for the material in consideration. These diagrams should graphically describe the relationships of layers within the texture – How do they interlock or pass by, penetrate, weave or twist? How do they layer on each other? These series of diagrams will be important for the next phase.

Once the textures are selected the drawing technique now becomes a learning endeavor. Investigation through experimenting with different techniques; lines, dots, dashes or combinations, will challenge them graphically how to best represent the material. What type method will result with the most accurate representation of the texture detail? Color must be translated into a tonal range. The student must be disciplined not to draw general representative lines for the object or texture, but to accurately draw what is seen. See Figure 1.

The value of this exercise is the sudden awareness by the student of materiality and textures all around them. This exercise brings back memories to me of my small children when we would go on hikes or scenic trips. The adult parents would marvel at the landscape and the views while the young children would be focusing on a small bug, the vein on a leaf, the glistening of a pebble or rock that they saw on the path, oblivious to the general landscape. The discovery and


Figure 1: Swatch drawings by student Courtney Wise

awareness of detail was part of the natural growing process that unfortunately gradually dulls as we grow older. This endeavor attempts to push these students back into "childhood" awareness of the surrounding rich textural environment no matter where they are located. As they slowly transform the observed object into a two dimensional drawing, ample time unfolds to concentrate on textural qualities.

Guidance is given to draw exactly what they see within their established window. Tonal differences begin to establish planes or shapes rather than

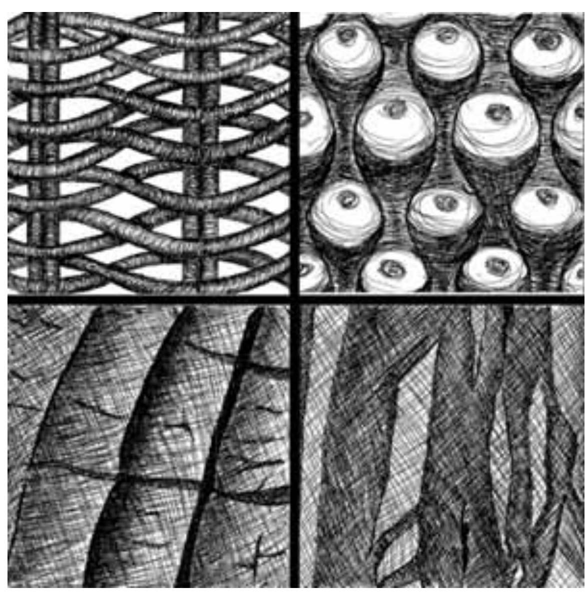


Figure 2: Swatch drawings by student Chad McCormick

pencil lines. Quality and quantity of light striking the object impacts the texture. The 5” x 5” square on the paper must be completely filled up, edge to edge on all sides. This obligation further discourages the drawing of a recognizable object, but rather a focus portion of the object’s defining texture as shown in Figure 2.

Phase Two: Three Dimensional Modeling

Materials: white museum board, white posterboard, white vellum, white trace paper, acetate and modeling tools. Materials should be easy to cut and manipulate.

The purpose of this phase is to move the student into a three dimensional representation of the phase one two dimensionally drawn object. Layered on top of this objective is to simultaneously begin to recognize and explore the effects of light and shadows. Note the requirement of white or translucent materials. This is to facilitate shadowing, reflection and transmission of light as part of the study. The sketchbook drawings showing layers of structure and interaction produced in the previous phase will now begin to come into play. The goal is to observe formative shadows, lines and edges to create a model that is not representative of the object, but of the pattern. With this in mind, the student selects one of their 5 x 5 drawings to scrutinize for this phase. The best visual representation may not necessarily be selected to advance to the next stage considering the challenge to convert to 3D.

The student must carefully study the selected swatch and imagine introducing a depth of depth 3”. Three 5” x 5” x 3” study models are requested to be constructed. Drawing lines now become part of an imaginative model, not a model replicating the original object, but one based on reinterpretation of the drawn lines, textures and shapes. An oval shape for examples could represent a void, a solid plane, a tube

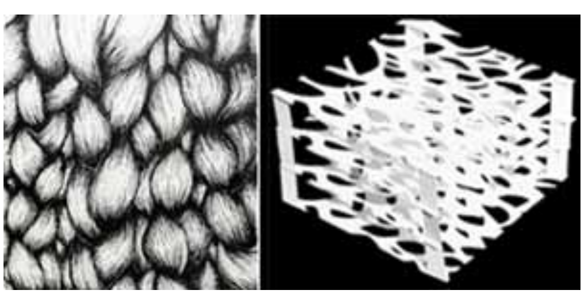


Figure 3: Swatch drawing and three dimensional representation model by student Demetrius Rease

poking towards you or a circle rotated at an angle away from the viewer. Parallel lines could be seen as a series of strips of different depths within the 3” deep object. One approach is shown in Figure 3.

This exercise stretches the imagination of the student to see how a two dimensional drawing can represent many possible shapes viewed at 90 degrees to the paper plane. It also brings awareness to the limitations of two dimensional drawings. Shadows on the drawings can be treated as separate surfaces or voids. Two class days are allocated for this phase. Two other interpretive swatch models are shown in Figure 4, derived from the upper left swatch drawing in Figure 1.

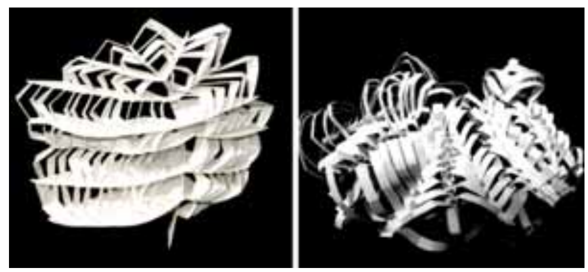


Figure 4: Swatch models by Courtney Wise

Shadowing and the effect of light on the object can now be introduced. The student is to examine his created object in strong sunlight to see the effects. Attention is pointed towards observation of the gradient of the shadows on the different planes of the model and how the combination of gradients, reflections and openings manifest into aesthetic interest. Then attention is pointed to the shadowing transmitted on the ground or a wall by the object. Another set of strategies can be defined if the ground plane aesthetic becomes the focal point. Next the student is challenged to think about how design strategies could be employed for both the object and the ground simultaneously. Value of a lighting aesthetic is explained but the awareness becomes evident when models are placed comparatively side by side. The differences may be formidable to describe but visually quite evident. The study of these small 5 x 5 x 3 models is an important stepping stone to Phase 5.

Phase Three: Back to Two Dimensional Drawing

Now that the student’s imagination and vision of the original two dimensional swatch drawing has been expanded, it is time to go back and revisit the drawing site of the chosen 5” x 5” swatch.

The selected 5" x 5" area is to be redrawn at a size of 15" x 15". More detail is expected in the enlarged drawing as shown by comparing the swatch drawing from Figure 1 and the drawing in Figure 5.

The perspective can be changed somewhat from the original and the drawing window by zooming in or out. Since detail perception has been enhanced from the previous exercise, the student will view the object in a much more sophisticated manner; structurally, technically, and texturally. Greater awareness will add more richness and depth to this new drawing. Evaluation will be based on density of detail. The time frame is two class sessions

Phase Four: Figure Ground

The term figure ground or figure ground perception is used to describe the tendency of our eyes to evaluate and simplify any visual field into the main object that we are looking at (the figure) and everything else into the background (or the ground) – hence the term figure ground. The figure ground phenomenon in visual perception was experimented with extensively by artists like M. C. Escher. These perceptual studies are enhanced when we distill the color in our drawing or scenes either black or white. As in the classic example of the faces and the vase, (Figure 5) depending upon whether you see the black or the white as the figure, you may see either two faces in profile (meaning you perceive the black color as the figure) or a vase in the center (meaning you see the white color as the figure). The effectiveness of this illusion is based on the perceptive balance of black and white. The eye is fooled trying to sort out which is which. An effective balance will typically yield half of the onlookers seeing one way and the other half the opposite.

Figure 5: Face & Vase Figure Ground Illusion

The student is now challenged to take their 15 x 15 drawing and convert it to a figure ground drawing. In this graphic exercise, there is a good example to verbalize to describe the process. Imagine taking an image, opening in Photoshop, changing the setting to black and white and then adjusting the contrast of the image to maximum. However this assignment has a higher level demand. The created drawing should create a condition of 50 / 50 balance between figure and ground. The material and method is to "draw" the new image using black and white construction paper only – either black paper on a white board or white paper glued to a black board. See Figure 6 for detailed phase two drawing and phase three figure ground drawing.

Figure 6: 15" x 15" detailed drawing (left) to 15" x 15" figure ground drawing by student Courtney Wise

This assignment becomes easy to analyze at evaluation time. All drawings are pinned up adjacent to each other in a tight rectangular area so the breath of them can be viewed without much head/eye movement. The successful drawings will be evident when questioned to the group about what they see in each particular drawing. If roughly half the students see the white as the figure and the other half see black as the figure, the student has achieved a successful balance.

Figure 7: Two Figure Ground drawings inverted to each other by student Michael Phaff

This exercise teaches on many levels demonstrating effectiveness of graphic composition and emphasis on the perception of an object verses the background. One student tried it both ways producing a second drawing reversing the black

& white tones in the figure ground. See Figure 7. Both drawings achieved a good 50/50 balance.

Another value of this exercise is that the original detailed drawing which had more depth and perspective has now been distilled down to a flat image. (Not quite the same as the Photoshop command “flatten image!”). In most cases the original form is still evident, teaching the students that simplification is usually an effective communication and design approach.

Phase Five: Light Tile

Now we move back to 3D model constructions Lessons learned in form generation and light study introduced in Phase Two models will be applied again here. Using figure ground “planes” as generative shapes create a 15” x 15” x 6” deep model. Emphasis is place on designing a solution that produces creative and captivating light and shadow varieties both on the object itself and on a ground or wall plane. From the phase four exercise, the student realizes that he can transform a detailed two dimensional drawing into simple two dimensional elements.

The materials are: white posterboard, white vellum, white trace paper, acetate, or any other white material that has unique light transmission properties.

Light is discussed from a functional and aesthetic standpoint, with this exercise more emphasis is placed on the aesthetics. Even though all materials are white, the student quickly realizes that the hue and intensity of the white surface vary greatly depending on how the light is reflected or transmitted through the material. The interplay between translucency and opaqueness adds multiple combinations to experiment with. A comparison of the figure ground drawing in phase four to the Light Tile in phase five is shown in Figure 8.

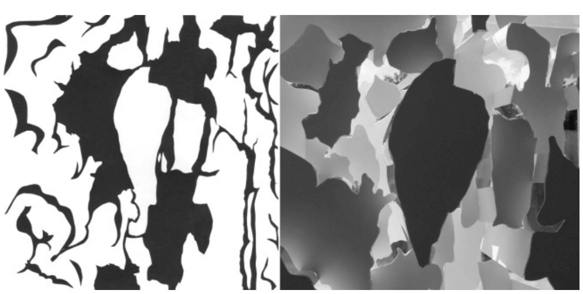


Figure 8: Figure ground drawing compared to light tile by student Rebecca Robinson. (See also Figure 9 for her Light Tile)

Figure 9 shows the light tiles arranged side by side with strong sunlight projecting from behind for the jurors to evaluate.

Figure 9: Evaluation setup at jury with strong sunlight

A standard light tile frame construction was dictated to the students. Framing become an important decision. Does the tile want to literally appear like it was slipped into a square cutout in the wall or does the frame want to be minimized as a visible element? I choose the latter requiring a clear Plexiglas frame to allow better light transmission and better observation and exploration of edge conditions. The clear frame brings more attention to the geometries of the created piece and requires a higher level of craft. Gluing solid material to or adjacent to Plexiglas (typically representing glazed openings) is always a challenge and requirement in most model making. Now the interface with the frame becomes a thought and craft challenge. Having a clear frame allows easy observation at an angle of multiple units as shown in Figure 10.

Fig. 10: Clear frames enhance viewing and light flow

A high level of craft is also demanded for transmitted light is also exposing light. Glue joints, knife cuts, slip joints all have to withstand the visual test. Intensity of light is established by showing the student ahead of time how the object is going to be evaluated with strong direct sunlight - light that is unforgiving of poor workmanship.

High contrast between light and dark areas made for more successful solutions, showing the student that certain amounts of opacity producing darker areas actually emphasizes the lighter areas. The same 50/50 play of imaging discovered in the figure ground generates innovative solutions.

Phase Six: Light Pavilion

We have reached the crescendo and answer to the wonder of where this series of exercises was leading to. Withholding the scope of the final phase keeps the student locked into each assignment without trying to hedge their efforts towards the next phase. In this phase we move to creating human scaled spatial form. The program is deliberately kept very simple modeled after the Serpentine Pavilion Competition. The Serpentine Gallery for Modern and Contemporary Art in Kensington Gardens, London, England annually commissions international architects of worldwide acclaim to design a pavilion on the gallery's lawn that provides a unique showcase for contemporary architectural practice. The pavilion is host to usages such as film screenings, talks, proms and a café.

Expanding upon what was learned from the light tile, the student is challenged to develop a skin and structural form that interacts with light and exhibits similar properties from the previous light tile. The body of the layers can be reshaped to form both structural elements and light refracting surfaces. Manipulated surfaces must create spatial quality for human interface based on an activity in mind for the pavilion.

Beginnings with a series of study models, I require that any discussion of models must include a scaled figure as part of the presentation. This is the most effective way to test success of spatial quality, grounding the reality of scale into each model.

Final deliverables are a ¼" scale white model. on a site, floor plan at 1/4" = 1'-0, site plan at 1/8" = 1'-0" (can be combined with floor plan at ¼" scale), two sections at 1/4" = 1'-0", two Perspective Sketches and photographs of the model in strong sunlight highlighting design aspects of light manipulation and form articulation. The site is designed by the student with changes in elevation strongly encouraged. (Figure 11 & 12)

Figure 11: Progression from large detail drawing (1) to light tile (2) to Pavilion (3&4) by student Katrina Alano

The use of the Architecture department's heliodon was encouraged to get a better feel for the light conditions, provide a basis for site orientation and encourage solar responsive design. (Figure 13)

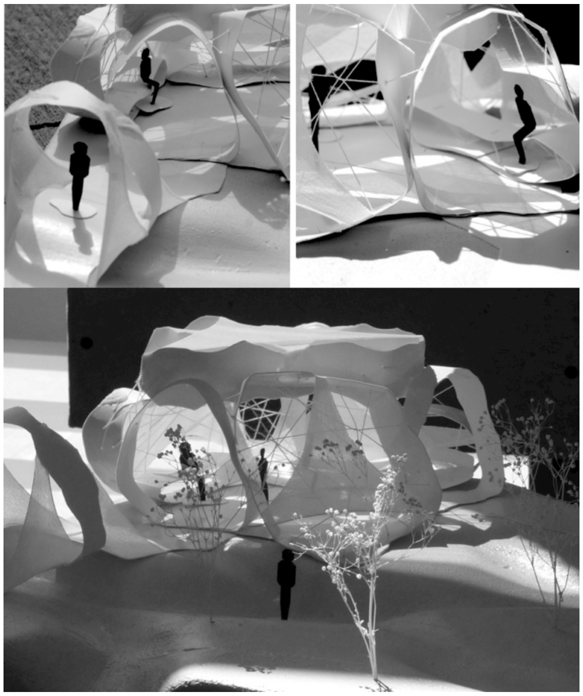


Figure 12: Pavilion model by student Michael Phaff

Conclusion

Within three and one half weeks this fast paced project of seven phases exposes the student to a wide range of learning objectives. Since the approach was broken down into distinct parts, students were less likely to fall helplessly behind, trying to cram a solution in the end, as compared to a longer duration project. Texture as a parti for light and form gives students a viable alternative when seeking a starting point for a project through greater awareness of texture and materiality. Texture from a leaf can be the basis for a building parti of a green building company. A steel grate could inform the skin of a steel fabrication building. A texture from a piece of wood could inspire a furniture showroom. A texture from a tire could lead to a skin/structure for an auto dealership. Possibilities are limitless.

Another goal was the awareness and examination of light from a functional and aesthetic standpoint. Awareness of light characteristics

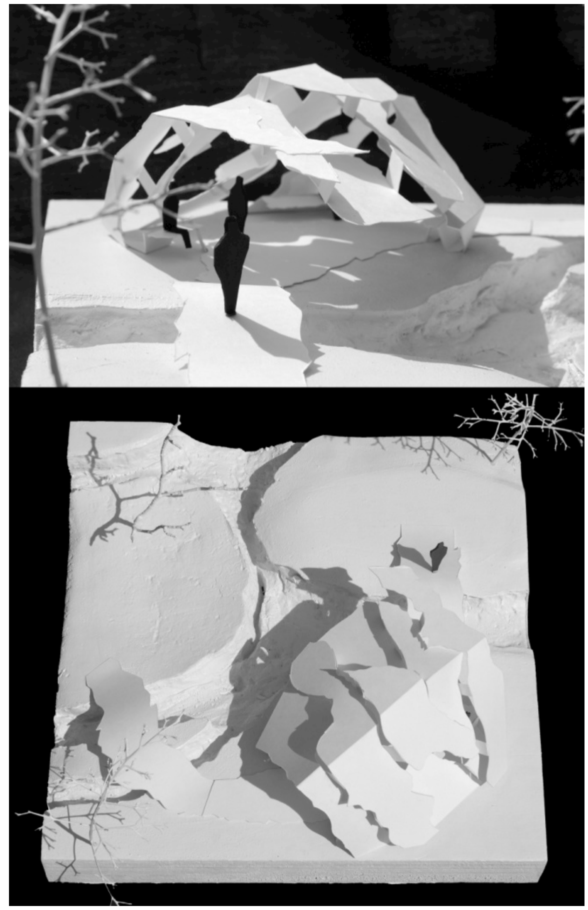


Figure 13: Pavilion model by student Rebecca Robinson derived from light tile shown in Figures 8 & 9.

and quality help form skin treatments and enhance spatial experience. Most importantly, all these process steps culminating into a piece of architecture gives credence to the journey in the eyes of the student.

Multiple approaches to addressing an architectural project are introduced in the various studio curriculums for Design Foundation students. Texture as a Parti for Light and Form provides an excellent option for a design process – a good addition to an aspiring architecture student's toolbox.

Notes

[1] Covey, Steven, *Seven Habits of Highly Successful People*, Free Press; Revised edition (November 9, 2004)

To Create Space Is the Concern:
Lessons in Space Making Via Donald Judd's Marfa, Texas, *"Untitled (15 Works in Concrete)"*

Stephen Temple

University of Texas San Antonio

Figure 1 Partial Plan of Donald Judd's *"Untitled (15 Works in Concrete)"* Chinati Foundation, Marfa, Texas [Temple]

Architecture as Space - A Prime Concern

One of the most difficult issues for beginning design students to learn is to transition from thinking of architecture as an object to thinking of architecture as space. Teaching architecture as space is also a difficult issue, particularly when within a context of teaching design thinking as key to design pedagogy. Objectness is easy. Looking at the world as objects is nearly mindlessly drawn out of the world, especially within the consumer culture in which beginning design student life-experiences are situated. Consumer culture presents a ready correlate with student preconceptions that architecture means designing buildings as a figurative equivalent to *things to be purchased*. For the beginning design student, this objectification of the designed environment, with its subsequent diminishment of the directly experiential, becomes a strong preconception (literally, *before realization of idea*) toward design. To instead realize the idea that space is the primary concern of architecture, this preconception must become supplanted with the more essential idea of spatial constructs that embody architectural experiences. The essence of what must be realized for designers is summarized by 19th Century architectural theorist August Schmarzow:

Man imagines in the first place the space which surrounds him and not the physical objects which are supports of symbolic significance. Architecture is "art" when the design of space clearly takes precedence over the design of the object. Spatial intention is the living soul of architectural creation.[1]

As a design activity, Schmarzow believed that to make space requires recognition that our bodily presence is evident in the experienced spatial body of architecture as its imagined and intuitive equal in material form. Our sense of space takes form as an occupant psychologically and "immediately strives to translate the inner intuition *[of space]* into an actual phenomenon,"[2] as the generative seed linking experience with thought systematically through architectural space. As a psychological activity, then, space is simultaneously experiential and intellectual, with elements of both feeling and calculation. Experience of space is bound into what phenomenology regards as one's relations with one's environment, whereby the self, submerged into its own bodiliness finds its relations to the surroundings within its sentient operations. Space is both experience and surroundings unified into one lived spatiality. Thus, the world is lived before being conceived (i.e., transformed into an idealized mental apparition) as a primary aspect of the lived body situated within space.[3]

Making space as a system of design thinking also means constructing voids out of proportion, structure, and material surface while developing volumes as the complement of masses and planes systematically interactive with other volumes as they are perceived and experienced. While making decisions in material dimensions can help bring the idea and experience of architectural space forward in the consciousness of a would-be designer, the notion that space is a primary objective of design is a much harder won pedagogical objective. The means for its demonstration, if in drawings, models, and architectural discourse alone, remains for a beginning design student a distinctly abstracted and disconnected transition toward a way of thinking about the world that ultimately alienates them from what they previously counted as complete experience. Drawn representations, in particular, demand of the student new forms of thinking and visualizing that also demand that they critically analyze their own experience in the world in ways not just unfamiliar to them, but disconcerting and outside of any presumed sense of order.

Figure 2 - "Untitled (15 Works in Concrete)" Donald Judd – Open Ended Concrete Elements in a Triangular Arrangement [Temple]

In light of these difficulties, it is the purpose of this paper to demonstrate that Donald Judd's series of concrete constructions, with the name, "*Untitled (15 Works in Concrete),"* located in Marfa, Texas, are paradigmatic of space making

for beginning designers and can be a catalyst to the comprehension of space in architecture and its realization in architectural design. Donald Judd's Minimalist concrete works constitute specific relations between subject, object, and space, and as such offer object lessons about space with which beginning design students can contend. Judd's *15 Works* offer both the experience of space as a primary aspect and, when drawn according to architectural convention, illustrate both the clarity and confusion necessary to representing spatial relationships in drawing form. Judd's "*Untitled (15 Works in Concrete)"* are constructs where space and form are in continual operative dialog with and through experience, where the experience of space is made specifically and precisely evident. Distinguishing relationships between painting and other art forms, Donald Judd viewed these operations as constructs of "real space" where actual space itself was powerfully assertive as the single subject matter. As Judd Stated in his seminal essay, *Specific Objects*:

Figure 3 – "Untitled (15 Works in Concrete)" Donald Judd – Open Sided Concrete Elements in a Triangular Arrangement [Temple]

In the three-dimensional work the whole thing is made according to complex purposes, and these are not scattered but asserted by one form. The thing as a whole, its quality as a whole, is what is interesting. The main things are alone and are more intense, clear and powerful. They are not diluted by an inherited format, variations of a form, mild contrasts and connecting parts and areas. Actual space is intrinsically more powerful and specific than paint on a flat surface.[4]

Judd's series of precisely constructed concrete "boxes" are laid out into a line on the otherwise barren landscape. Together, they exist as basic rectilinear and very material elements that construct their own context, and their own relationships, with distinct specificity to the very space they construct. Experience of the *15 Works* takes form as a walk along and among them, in an out and between a lengthy series of various careful configurations of repeating yet varied rectilinear forms. In experiencing the *15 Works* the observer becomes located as both the subject

and the object of the work within the changing definition set forth by each work itself within in the space of the object. As the concrete boxes enclose the observer moving among them, the space of occupancy becomes clearly and specifically evident as a relation to the viewer. In this

Figure 4 – "Untitled (15 Works in Concrete)" Donald Judd – Open Ended Concrete Elements in a Three by Three Arrangement [Temple]

Figure 5 – "Untitled (15 Works in Concrete)" Donald Judd – Open Sided Concrete Elements in a Triangular Arrangement with Three Elements Beyond [Temple]

way, the viewer is an active participant in the making of space in a way specified by the work itself. Judd's *15 Works* contain *just enough order* to demonstrate potential manifestations of space as equivalent to our inner experience and simultaneously, in the multivalent forms of their various specific arrangements.[5] Judd's *15 Works* enable the conjuring of space within a kind of self-situating wherein we realize "we are living in a little point and everything is infinite in all directions."[6] Additionally, Judd's *15 Works* are concerned for thought in relation to the material structure in space. As Judd stated, "The form of a work and its materials are closely related."[7]

Concrete was used because it is a material heavy with is own sense of permanence and its own history in the form and marks of its own making (as given by formwork). The direct and straightforward depiction of structural loading is made evident in the brief linear reveal that separates the top from sides from base. The materiality of each piece lends an autonomy to the pieces such that they "exist in and for themselves; they signify their own content through the space they occupy and the time they encompass' as they are experienced."[8] Each of the *15 Works* are self-referential to nothing other than its own intentionality, in a phenomenological sense, within its precise, material existence in "real space" in the moment to moment perception of its surfaces in light.

What is most evident as a lesson for beginning designers is to realize the potential for spatial experience that Judd sought in his work - to make sense of object and volume as space, and thereby transform formal, figural concepts belonging to the world of material objects into spatial relationships, specifically as a matter of experience. Realizing experiential space over object is also a primary aim of beginning design pedagogy. Through explorations of Judd's *15 Works*, it can be made clear that space must be located both by body and simultaneously imagined by mind as a locus of space. If the design act is to be realized that recognizes space as a primary antagonist, the spatial environment that springs from it must actually *transform* spatial experience instead of simply formally manipulating the objects (walls, roof, floor, etc.) that bound it as imaginary forms or compositional figures.

Short of the truest way to experience Judd's *15 Works* - directly in Marfa itself - the spatial intentions of the *15 Works* can be modeled In the studio classroom by way of manipulating and photographing large scale models, followed by a brief design project that incorporates the intent of spatiality with minimal imposition of program. Students first build large scale chipboard models of each element of Judd's *15 Works*, then test them for the claim of spatial distinctions, both in the studio under ambient light (simulating a cloudy day) and in direct sunlight. Models are first placed according to Judd's modulated layouts, with students placing themselves (and their cameras) on the floor to simulate eye level experience. Then the models are moved incrementally as a first-hand test of spatial experience, until moving the models reveals that spatial distinctness is specific to distance, material surface, and form as an aspect of experience. Scale is of course a primary issue, because these are scale models, thus revealing to students a primary lesson that the complexities of spatial experience are subtle and not easily anticipated in representational forms and must not be taken for granted in design decision making or even full-scale realizations. Judd's lifetime of artwork is a testament to the basic challenge of human experience.

A Design Project for the Primacy of Spatial Experience

Sunlight is an inherently deliberate aspect of the spatial specificity of the experience of Judd's *15 Works*. Shadows caused by the intense west Texas sun amplify depth and distinctness. On the few overcast days that may occur, the cavities of each element and the space between them become accentuated by an even, ambient light. Light is essential to the experience of space. In recognition of the presence of sunlight as a key aspect of spatial definition, a design project was developed for an architectural place that exploits Judd's notion of spatial experience. The project is only three weeks to make them focus on conceptualization rather than the totality of the realities of architecture. The narrative of the project locates it as a roadside architectural construction that one comes upon along a remote country road. The site is north/south oriented area of flat ground with large trees to the north. Solar orientation, solar diagrams, and issues like azimuth and altitude are first learned using the production of shadows of students own bodies. The project asks students to develop an architecture in which to experience sunlight on four days of the year (summer and winter solstice, and the equinox) but must also describe to an occupant this specificity even when not at these four time frames, when no alignment can happen, or when skies are overcast. Key to the project description is that the architectural space must explain itself through experience.

Since light has no scale, the project asks students to take study models into sunlight to study light effects, especially as a test of more cognitive speculations made with section drawings. In sunlight, students realize that sunlight projections into space from specifically located openings or edges in an enclosure can make telling alignments with ground or wall markers that specify the required days of the year. Some students exploit the potential for future alignments while others realize that an incomplete rendition of the opening from which light enters describes light as a crescent moon tells of the full moon. While addressing a rather mechanical problem, constructing the means to support the spatial experience necessary to observe these specific light projections is found to be as important as mechanisms of sun movement. Since architecture that

Figure 6 – Classroom Explorations of the Spatiality of Donald Judd's "Untitled (*15 Works in Concrete)" through Large Scale Representations* [Temple]

specifies the sun derives its meaning from human experience, any formal definition of space that specifies mechanisms of sun penetration must occur with respect to the spatial experience that also specifies a perceptual viewpoint that will lead to the comprehension of the sun's particular movements. The space of the viewer is found to be is as important as the space of sun movement.

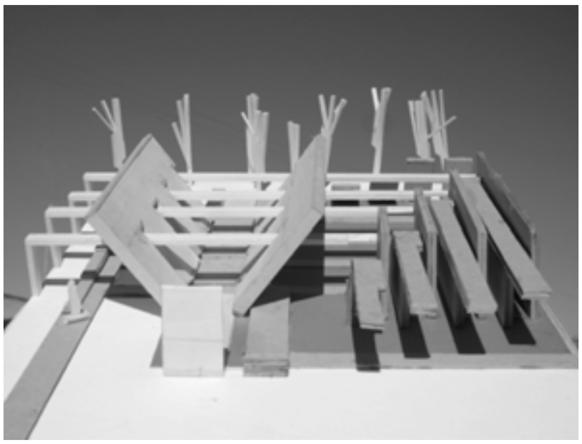


Figure 7 - Student Project Sun Testing (D. Lindsey) – Place for the Sun at Four Times of the Year [Temple]

Models in sunlight both bring about and support these realizations. Drawings of plan and section in projection reveal the difficulties in representing and explaining spatial experience but also reveal that thinking through representational drawing helps develop the necessary specificity of architectural experience. Students realize they can use drawing to confirm what they have experienced or they can use drawing to speculate on issues of experience. A model is used as both as a form of discovery and a test of what is speculated in other forms. Because sunlight only happens in space, and is only experienced in space, the primary issue of discovery and speculation in the project is spatial experience itself, not just how space behaves in an objectified, formal sense but how an occupant comes to be within space as the subject of consciousness in experience.

Lessons in Space Making

Judd's *"Untitled: 15 Works in Concrete"* offers a basis for inquiry into space making in beginning design projects if harnessed within a controlled project. The project shown in the paper reduced issues to space and light with a marginal program following student studies of spatial definition using large-scale models. Whether or not this

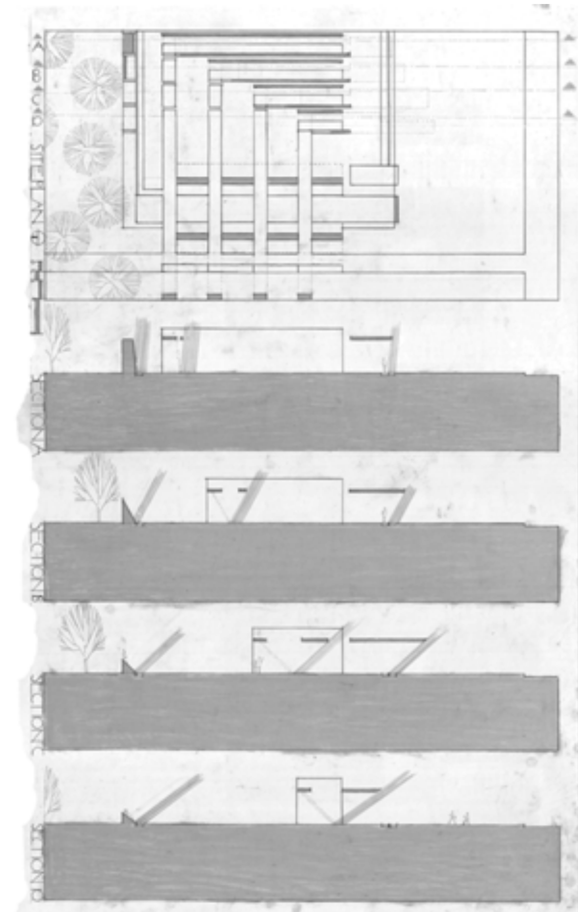


Figure 8 – Student Project Drawings w/ Sunlight shown in Section (D. Lindsey) – Place for the Sun at Four Times of the Year [Temple]

is in accordance with Judd's Minimalist agenda in the *15 Works* is not the primary question of this inquiry. Judd's *15 Works* are used as a springboard of transformation of design students' attention from object to space and the way issues of experience become present in built work. The project is used to make inquiries about how drawings and models can predicate these issues of experience or otherwise obfuscate them. The primacy of space as an agenda for architectural design that can be realized in Judd's *15 Works* is that the objectness of form and material need not be the focus of design but can construct spatial experience as an essential characteristic of architecture.

Space is experiential and thus requires time, memory, and movement, none of which are available to the static space of a section or plan drawing. Thus, the strictly representational nature of conventional drawings can happen at the risk and near expense of experience. Architectural ideas originate and come to life in experiences that drawings can only point to abstractly. Students engaged in this short exploration learned quickly that thinking through drawings and models brings on complexities of translation in these forms.

Judd's *15 Works* is an inquiry into "essences" of form, materials, and space as a search for what is essential to creating space in a phenomenological sense. Judd's artistic works probe the directly experiential versus what is indirect and outside direct experience. This is a critical distinction to make in beginning design because architecture must always grapple with direct and indirect relations in human experience. For example, Judd's *15 Works* are *"Untitled,"* just as is most all of the architectural environment, because a title adds narrative that is outside direct experience. This is a very important lesson for beginning design students that because they must learn, in order to become designers that explore and innovate, must learn to separate design of buildings from titles like "library," "arena," "kiosk," etc. that prejudice design decision making toward predetermined forms that take experience for granted.

Another aspect of this inquiry, and of Judd's *15 Works,* is that the mere *expression* of construction or 'constructedness' of materials is not a strong aspect of spatial experience. A material agenda for architecture becomes significant only if it gives reciprocal definition to surface and occupant as connectivity of the *feeling* of materials relative to spatial distinctions in experience. Of course, material workmanship is a critical aspect of making spatial distinctions. Poor workmanship can distract from spatial experience as workmanship is attributable to both the material substance itself and to the worker's presence as an expression. In Judd's *15 Works*, the workman's "hand" is limited (not even visible as fingerprints). Good workmanship contributes directly to increased intentionality by imparting both greater care and order at the level of the material itself, aspects which belong ultimately to human experience in space. Workmanship conveys an *idea* in its realized state.[9] Judd wanted workmanship to be quiet, even silent, in the *15 Works* so that their presence could be experienced more closely to an idealized state – moving about them is not about their materiality as concrete material but as thickness, heaviness, and mass against the ethereal lightness of sunlight and experience itself. Hard shadows emphasize this comparison and exist almost as another material presence. But nothing is more present than space as experienced by and through the inhabited moving body of an occupant.

Spatial construction in experience is directly correlated with architectural order. Space is equally experienced in architecture and sculpture. Judd's agenda as an artist was ultimately to bring about spatiality in his art works in a manner inextricably tied to the study and practice of architectural spatiality. That Judd is labeled a Modernist or a Minimalist is not at issue regarding the efficacy of this issue for beginning architectural design pedagogy. The principle distinction between architecture and art is that art seeks its meaning primarily within reflective experience while architecture derives its meaning during use in lived experience. The purposefulness of architecture as experienced in ordinary life (program, function, etc.) can add to or diminish the experience of spatial intentionality. Thus, while design must structure its experience with respect to a different agenda than do art forms, spatial definition as an act of experience remains basic to both. Judd's agenda for art arose both out of disdain for pictorial art that relies on references outside of itself and a deep concern that the conditions of both viewer and art exist in the same "real space" that placed the power of the work in its direct spatiality given by the viewer's direct and embodied engagement. This manner of engagement is that which is always present in architectural occupancy. In recognizing space, and especially space over object, beginning design students can comprehend that architectural design is not merely a clever idea or a compelling pattern but becomes evident in the depth of direct human engagement as relationships between object and space and mass and volume are transformed in spatial experience. Beginning design projects that increase the depth of engagement beyond three-dimensional objectness can attain a layering of spatial experience fully into its objects, and allow beginning designers to attain the measure of experience essential to the experience of buildings.

Notes

[1] Schmarzow, August, quoted in *Elements of Architecture: From Form to Space*, Pierre von Meiss. (Londan: E & FN Spon), 101.

[2] Schmarzow, August, "The Essence of Architectural Creation," in *Empathy, Form, and Space: Problems in German Aesthetics 1873-1893*. Edited by Harry Francis Mallgrave and Eleftherios Ikonomou (Los Angeles CA: Getty Center for the History of Art and the Humanities), 287.

[3] Merleau-Ponty, Maurice. *Phenomenology of Perception.* Translated by Colin Smith (London: Routledge & Kegan Paul) 1981.

[4] Judd, Donald. *Specific Objects.* in *Donald Judd: Early Work, 1955-1968,* Thomas Kellein, (New York: D.A.P., 2002. Originally published in *Arts Yearbook 8*, 1965), 4.

[5] Stockebrand, Marianne. *The Whole Judd*. in The Chinati Foundation Newsletter Vol 17 (Marfa Texas: The Chinati Foundation, October 2012), 15.

[6] Potter, Jochen (ed.) *Donald Judd* (Baden-Baden: Staaliche Kunsthalle Baden-Baden, 1989), 92.

[7] Judd, Donald. *"Specific Objects"* in *Donald Judd: Early Work, 1955-1968* Thomas Kellein, (New York: D.A.P., 2002. Originally published in *Arts Yearbook 8*, 1965), 4

[8] Morgan, Robert. "Rethinking Judd." in *Sculpture Magazine* Vol 20, no 3. (April 2001), 4-5.

[9] Pye, David. *The Nature and Art of Workmanship.* (Bethel, Mass: Cambium Press, 1968)

Context to Concept:
Place, Phenomena and Experience Made Tangible

Liz Teston, Valerie Friedmann, Jennifer Akerman

University of Tennessee, Knoxville

Introduction

A fundamental objective of design education is for students to develop the ability to approach problems creatively and generate conceptual objectives within their work. How might the direct engagement of sites, explorations at multiple scales, and making of representational material artifacts—collages, drawings, and models—facilitate the beginning students' ability to develop a point of view rooted in a conceptual agenda?

This question was explored during the Summer 2013 Design Foundations Studio; an expedited nine-week beginning design course that was vertically integrated and interdisciplinary. Recent experiments with the studio's instructional methodologies were developed with the intention of improving student achievement and easing the transition inherent in becoming a design student. Undergraduate and graduate students from all of the college's degree programs—architecture, interior design, and landscape architecture—were combined into one studio section providing a diversity of backgrounds and prior experiences. The course was co-taught by two faculty members rotating every two weeks. This structure's goal was to ensure the exposure to a variety of design perspectives and instructional methods, and to establish a strong network for the students at the outset of their education.

The summer curriculum's emphasis on experience, scale, and iteration through physical modeling techniques resulted in an appreciation for haptic and phenomenological qualities of design that are integral to each design discipline. This paper outlines the approach explored in the final four weeks of the studio.

Pedagogical Approach: Place, Phenomenon, Experience

Many introductory design curricula, including the "normative" fall courses taken by the majority of students in this college, present early design as rooted in abstraction, composition theory, and Modern ideals of universal space, abstracted ornamentation, and functionalism. This kit-of-parts approach, though time-honored and effective in many contexts, is problematic for several reasons. Some contend that beginning design students have difficulty understanding the objectives of non-representational composition; it is not true abstraction, as students do not yet know what they are abstracting. More importantly, this approach privileges the architectural discipline and may be less accessible to students of interior design or landscape architecture.

In an effort to address these problems, this summer sequence was designed to focus on more tangible and immediate design problems, emphasizing the issues of scale and experience that are especially important for all beginning students. The design projects, situated in actual sites, asked students to investigate the human condition as it relates to variations in scale. Students' decisions about space composition were rooted in sensorial experiences of phenomena in real urban contexts.

To represent the variety of disciplines in the college, project briefs incorporated learning objectives characteristic of each discipline. Interior design objectives included the relationship of the body to architecture. Landscape architectural objectives centered on the interpretation of site processes, and cultural design implications at the urban scale served as objectives in architectural endeavors. These moments of overlap between scale and discipline were the most compelling. How does the body relate to the landscape? How does the body interact with the city?

This line of empirical questioning provided an understanding of site as a situation composed of physical material continually animated by environmental phenomena. Students observed and interpreted a specific site phenomenon and creatively considered how others experiencing the site might detect it (Project I). In this way, students formed a design concept based on a familiar, yet often overlooked, phenomenon (wind, light, water, sound) that was amplified through the creative integration of another familiar phenomenon—the five senses (vision, hearing, touch, smell, taste). Students then worked extensively through physical models to design an installation that facilitated an individual's observation of the selected site phenomenon through a specific physical sense (Projects II-III). Next, the installation for an individual was reinterpreted at a civic scale through means of copy-paste-modify, explored through models and drawings and resulted in a designed urban environment facilitating the appreciation of public art (Project IV).

The basis for this pedagogical approach, in which students examine project sites through empirical analysis and focus on sensorial and phenomenological combinations, is founded in Juhani Pallasmaa's *The Eyes of the Skin*. In this text, Pallasmaa posits that ocular experience is given inappropriate primacy in the design of today's built environment; that often overlooked senses of touch, smell, sound, and taste have the ability to induce an intense architectural experience. Repetitive haptic episodes generate body memory, and olfactory conditions inspire nostalgia. He explains that acoustics manifest intimacy with other occupants, and coupled with visual cues, connect people to their surroundings in a communal way. Just as our "hands want to see," our eyes want to taste. The visual taste of polished materials immerses us in the spaces we occupy. Pallasmaa's text was chosen for its relative accessibility to beginning students. Following the reading, students' projects developed a synthesis between phenomena and senses that promoted a critical position on the built environment.[1]

A related perspective on the importance of designed and environmental phenomena comes from writer and educator Anne Spirn. Spirn suggests that by observing and interpreting elements of landscape one can derive significance; that meaning is molded by observed phenomena. In this way, each unique context produces a distinctive design approach. As she suggested in *The Language of Landscape*, experiences are interpreted relative to other experiences. Students were asked, "How might one observe sound using the sense of sight? Wind using the sense of touch?" Exploring the answers through design, students uncovered how a phenomenon interacts with and animates the surroundings and how they might design to create heightened haptic experiences. In this way, the in situ experience for an individual may be intensified.[2]

In shifting focus to design for the public, students were confronted with the commonly held misconception that public spaces are often considered static, historical, and geographic. However, the commons does interact with the body when appropriate scales are considered in the built environment. Society's public space is part of our collective memory, reproduced through repeated haptic movements, a type of rote memorization.[3] As such, students were exposed to writings by Kevin Lynch, in which he documents the pedestrian's sensitivity to topography and building mass. Lynch explores Boston's perceived landmark adjacencies—all to understand the relationship of the human experience within the urban environment.[4]

The daily routine of everyday life in public spaces—and its subversion—is also documented in the Situationists' political and creative agenda. They attempted to reclaim public space and "occupied the streets which were no longer their own."[5] Psychogeographic mapping, a speculative representation of zones that create distinct experiences, lends importance to place-psychology and the senses.[6] Readings, diagrams, and maps by both Lynch and the Situationists helped students shed preconceived notions of static public spaces.

Additionally, the introduction of public art, as a vehicle for shared culture and interactive engagement, prompted the reinterpretation of the individual observatory into a civic project. For example, Doug Aitken's sublime *Song 1*, allows direct engagement with the installation. Visitors walk around the Hirshhorn Museum in an effort to see the film from all angles, creating a varied sensory experience.[7] The incorporation of a public art program within the iterative copy-paste-modify studies of Project IV provided a formal connection between the previous design for an individual and this urban project. Maintaining the project brief's sensory objectives created an experiential connection between the projects, in spite of the scalar shift. The studio pedagogy introduced students to the cultural implications of the built environment by exploring transformative human experiences made possible through design at the scale of an individual and the commons.

Course Goals

In recognition of its role as the introductory design course taken by students new to architecture, interior design, and landscape architecture, the course objectives were designed to help students succeed in the summer and be well positioned to thrive throughout their degree program. These goals were addressed through pedagogical choices in course structuring, as well as the decision to focus on conceptual ability and a phenomenological agenda with beginning design students.

Course Structure and Learning Outcomes

The course was intended to help ease the transition into studio culture. As such, it was important to provide ways of unlearning preconceptions for all disciplines. The course introduced several processes for building and instilling confidence in students' creative and generative capacities. Design projects and daily studio activities were crafted in ways that privileged critical and conceptual thinking. Students co-enrolled in introductory representation courses, with studio as the venue for applying specific representational techniques in support of developing conceptions of the haptic experience.

A unique goal of the Summer Design Foundations Studio, distinguishing it from fall foundation studios offered in this college, was the intent to help students quickly build an effective and lasting support network across design disciplines. Undergraduate students enrolling in the summer program are typically transfer students who will blend into a much larger cohort of second-year students in the fall. Graduate students in the program are members of Masters programs with relatively small cohort sizes as compared to the undergraduate programs. In all cases, there was a concerted effort to prevent a sense of alienation for these students during the transition into the fall semester. Students began their first fall semester on campus having worked with seven studio instructors, two representation instructors, a theory instructor, and having received individual critique at design reviews from the program heads of all departments.

Additionally, studio projects were designed both to ensure diverse disciplinary teams for group work and to provide a balance of group and individual work. Anecdotal evidence of this approach's success could be seen in the students' peer-to-peer critique during studio.

Methods

Through the series of four design projects, students visited urban sites to make empirical observations. They analyzed their findings through the production of collage and designed a series of interventions at varying scales, primarily through physical modeling. The projects linked the human body—one's scale, how one interprets place through physical senses, and how that interpretation is colored by phenomena—to a reading of place as construct. This understanding, rooted in the body and direct experience, provided an accessible and discernable basis for conceptual design.

Projects I and II: Site and Phenomena

A primary goal of the first two weeks was to help students become receptive to the complexities of urban environments and to develop tools to translate observed conditions into composed space. To begin, students were asked to choose one parallel, on-street parking space (approximately 10' by 20') from faculty-determined locations in the downtown district. Faculty members carefully selected the locations of the parking spaces to ensure a variety of surrounding site conditions and design potential that could be considered in subsequent assignments.

Students spent a minimum of three continuous hours examining their site and context and were asked to record at least 30 observations and 15 events pertaining to one site phenomena: water, light, sound, or wind. Students were encouraged to use hand-sketching and photography as recording tools. During on-site observations, students became keenly aware of the ability for phenomena to influence, sometimes very subtly, the experience of site. For example, there was no precipitation in the days surrounding this project, but many students observed water's effect in the rust-colored streaks across their parking spaces or sediment near a drain inlet. Students examining light became aware of a protracted sense of time as they watched shadows move across their site (see Fig. 1). Students observing wind became aware of patterns of movement and pause, and those studying sound became aware of vehicular and pedestrian rhythms.

Next, students were asked to visually synthesize their site studies using collage and diagramming techniques. The assignment required that the on-site observations be conveyed visually and annotated hierarchically in terms of direction, duration, frequency, and intensity. Lectures provided examples ranging from the work of photographer David Hockney, photomontage from various designers such as James Corner and Rem Koolhaas, and student work from Bradley Cantrell's Reactscape.[8]

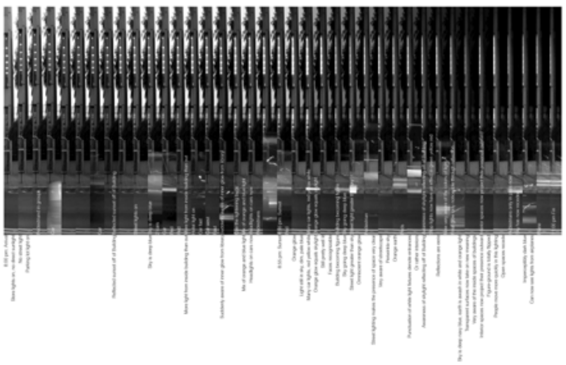


Fig. 1: Collage, Site Observations: 30 Observations, 15 events [phenomenon: light, sense: vision]; student: K. Jeffers, 2013

The site observations and colleges were completed in two days and were intended to help students quickly see the numerous, and often subtle events, which influence the built environment. The observations resulted in a common reference point: site as animated by diverse phenomena, and collages increased skill in visually communication.

In Project II, students' documented site from a more quantitative perspective though an introductory level site inventory and analysis. To foster networking, students worked in interdisciplinary teams composed of students with adjacent parking spaces to create a site documentation presentation board and model. Each team contained four to five students and at least one interior design and one landscape architecture student. Students became familiar with the production of scaled site plans, sectional drawings, and model building techniques. Additionally, students developed basic diagramming techniques to synthesize and visually communicate significant aspects of each site. Projects I and II created the framework needed for the diverse group of beginning students to develop a conceptual agenda for Project III, rooted in the experience of site.

Project III: Site and Phenomena, Body and Senses, An Observatory for One

In this project, students reviewed their previous collage and site studies and considered how the sensory experience of their chosen site phenomena could be enhanced through design. To foster creative and generative capacities, students were asked how a design privileging one of the five senses might allow an individual to interpret site phenomena in an unexpected way.

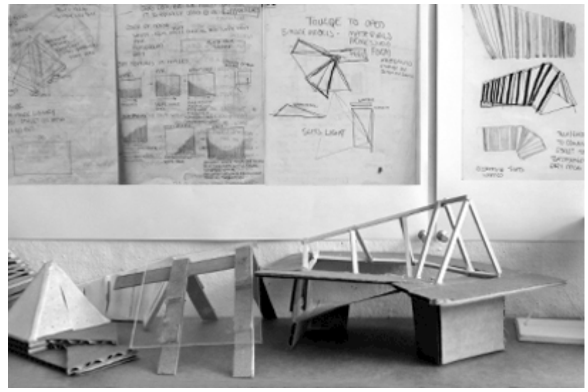


Fig. 2: Models and Final Drawings, An Observatory for One [phenomenon: sound, sense: vision]; student: R. Gillogly, 2013

Each student designed an Observatory for One that was restricted to the plan dimensions of the parking space with a section not to exceed 16'. Successful projects revealed a relationship between the selected site phenomenon and sense at a built scale appropriate for an individual. The student work shown at right is designed to reveal aspects of sound through the sense of vision (see Fig. 2). This student's observatory, located along a heavily trafficked street, invited passersby into a subgrade chamber where sounds are muffled. Above grade, the light frame and transparent glazing allows the individual to see what they no longer hear as they lean against the sunken, tilted back wall of the interior.

Fig. 3: Study Models, An Observatory for One [phenomenon: wind, sense: touch]; student: L. Venegas, 2013. Iterative model building helped students discover unexpected combinations of phenomena and senses.

During Project III, students developed confidence in spatial and conceptual thinking by fabricating multiple study models and orthographic and representational drawings. This iterative approach, used across the first three projects, strengthened students' critical thinking, enhanced their ability to quickly test ideas, and provided them with a means of editing and focusing haptic experience. Empirical site observations provided a common and accessible reference point for beginning students, and quick model building provided a means to test a conceptual agenda with multiple spatial explorations (see Fig. 3).

Project IV: Scalar Transformation, Haptic Craft

For the last two weeks of the studio, students were asked to reinterpret the Observatory for One at a larger scale. Working on an expanded site, students designed a civic space where groups of people could appreciation public art. Still working in the context of an urban street, students' sites were expanded to 20' by 100' by reconfiguring the existing street section. Building on students' previous focus on the solitary experience of phenomena in space, the Public Art Installation required them to design in consideration of the myriad experiences of many people, whether visiting individually or in groups.

Students were given one day to generate ten potential approaches based on the device of copy-paste-modify. Their previous Observatory for One project became a module that was repeated in various configurations and scales as a means of quickly generating many alternative solutions. Initial proposals were executed in plan, section, elevation, and perspective. Students were then asked to build model representations of the three most promising options (see Fig. 4). Through this process, students were required to refine the scalar and experiential qualities of their schemes to provide spaces where people might want to congregate, spaces where individuals could reflect on their own, and spaces that considered and choreographed pedestrian movement through the constructed site.

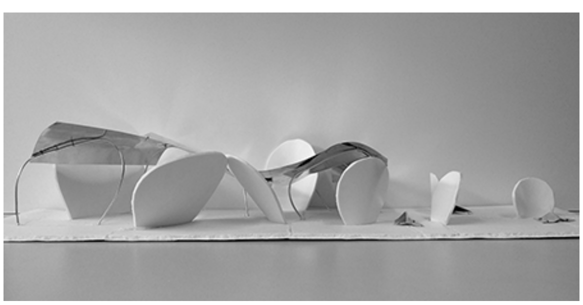


Fig. 4: Study Model, Copy-Paste-Modify Public Art Installation; student: C. Walsh, 2013

One outcome of these early iterations was students developing confidence in quickly generating multiple viable options. In this process, they experimented with formal, spatial, and material approaches, evaluating each against student-articulated conceptual goals. Students also built facility with modeling quickly through in-class workshops and critique of different craft approaches, often verging into *messy chic*. Students were asked to choose their material palette and representational approach in support of specific haptic objectives of their work. It was important that drawings and models reflected the intent and point of view of the student.

Public Art Installation

Lectures in studio introduced students to several examples of art in the public realm. With this, students were asked to reformulate their understanding of urbanity in the context of public art. Each student selected a type of art, whether it was three dimensional and displayed in the space, two-dimensional projections on architectural surfaces (recalling Aitken's *Song 1* at the Hirshhorn), aural experiments affected by the form and material of the built project, or art consisting of performances such as dance or other temporally shifting events. Choices made about the type of art inherently affected choices made for the built intervention.

The examples shown on the following page are for a Public Art Installation based on experiencing sound, either in groups or as an individual (see Fig. 5 and 6). Working with subtle changes of elevation, this student created a series of spaces that would be differentially animated by sound. Using a combination of material properties—reflective, absorptive, refractive—and the calculated composition of tilted planes coupled with

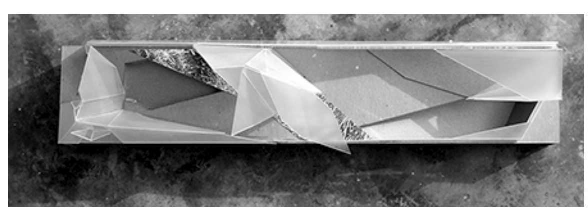


Fig. 5: Final Model, Public Art Installation; student: R. Gillogly, 2013. Traces of the copy/paste/edit project are evident in use of repetition and regulating lines.

motion-activated speakers that could capture, alter, and playback sounds of the city, this project would invite users to situate themselves within the built environment in response to their own experience of an altered aural condition.

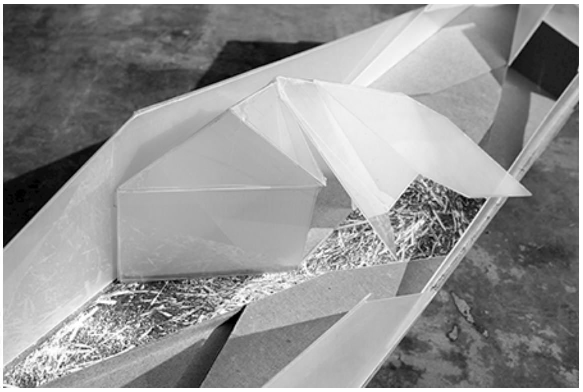


Fig. 6: Final Model, Public Art Installation; student: R. Gillogly, 2013. Detail of material choices made to augment differential reflection, absorption, and amplification of sound.

Conclusions

A survey of ten questions was given to 100 students (both summer participants and non-participants) enrolled in a studio with 2013 summer students. Twenty-two students responded. The survey results may give some insight into the pedagogy of the summer studio, but information would need to be collected over a longer period to infer correlations. Two preliminary patterns arose from the data that has been collected thus far. First, summer participants appear to be more self-critical when evaluating their skill set as compared to their peers. Eighty-three percent of summer participants responded that they “needed work” in one or more areas while only 13 percent of non-summer students responded the same. When asked about connectedness to peers and faculty, summer students did not report feeling more connected to either group than non-summer students. Interviews with individual students might yield better results in gauging the long-term effectiveness of the studio’s pedagogy.

The Summer 2013 Design Foundations Studio was an experiment in both logistics and pedagogy, and upcoming summer programs will likely continue to question the most effective ways to teach design to a diverse group of beginning design students.

The authors of this paper, each an instructor from one of the college’s three degree programs, co-taught across disciplinary lines in the summer studio and then taught the same students in their first discipline-specific fall studio. Upon reflection, it remains to be seen if there are real correlations between this experiment in summer pedagogy and long-term learning outcomes, but it does seem, at least based on the outcomes of the fall studio, that summer studio participants have developed a point of view rooted in a conceptual agenda and that using real sites and specific phenomena has helped them to achieve an understanding of scalar relationships. However, it is not evident that summer students are more or less adept than their non-summer peers regarding conceptual thinking and scalar relationships, or that they have a perception of greater connectivity within the college.

However, there are some less quantifiable positive outcomes that emerge from the summer experience. Students are exposed to a wide range of ideas and techniques employed by each discipline. These “lessons learned” might not become evident until subsequent and more advanced studios call on students to expand their resourcefulness. Furthermore, students are intentionally placed on diverse teams in the summer and experience many other relationship building opportunities—from traveling for field trips to sharing stories over dinner. Summer students make cross-disciplinary bonds that serve them well in the coming years. They are comfortable in each other’s studios and attend each other’s reviews. This awareness and comfort with other disciplines will hopefully carry forward into professional practice.

In professional practice, with the rise of the open-sourced designer, discipline boundaries are fading. Collaboration and research outcomes are improved by reaching beyond these historical boundaries and developing an interconnected web of partners. This vertically integrated and interdisciplinary design studio provides the underpinnings for a professional landscape of collaboration.

Notes

[1] Pallasmaa, Juhani. The Eyes of the Skin: Architecture and the Senses. Chichester: Wiley, 2012.

[2] Spirn, Anne W. *The Language of Landscape.* New Haven, Conn: Yale University Press, 1998.

[3] Ross, Kristin. Rimbaud and the Transformation of Public Space. Yale French Studies. New Haven, Conn: Yale University Press, 2000.

[4] Lynch, Kevin. The Image of the City. Cambridge: The Technology Press & Harvard University Press, 1960.

[5] Ross, Kristin. Rimbaud and the Transformation of Public Space. Yale French Studies. New Haven, Conn: Yale University Press, 2000.

[6] McDonough, Tom. "Delirious Paris: Mapping as a Paranoiac-Critical Activity." Grey Room 19. MIT Press.

[7]http://www.hirshhorn.si.edu/wp-content/uploads/2012/03/Aitken-combined.pdf

[8] http://reactscape.visual-logic.com/2011/03/latest-site-observation/

Drawing and Embodiment

Andrew Reed Tripp

School of Architecture at Mississippi State University

The understanding of physical materials is rooted in the larger discussion of corporeality, and the fundamental division that is reified by the architectural trope of "material / immaterial" is modeled after an original division within the human body; which, traditionally, was whole before it was split.

This paper is presented in three parts: 1. a critical comparison of two basic design assignments that focus on the image of the human body in drawing, which argues for continued reflection on the role of the body in architectural education; 2. a historical and theoretical "bridge" on the topic of embodiment, which argues for the value of deep historical perspectives in basic design pedagogy; and 3. a third, more speculative assignment involving drawing, the body and spatiality. All of these assignments were accomplished by freshman architecture students, either in their first or second semester of an undergraduate architectural design studio at the School of Architecture at Mississippi State University. These assignments do not reflect a single curricular proposal; but rather, they are presented in an effort to critique, interpret, and position a small portion of basic design education.

Sectional Self Portraits (Spring 2012)

The first assignment began with the description of the human body performing a useful action. After their first semester of architectural design studio, these students had little to no experience with orthometric or sectional drawing, and the most basic objective of the project was to provide this skill. The students choose a wood-shop tool and then photographically documented a significant moment that coordinated the use of the tool, the material that was cut, and the position of their body. They were compelled to research their bodies and tools with direct observation and measure, but also with anatomical textbooks and operating manuals, parts lists, and manufacturer's illustrations. With these resources at hand, the students traced their photographs and illustrations to reveal plausible cross-sections, which they then enlarged and collaged onto a large sheet of drawing paper. As they grew more confident in their work, they translated their collages to the surface of the paper, which consumed the evidence of their research in the process.

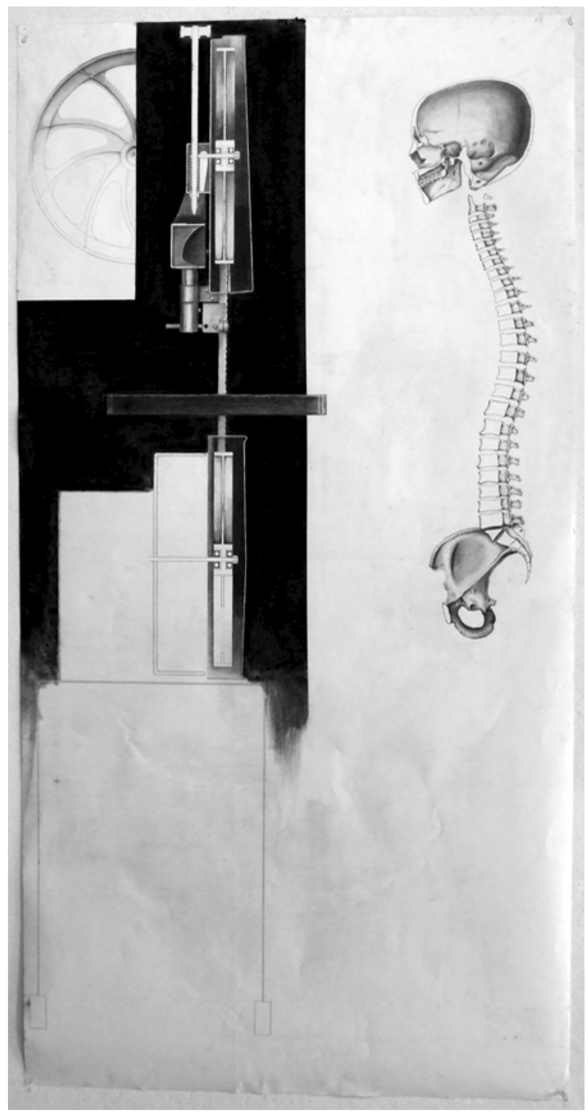


Fig. 1. Patrick Brown, "Sectional Self Portrait" (2012)

The assignment is clearly indebted to the analogy between architectural and anatomical sectioning; the body and the tool are described according to a single system of representation that consistently measures and positions objects in space, regardless of their kind. The unfortunate result is that, while the tool appears no more or less a part of a living world, the body appears petrified and lifeless, dismembered or disemboweled. In its analogy to a tool, the body is taken for granted as the presupposition for knowing something about an objective world, and yet, in order to accomplish this it becomes an object of intensive examination itself.

A symptom of this method of knowing and representing was that all of the students avoided drawing the genitals. Certainly this was due to issues of decorum, but it was also consistent with a failure to address the living potential of the human body.

To avoid the problem, the most ambitious students simply drew the skeleton, many drew only outlines of a generalized skin or cloth, others rotated the paper horizontally, and at least one student simply stopped drawing rather than confront it. The result of these systematic lacunae was that very few of the drawings addressed the primary relationship of the body to the ground; instead they most often chose to relate the formal aspect of the tool to the upper body, in particular, to their head. The formal relationship between the tool and the head, ungrounded, with little sensitivity to the interpretation of life, confirms that the portrait of the human body represented here were conditioned by a technological view of the body as a physical instrument, which altogether undermines the deeper intention to provoke students into to reconsidering their bodies in the world.

Haptic Maps (Fall 2012)

This second assignment, which was from the subsequent class of freshman studio, began with the description of an object, but ended with an understanding of the body. This assignment was also developed and delivered several times while I was teaching the architectural drawing class at the Cooper Union with Prof. Joan Waltemath. The students were asked to choose an object that met six criteria: it had to be portable, larger than your hand, non-perishable, safe, variously textured, and it had to be meaningful to the student in some specific way. They returned with a number of appropriately self-reflective objects, including accordions, antlers, fishing rods, shoes, and stuffed animals. They photographed the variety of textures and aspects of their objects, and then we asked them to "create a map of the haptic experience of their object," where haptic is to touch as optic is to vision. The students were to make two drawing, one a collage of photographs, the other, graphite on paper, followed by a final graphite drawing.

Like all of the assignments leading up to this, the students worked iteratively in both media, and were challenged to invent systematic ways of defining the criteria by which they judged their work. So much attention is given to drawing in the first semester because, in a basic and economical format, it provides most of the necessary conditions for cultivating this relationship between judgment and practice. Furthermore, in the spirit of philosophical pragmatism, all of the drawing assignments were presented as "indeterminate situations" in which a student was challenged to name increasingly articulated objectives that he or she personally defined in the course of experiencing the work.[1] However, in the case of the "haptic map" this indeterminacy was exaggerated by the unpredictable sensory experience, which, to be frank, was often difficult for freshmen students to initiate.

The objective of this assignment expressed nothing more than the naïve hope that we could consider the wide range of sensory experience as part of design, and in the process, question the disembodied rational of visual representation and visual culture. Admittedly, this assignment originated from a "weak phenomenology," that is, a reductive misinterpretation of phenomenological thinking as a primitivist aesthetic theory. Nevertheless, despite these initial failures of imagination, the students tended to discover more than was expected.

In the tradition of Itten's Bauhaus, the students had already investigated potential relationships between marks and textures, and had considered possible ways of making texture a problem of proportionality. When the students confronted the haptic map they continued this translation work, but as they progressed, it became increasingly evident that the format of the paper was not adequate as it was given; it was either disproportionate to the kind of temporal experience they were describing or its rectangular frame was unreasonable in some way. It became clear that the paper conceived of as a "window" for "seeing-through" was presumptuous and limiting.[2] The students began to reconstruct the nature of their material support in the same way that they were reconstructing their methods of translation; the paper became analogous to a skin, and the corners became descriptions of members rather than instruments of enframing.[3] Instead of presuming the relevance of a given format, they projected their bodies onto the drawing, what Hans Blumenberg has called a "physiognomic projection".[4] Without prompting from the instructors, many drawings began to take on a formal resemblance to their bodies; they were vertical, with similar heights and divisions, bilateral symmetry, and a certain number of members or profiles. Here, the image of the body was not an instrument for knowing something about the object they chose; rather, it was an outline that gave order to the knowledge they acquired in the course of the work. The human body, if it can be seen in this work, is a symbolic representation of order wrestled out of an unpredictable sensory experience; but at the same time, it never reaches beyond a highly generalized and unspecific utterance.

These two kinds of drawings are clearly very different, and yet in terms of the image and the idea of the human body, I believe they provide an important comparison that would benefit from an historical and theoretical exegesis of the privileged place the human body holds in the history of western culture.

...bridge...

Man's world-openness might appear to be a great burden. He is flooded with stimulation, with an abundance of impressions, which he somehow must learn to cope with. He cannot rely upon instincts for understanding his environment. He is confronted with a 'world' that is surprising and unpredictable in its structure and that must be worked through with care and foresight, must be experienced. By relying on his own means and efforts, man must find relief (Entlastung) from the burden of overwhelming situations; he must transform his deficiencies into opportunities for survival.
– Arnold Gehlen[5]

The "law of relief" (*Entlastung*) is a useful concept for understanding the image of the human body in western culture. Derived from philosophical anthropology, "relief" defines a fundamental human process of confronting "unpredictable" and "overwhelming situations" and transforming them into symbolic representations, thereby "relieving" our body from the burden of adaptation. With "care and foresight," symbolic representations come-forth out of an unintelligible background, but at the same time they are contingent on this background which gives them meaning.[6]

Fig. 2. Thomas Hampton, "Haptic Map" (2012)

When the image of the human body first appeared in Archaic Greek art it was not just a copy of man; rather, it was a symbolic representation of an unintelligible reality that was projected into familiar forms and gestures. The image of the human body represented an idea of known reality, which was fundamentally contingent on the unknown.[7] In western philosophy, the theorization of the body begins somewhat later with the Pre-Socratic argument between the Eleatics and the Atomists, following which the body was an inseparable compliment of invisible movements and corporeal substances. This was the basis for Plato, who understood that the body was part of a dialectical process of ordering (cosmos), which was always incomplete and therefore "open" to growth. But while the body was neither static nor isolated, it did appear to be a relatively stable order within "the context of reality as a whole," and through analogy (*analogia*) the body (*microcosm*) could serve to represent this larger whole (*macrocosm*). Following Plato, Aristotle emphasized the role of place, position and contact in the stability of this order, which laid the foundation for the Epicurean and Stoic understanding that the moving body was simply the effect of isolated entities in contact with one another.[8]

This idea of the body as a composition of isolated entities was the context for Vitruvius and the Renaissance tradition that "rediscovered" him, in which the image of the human body was divorced from its role in representing the primary dialectic of embodiment.[9] Where the body "was [once] a construction that represented the achievement of a certain understanding of reality" it was now a "fundamental presupposition to [understanding reality]". It was this epistemological reversal that finally made it possible to conceive of the body as an objective entity and make it the focus of intensive physical examination and description, that is, the body of anatomy.[10]

The anatomical art of dissection depends on this notion of the human body as a stable and isolated material entity that can be systematically examined and described. This notion was the basis of Vesalius's famous anatomy, *De humanis corporis fabrica* (1543), as well as Dürer's *Vier Bücher von menschlischen Proportion* (1528), in which the body was measured and described with orthometric and perspectival construction. In the name of "microcosm," but elaborated by the discipline of anatomy, Renaissance art theory sought a stable source of measure, number, and proportion in the human body; however, in works of art the image of the body was always composed of unstable differences and distortions. In practice, it was understood that variation from normative types demonstrated "a quality of judgment [as well as] a complementary manner of working".[11]

This qualitative and practical judgment was nowhere more pronounced than in the bodies of Michelangelo's art, in which his prudent judgment (*giudizio dell' occhio*) was revealed in the dynamic distortions of the body according to the movement of its passions.[12] These distortion do not mean that Michelangelo embraced "license" without regard for the measures of the human body; indeed, he actively studied human cadavers, was involved in projects to supplant the anatomies of Vesalius and Galen, and planned to write his own treatise on human proportions, which, in deliberate contrast to Dürer's, was intended to deal with its movements and gestures.[13] No such treatise exists, but David Summers has convincingly traced Michelangelo's ideas on the body into Vincenzo Danti's *Trattato delle perfette proporzioni* (1567).

Danti admitted that the human body had no stable or fixed proportions, and, like Michelangelo, he emphasized a distinction between "quantitative" and "qualitative" "kinds" of measure, where the later was associated with the life or animation of the body.[14] "If bodies seem to have some action they act not through their bulk, but through some innate force or quality".[15] Quality (an Aristotelian category that was given greater emphasis when it was appropriated into the Neoplatonic discussion) was an elementary force that accounted for the body's movement and growth; "qualitative proportioning" re-described this force as an ordering principle. Furthermore, the understanding of qualitative proportioning "enabled" the artful composition of bodies not as stable and isolated entities, but as "potential" or "intentional" figures in an open-ended process of contingent "coming-forth".[16]

Michelangelo's architectural drawings are mostly elevation details and profiles, often constructed from parts of the human figure that present themselves as either an under-drawing or a post-hoc tracery. Measure, number and proportion play a small role in constructing the figure in contrapossto, but this is ancillary compared to the concern for visible surfaces and their foreshortening.[17] While perspectival construction describes a homogeneous space against the cut of a cross section, i.e., the "picture plane," foreshortening describes relationships by the profiles that separate bodies.

To Michelangelo's biographers, this approach to drawing often made his bodies "seem monstrous, as when an arm or leg is made very short, not corresponding to the other proportions in the field of vision".[18] The noun "monster" (or sometimes "grotesque") was associated with bodies that, in their ontological openness and contingency, were somewhere in-between human and animal or vegetal bodies; but despite this contradiction to naturalism, they were also revelations of a certain "kind" of truth that could be "observed" in the appropriate "time and place":

If, in order to observe what is proper to a time and place [the artist may] change the parts of the limbs... and convert a griffin or a deer downward into a dolphin or upward into any shape he may choose, putting wings in the place of arms, and cutting away the arms as if wings are better, this converted limb, of lion or horse or bird will be the most perfect according to its kind...; and this may seem false but can really only be called well invented or monstrous... And sometimes it is more in accordance with reason to paint a monstrosity... rather than the accustomed figure... of men and animals.

–Michelangelo, quoted in dialogue by Francisco de Hollanda.[19]

The idea of the monster refers to bodies, human or otherwise, that are depicted in the process of becoming ordered by an inseparable dialectic of the body and its motive force.[20] These bodies are liminal and incomplete; they are waiting to be finished by the prudent judgment of the observer or observing artist who – as the saying goes – discovers a "figure inside... every block of stone".

Frames / Monsters (Fall 2012)

The last assignment presented here followed the haptic map by several weeks. The title of the assignment was "Frames / Monsters," although only verbal direction was given to "create a drawing in which the intention (or meaning) changes depending on where it is hung (or installed)." This was accomplished iteratively and documented photographically. The context of this assignment was provided by readings from David Summers *Real Spaces*, in which he developed the notion that a work of art's "real spatial" situation and relationship to the human body was fundamental to the understanding of "format" and the presentation of meaning.[21] However, there was no declared intention to describe the human body, except insofar as the students had to consider the real spatial conditions of "observing" their work in "a time and place."

In the students' drawings, which ranged wildly, the material conditions of their lines, values, textures, and supports were now placed in direct relation to the given conditions of a space. While many of the drawings were very problematic, there emerged four types: a portion of the drawings were dismissive, some exemplified anamorphisis, others were constructivist, but in retrospect, the most compelling group of drawings involved a curious play on the "chaotic" (their words) situations that were found in desk drawers, garbage cans, or "outside" in the natural world. Without provocation, the students had relieved their environment and demonstrated, even if only allegorically at first, an elementary kind of contingent ordering.

Notes

1 Dewey, John. "The Pattern of Inquiry," in *Logic: Theory of Inquiry* (1938).

2 Panofsky, Erwin. *Perspective as Symbolic Form* (1991), p. 27.

3 On "enframing" see: Heidegger, Martin. "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays* (1977), p. 3-35

4 Klassen, Helmut. "Michelangelo: The Image of the Human Body, Artifice, and Architecture," in *Chora* 1 (1994), p. 58.

5 Gehlen, Arnold. *Man: His Nature and Place in the World* (1988), p. 28.

6 Ibid., p. 28, 54.

7 Klassen, p. 58

8 Vesely, Dalibor. "The Architectonics of Embodiment," in *Body and Building: Essays on the Changing Relation of Body and Architecture* (2005), p. 29-31.

9 Ibid., p. 30.

10 Klassen, p. 58-61.

11 Ibid., p. 60.

12 Summers, David. *Michelangelo and the Language of Art* (1981), p. 352-364.

13 Ibid, p. 380.

14 Michelangelo's "Letter to Unknown Prelate" qtd. in Ibid., p.418.

15 Marsilio Ficino qtd. in Ibid., p. 329.

16 Klassen, p. 58.

17 Summers, p. 384-396.; Klassen, p. 72-76.

18 Francisco de Hollanda qtd. in Summers, p. 479.

19 Francisco de Hollanda qtd. in Ibid., p. 103.

20 Frascari, Marco. *Monsters of Architecture: Anthropomorphism in Architectural Theory* (1991), p. 32.

21 Summers, *Real Spaces: World Art History and the Rise of Western Modernism* (2003), 36-41.

Model as Diagram:
Precedent Analysis through Physical Abstractions, Connecting Essence to Substance

Jennifer Akerman

University of Tennessee, Knoxville

Even in the age of computer-aided design and virtual modelling, physical models are incomparable aids in the design process of the architect and the designer. The three-dimensional material model speaks to the hand and the body as powerfully as to the eye, and the very process of constructing a model simulates the process of construction.

—Juhani Pallasmaa[1]

Precedent has always been a vital element of architectural education, though each successive generation since the Beaux-Arts has assigned it different values and applied it in different ways. The Beaux-Arts focus on plan organization as fundamental to typology and use, as well as its emphasis on the *analytique* and *equisse*, all engaged historical precedents as sources to be emulated in various ways. Current pedagogical approaches seek to help students learn to study precedent through analytic means so that key ideas may be identified, abstracted, and then reinterpreted through their own design work. Often relying on diagrams—especially plan-based diagrams—precedent analysis exercises for beginning design students often feel incomplete or ineffectual, as students have difficulty applying the ideas of others to their own approach without feeling as though they are copying, or otherwise acting inauthentically. Connecting the essence of precedents to the substance of new design work is challenging, and even well-intentioned pedagogical approaches for addressing the precedent in design studio can be problematic.

How should we ask beginning students to analyze architectural precedents? How should we encourage them to incorporate the ideas of others into their work, while also helping them develop their own point of view? Might privileging a more hands-on and physical engagement of the diagram help students appreciate haptic qualities of architecture in ways that help them advance their own processes of generating architectural ideas?

In this design studio for beginning graduate students of architecture, precedent case studies were diagrammed through abstract physical models to explore whether students might develop a heightened understanding of design intent as directly connected to organizational, spatial, and ultimately experiential qualities. In the process of engaging physical modelling techniques as a primary means of understanding precedents, students developed a facility with the diagram not only as analytical tool but also as generator of significant architectural experiences. By engaging their mind, hand, and body in the analysis of the work of others, students became much more comfortable extracting key conceptual and experiential qualities from the precedent which then informed their own intentions for subsequent design work.

Problem: The Difficulty of Applying Precedent Generatively and Authentically

Beginning design students have difficulty making the connection between architectural example examined as precedent and its application to their own creative work. Many approaches have been problematic, evidenced by advanced and very talented design students being unable to effectively use precedent in their design work. A facility with mimesis encourages students to overlook the rich opportunity for authentic critique that is possible when one reinterprets or rejects what came before. This problem has further implications in contemporary professional practice, where precedents are inappropriately or inelegantly used as little more than surface reference.

A related problem is the difficulty beginning design students have in understanding the purpose or potential of the diagram. The ability to abstractly represent organizational, conceptual, or experiential motives through geometric drawings requires great practice and reflection to be fully honed and understood. Precedent analysis, in its normative application in recent decades of architectural education, engages both the use of precedent and use of diagram, and can thus be doubly misunderstood and misapplied by beginning design students.

Mimesis

In *The Portfolio and the Diagram,* Hyungmin Pai provides a thoughtful overview of changing ideas of the profession and discourse of architecture throughout the late 19th and early 20th century. Especially noteworthy is his review of the various attitudes toward the role of precedent in years leading up to Modernism. His discussion of the Beaux-Arts educational method underscores that precedent, both historic and contemporary, was seen as source material to be carefully copied in the appropriate context. The *analytique* exercises are a prime example—small architectural fragments students were asked to execute in the manner of specified historic traditions. Students were also required to rely on their knowledge of precedent buildings, particularly their plan organization, in the generation of *equisse* design solutions—essential organizational *parti* diagrams which then became the basis for more developed architectural projects. Pai also goes on to analyze the role of published portfolios of historic precedents, and their place in architecture libraries as related to the role of precedent as something to be quite literally copied, at least as means of helping students and professionals understand key concepts through the act of trace overlays. He notes that early portfolio publications often included scaled reproductions of plans, sections, and elevations printed on loose plates that could more readily be removed from the bound text to facilitate copying through traced drawings as a means of further study. [2]

Abstraction

A mainstay of architectural education in the late 20th and 21st century has been the use of analytical diagrams as a means of understanding fundamentals of design. The method of abstracted diagram overlays of plans and sections, quintessentially presented in *Precedents in Architecture* by Roger Clark and Michael Pause[3] and *Architecture: Form, Space, and Order* by Francis Ching[4], are almost universally adopted by architecture schools throughout North America, especially in initial architecture studios. The ability to understand works of significant architecture through the act of drawing essential qualities in graphic shorthand is a critically important skill. It encourages one to develop clear intentions for formal organization of a building's program and for communicating those intentions to others. For Clark and Pause, the diagram constitutes a means of understanding and discussing architectural principles through abstracted reference to precedent. They write: "The intentions of this study are to assist the understanding of architectural history, to examine basic similarities of architect's designs over time, to identify generic solutions to design problems which transcend time, and to develop analysis as a tool for design."[5] This approach of attempting to relate to historic precedent through drawn abstracted diagrams is a foundation of most beginning design studios even today.

However, beginning design students typically encounter such exercises long before they reach upper level architectural history courses delving into significant works of modern architecture, and as such, they lack a deep understanding of the precedents they are asked to represent. Even when their own research raises familiarity with the object of study, it's very difficult for beginning design students to undertake an informed analysis of these works through abstract analytical diagrams. Though some may succeed at generating diagrams that appear to be compelling, students at this stage are often simply unable to connect the essence of a profound 3"x3" diagram with the substance of its true architectural effect. Such connections often require direct experience of the precedent in order for key ideas to be comprehensible. Moreover, deep understanding of how such diagrams can reinform their own design work tends to emerge later in one's architectural education and continue developing into practice. This is not an overtly harmful thing, though relying purely on analysis through drawn, Clarkian diagrams may be frustrating and demotivating to beginning students.

Eradication of Meaning

It is valuable to consider possible alternative approaches. Rather than using the diagram as a means of understanding the past for purposes of mimesis in one's future work, Peter Eisenman's body of work offers an understanding of the diagram that productively generates form in disjointed application. Beginning in his doctoral dissertation, *The Formal Basis of Modern Architecture*[6], executed at Cambridge in 1963, Eisenman initially used the diagram as a means of understanding and explaining key formal and organizational strategies inherent to significant works of modernism. He also sought understanding of historical precedent through diagram, and attempted a positioning of Modernism as a tradition founded on formal organization. His subsequent work explored using diagrams in other ways, notably, "the possible opening up of the formal interiority of architecture to concerns of the conceptual, the critical, and perhaps to a diagramming of a pre-existent instability in this interiority."[7] In subsequent architectural projects built and unbuilt, beginning with the series of houses executed in the late 1960's, and culminating in the design and construction of the Aronoff Center and later projects, Eisenman systematically used diagrams as generators of form, critiquing or challenging the status quo of architecture through the eradication of meaning. This work often drew from linguistic theory and other influences. However, his focus on problematizing architecture, though fascinating and of extreme importance to the development of architectural discourse and practice throughout the late 20th century and beyond, is a challenging approach for beginning design students whose own understandings of architecture are far from fully-formed.

Rupture

Looking further at Eisenman's work and its application to this topic, his seminal text *Ten Canonical Buildings: 1950–2000*, may initially seem to be a call for the use of precedent projects as exemplars that could be copied or reapplied in the generation of new work. Yet Eisenman explains his interest is in undertaking a close reading of select Post-modern examples that serve as a critique of the status quo at multiple historical moments. He writes, "Canonical in this context refers to a rupture that helped to define a moment in history; it is a constant reevaluation in the present as to what constitutes such a rupture."[8] In studying such precedents, his agenda is not to promote emulation through either mimesis or abstraction of works from the past. Rather, he seeks to understand how provocative works of architecture carry the power to reshape our construction of the canonical by positioning themselves in opposition to what came before.

While this is an inherently intriguing intellectual approach to architectural history, its dependence on understanding interconnections across time—from one moment to the next, as understood from the vantage of the present—likewise makes it a difficult avenue for beginning architecture students to apply an understanding of precedent to their own design work. However, it is revelatory that the analysis of precedent can so closely support one's own agenda in architecture: the life work of Eisenman can be understood as a constant challenge to the status quo. Though his specific approaches may be out of the reach of beginning students, perhaps we should continue to let our educational approaches be guided by his use of precedent and diagramming as a kind of critique, to help students develop strategies that intentionally challenge what came before.

Limits of the Diagram

Through all of these examples of ways of understanding and applying precedent when generating new architectural ideas runs the common reliance on plans and abstraction of formal strategies as the basis of architecture. Though Le Corbusier admonishes us to remember that "The Plan is the generator,"[9] perhaps there is room for an expanded approach to engaging precedent—its analysis and application— in teaching beginning design students processes for generating their own work.

Proposal: Essence to Substance Facilitated through Model

My interest is ultimately in helping beginning design students develop a sense of their own agency and form an authentic approach to architectural problems.

This seems to be most successful when explored in a more hands-on way, using tactics that engage the students' minds, eyes, and hands, especially when asked to craft models as a means of exploring their intentions. The premise of the studio design exercise discussed here is that by building physical models as diagrams of significant architectural precedents, students make connections to profound experiential and phenomenological potentials of architecture that are not always perceptible through other forms of drawn abstracted diagram. They also gain proficiency in making models that express ideas of intention, aiding their development of fluency in articulating intentions for their own work.

Juhani Pallasmaa has written evocatively on architecture being a multi-sensory experience. "Every touching experience of architecture is multi-sensory; qualities of space, matter, and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton, and muscle. Architecture strengthens the existential experience, one's sense of being in the world, and this is essentially a strengthened experience of self. Instead of mere vision, or the five classical sense, architecture involves several realms of sensory experience which interact and fuse into each other."[10] Pallasmaa also promotes acts of architectural representation and fabrication that engage the body, such as drawing, but especially building models, as explored in his book *The Thinking Hand: Existential and Embodied Wisdom in Architecture*.[11]

Method

Working in teams of two, Master of Architecture students in this first-year architectural design studio conducted a three-week-long analysis of an assigned precedent building. They were to rely heavily on the development of analytical models as a kind of diagram, complimenting and furthering the students' drawn diagrams and written interpretations of design intent. Student teams were required to study the project through narrative and visual means, reading as much written content as possible to identify key intentions, then carefully observing drawings and photographs of the project in search of those intentions' application. From this, each student team formed their independent interpretation of the project's most significant themes or essential qualities. Each theme was then explored through a series of diagrams. The result was an analysis presentation composed of written narrative, drawn diagrams, and—most importantly—a series of physical diagram models tied to the essence of the built work, as identified by each student team.

Examples

The projects selected for analysis span many decades of architectural production and represent seminal works by significant architects, including Le Corbusier, Sigurd Lewerentz, Peter Zumthor, and Rem Koolhaas / OMA. All are projects with profound spatial and organizational elegance, integrating program, structure, and relation to context in masterful ways. Moreover, all are works with true phenomenological impact and broader conceptual goals that were equally important for students to understand through analysis.

Fundamentals of Organization

A team's analysis of the Millowner's Association Building in Ahmedabad, India, by Le Corbusier, used very small wood models to capture its most essential organizational strategies (Fig. 1). Nominally measuring 1"x1"x1", these cubic studies necessitated brevity and became useful ways of seeing three-dimensional impact of regulating lines and Corbusian proportioning systems, while also serving as a compelling compliment to this team's complex two- and three- dimensional drawn diagrams. The simplicity of these pieces is in keeping with qualities of monumentality and celebration of the iconic primitive tangible in the built project.

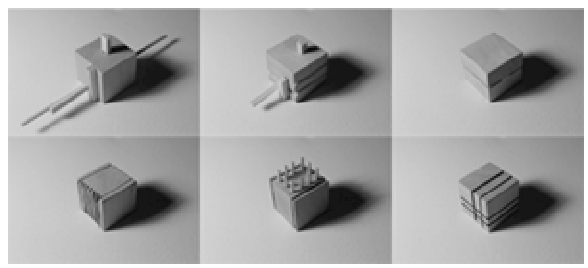


Fig. 1: Primary Organizational Strategies—Precedent study of the Millowner's Association Building by Le Corbusier, Ahmedabad, India (1954); students: K. Jeffers and D. Hodge, 2013

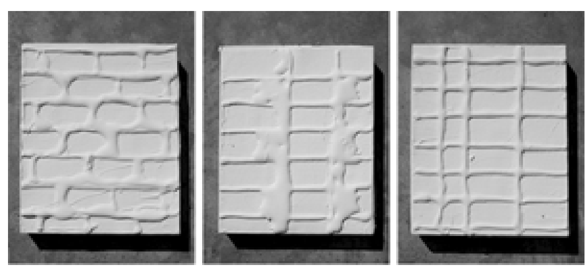


Fig. 2: Materiality and Craft—Precedent study of St. Mark's Church by Sigurd Lewerentz, Stockholm, Sweden (1960); students: A. Buchanan and A. Traylor, 2013

Craft, Materiality, and Space

The work of Sigurd Lewerentz initially posed challenges to the student team analyzing St. Mark's Church in Stockholm. They read a great deal about Lewerentz's process, including his practice of working on site daily with the team of his favorite masons to continually direct and edit the construction of brick walls. In acknowledgement of the implied importance of masonry details to Lewerentz's intentions, this group executed a series of models of the various brick bonds used, helping them understand the impact different ordering patterns and different degrees of mortar thickness may have on one's experience of different spaces within the building (Fig. 2).

Further models explored intensity of light and its relation to activity and use of the church's more public zones (Fig. 3).

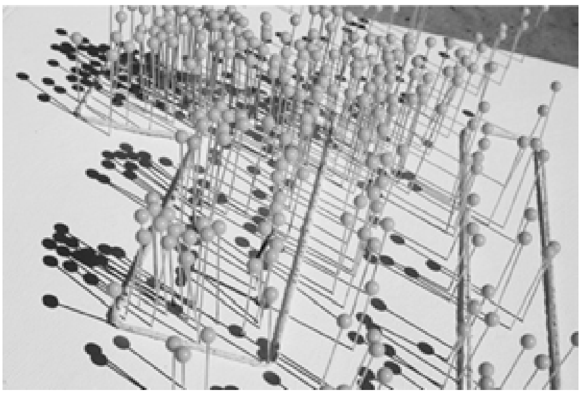


Fig. 3: Activity and Intensity—Precedent study of St. Mark's Church by Sigurd Lewerentz, Stockholm, Sweden (1960); students: A. Buchanan and A. Traylor, 2013

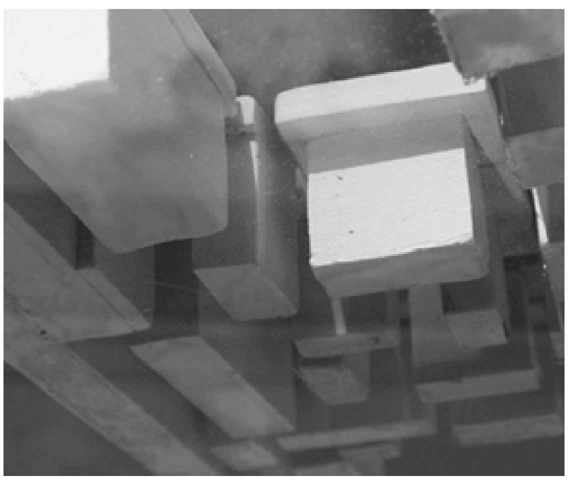


Fig. 4: Stones and Table-Tops—Precedent study of the Thermal Baths by Peter Zumthor, Vals, Switzerland (1996); students: R. Gillogly and R. Truka, 2013

Material, Structure, and Space

The student team studying the Thermal Baths in Vals, Switzerland, by Peter Zumthor used study model diagrams to understand basic relationships between material, structure, and space. In modelling the disposition of "stones" and "table tops" in the main level, students created a means of understanding both the primary organization and the spatial differences informed by the shaping of light through gaps between the massive elements (Fig. 4). Their interest in the sensorial experience of occupying such spaces was richly informed by these physical model diagrams.

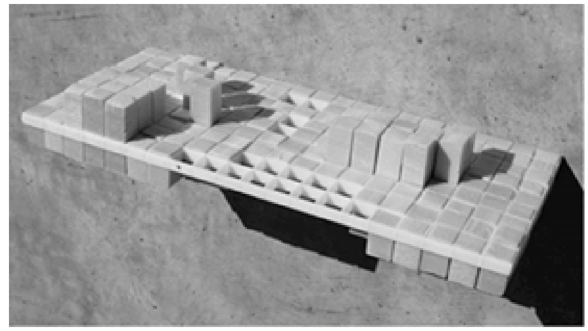


Fig. 5: Perception of Sectional Difference—Precedent study of the IIT McCormick Tribune Campus Center by OMA, Chicago, IL (2004); students: J. Hare and K. Wojcik, 2013

Diagramming Precedents Students Will Visit

One team was assigned a project they would be visiting as part of a studio field trip later in the semester, OMA's McCormick Tribune Campus Center at the Illinois Institute of Technology in Chicago. The ability to directly experience this precedent gave these students and their classmates the opportunity to reflect on their understanding of key ideas before and after their visit to the building. Though their early analytical models of this precedent had begun exploring notions of sectional difference and effect on the spatial experience, most of the models they executed prior to the visit privilege broader qualities of massing and program (Figs. 5 and 6). Sketched diagrams executed on site, however, became more attuned to the human scale and the substantive effect these sectional manipulations hold for experiencing the building and its relationship to context. Having explored the project in model in tandem with being able to experience it directly as part of a field trip thus allowed the whole class to use this example as a means of transcending the normative limits of precedent analysis.

Reflection

Use of physical study model has many applications and potential benefits for design students at all levels. In this context, tangible features of scale and craft related to making physical models facilitated the students' ability to abstractly convey ideas through physical and visual means. As a result of having made the abstract models, students were able to generate clearer drawn diagrams. Moreover, working in model attuned the students to issues of craft, materiality, and spatial definition in architecture they might not otherwise have grasped.

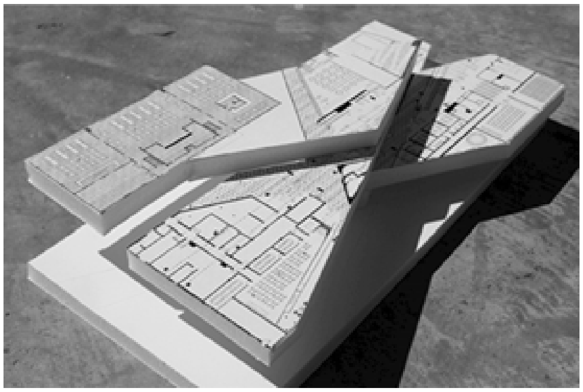


Fig. 6: Spatial Organization—Precedent study of the IIT McCormick Tribune Campus Center by OMA, Chicago, IL (2004); students: J. Hare and K. Wojcik, 2013

This process also seemed to advance the students' facility in forming their own voice and assuming authorship of their work. In part, this may be because each student or team of students was compelled to make independent decisions related to craft, materiality, and scale for their model studies. The class structure provided no pre-conceived sense of what issues these model diagrams should explore or what form they should take.

This analysis project discussed here segued immediately into a small-scale design problem in which students were required to develop iterative physical diagrams of their intentions for the work as the first step in project ideation. Abstract diagrammatic models led to more spatially-representative models, which then led to two- and three-dimensional drawn representations of the design. These initial projects were all characterized by a sensitivity to mass, materiality, and essence as expressed through the physical substance of architecture in ways not always endemic to first-year work.

The modeling exercise discussed in this paper was a first attempt at using physical models as a means of understanding architectural precedents in beginning design. In addition to working through analytical models, students generated drawn diagrams, and wrote about their understanding of essential qualities of their case study project. This combination of modeling, drawing, and writing as three balanced and interconnected approaches to understanding and application seems to hold great promise. Rather than allowing any one approach to take control, developing all three in tandem helps students draw connections between the precedent and the generation of their own design ideas in more effective ways.

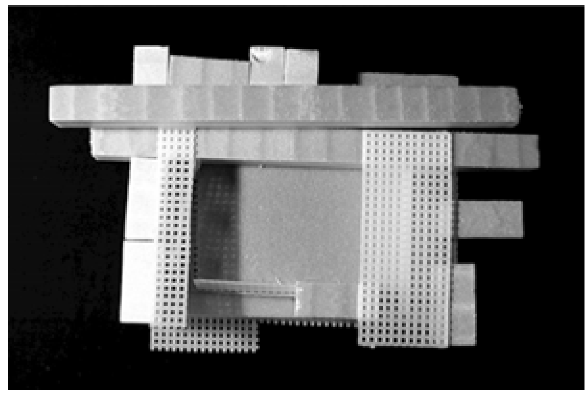


Fig. 7: Essence study model for Architecture Archive project; student: R. Truka, 2013

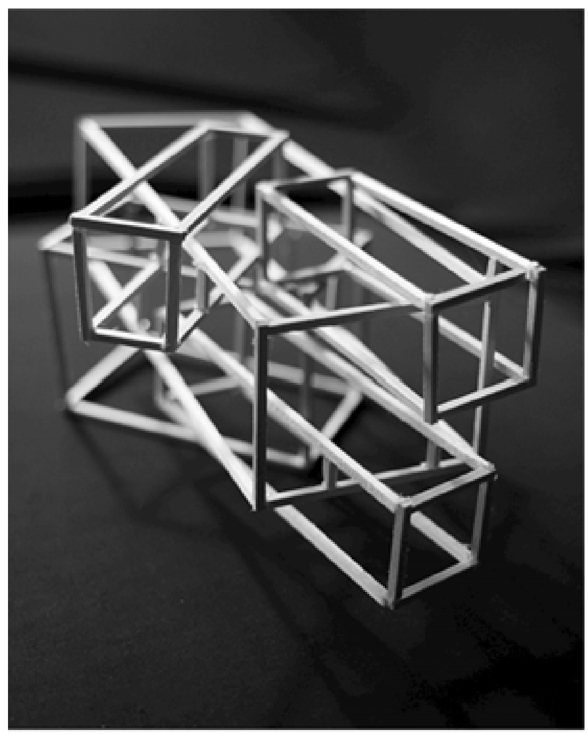


Fig. 8: Essence study model for Architecture Archive project; student: R. Gillogly, 2013

To develop this approach further, subsequent studios may employ this exercise while offering more examples of analytical physical models as references for student consideration and debate. Models produced by the Portland-based firm

Allied Works Architecture are one such exemplar[12]. Additional in-class workshops and collaborative experiments with modelling techniques might also be useful for beginning design students.

Broader Implications

Alberto Pérez-Gómez has written on the limits of formal abstraction as the primary generator of architecture: "While construction as a technological process is prosaic—deriving directly from a mathematical equation, a functional diagram, or a rule of formal combinations—architecture is poetic, necessarily an abstract order but in itself a metaphor emerging from a vision of the world and Being."[13]

Hyungmin Pai offers the following on the limits of the diagram: "When the diagram is approached as the necessary product of an idea, it perpetrates a betrayal. For the moment the diagram is materialized, it is unable to keep the promises of its originating program. Subjects constantly see, do, and say things unpronounced in the program, using the architectural instrument for purposes contrary to its 'idea'."[14]

These observations suggest that there is more at work than just the architect's conceptual agenda for a project. We must emphasize pedagogical approaches that prepare students to operate in a more fully-engaged consideration of architecture as animated by context and interpreted by our myriad senses. Moreover, we must develop a more engaged means of using the design studio as a place for exploring architecture in the context of history, historical precedent, and other aspects of architectural production, including building technology, contemporary culture, sustainability, professional practice, and any number of broader obligations of the architect.

Notes

1 Pallasmaa, Juhani. The Thinking Hand: Existential and Embodied Wisdom in Architecture. Chichester, U.K.: Wiley, 2009. P. 57.

2 Pai, Hyungmin. The Portfolio and the Diagram: Architecture, Discourse, and Modernism. Cambridge, MA: MIT Press, 2002.

3 Clark, Roger H., and Michael Pause. Precedents in Architecture. New York: Van Nostrand Reinhold, 1996.

4 Ching, Francis D.K. Architecture: Form, Space, and Order, second edition. New York: Van Nostrand Reinhold, 1996. Note the common publishing house and date for Clark / Pause and Ching's works.

5 Clark and Pause, p. v.

6 Eisenman, Peter. The Formal Basis of Modern Architecture. Cambridge: Trinity College, 1963/2006.

7 Eisenman, Peter. Diagram Diaries. New York: Universe Publishing, 1999. p. 48.

8 Eisenman, Peter. Ten Canonical Buildings: 1950–2000. New York: Rizzoli/Random House, 2008. p 21.

9 Le Corbusier. Towards a New Architecture. Frederick Etchells, translator. New York: Dover, 1986. p. 45.

10 Pallasmaa, Juhani. The Eyes of the Skin: Architecture and the Senses. Chichester, U.K.: Wiley, 2005. p. 41.

11 Pallasmaa, Juhani. The Thinking Hand: Existential and Embodied Wisdom in Architecture. Chichester, U.K.: Wiley, 2009.

12 Cloepfil, Brad. Allied Works Architecture: Occupation. New York: Gregory R. Miller, 2011. AWA's website is also an excellent resource: http://www.alliedworks.com.

13 Pérez-Gómez, Alberto. Architecture and the Crisis of Modern Science. Cambridge, MA: MIT Press, 1983. p. 326.

14 Pai, Portfolio and the Diagram, p. 290.

Imagining the Ideal

Zulaikha Ayub, Jeffery Roberson

Harvard University, Mississippi State University

Introduction

The binary of essence and substance originates from the Classical distinction between *eidos* and *hyle*, form and matter. Plato asserted that objects in the material world are crude imitations of Ideal Forms—archetypes separate from matter existing outside of space and time. Aristotle maintained this distinction but brought Plato's Forms back down to earth by insisting that Forms cannot exist independently of material things, but rely on material things to exist. What both stressed was the distinction between form and matter, essence and substance, mind and body, physical and metaphysical, sensory phenomena and intellectual concepts.

Plato who founded the Academy where Aristotle studied for twenty years had the motto "Let no one ignorant of geometry enter here" inscribed over the entrance. In the *Republic* Plato insists that, geometry "is pursued for the sake of the knowledge of what eternally exists, and not of what comes for a moment into existence, and then perishes"[1]. Geometry then, as appropriated by architects, poses the paradoxical challenge whereby drawing three lines, for instance, to form a triangle violates both the definition of 'line' (length without width) and 'triangle' (figure contained by three straight lines) as the material inscription of the former necessitates thickness and renders the latter as never perfectly straight. And thus drawing, and the building itself, can only exist as the crude imitation of an idea--only when one can grasp the idea, then, one comes to know reality. According to the architectural and intellectual historian John Shannon Hendrix the struggle between substance, or material, and essence, or idea, is what defines "a humanistic architecture—an architecture that reveals the relationship between the human mind and the material world"[2].

'Boot Camp'

"Introduction to the Built Environment" (ARPL 500) is a beginning design studio for graduate students in their first year of study at the Catholic University of America. It has a long history within the school and is colloquially referred to as 'boot camp' as the course essentially compresses a semester's worth of studio work and seminar into four labored weeks. We began with the simple assertion that architecture emerges out of the space of drawing, which is the aforementioned field of oscillation between essence and substance. Students were instructed to rigorously and thoroughly examine an existing, canonical chapel through conventional orthographic projections, axonometry, diagramming and modeling. The pedagogical framework of the course premised on an inductive framework that positioned the Albertian invocation that architecture resides in the drawing as its central concern. It is whereby only through careful consideration of marked inscriptions upon the drawing surface and the accumulation of each successive mark, that the underlying order and geometric derivations of the architectures in question be understood. As the studio progressed, the engagement with the material substance of, for example, 6H graphite pencil on heavy, toothed paper, took on a material reality, where the drawing surface bore the carvings, erasures and layering through which the essence was being constructed, simultaneously, in the mind. The entire process became the exposition of the ideal.

Phases

I. "The Construction of Research" or "Meaning Through Order"

Students were instructed to gather, format, and systematically organize into a cohesive, legible, and meaningful visual narrative, available drawings, images, writings, and scholarship of their case-studies. Their presentations were not simply to display their ability to excavate knowledge, but to address the contingencies surrounding precedent curation, which included composition, sensitivity to scale and modular sequencing. Page size, boundaries, and center of alignments were derived from each project itself, and students were responsible to engage in the historical and theoretical issues relative to their building.

II. "The Construction of Drawings" or "Rendering Visible the Invisible"

Students were instructed to construct plan, section, elevation, and axonometric drawings of their case-studies. There was absolutely no tracing allowed, but rather that each drawing be systematically built-up from a foundation of simple lines and geometries. Students were introduced to basic (planar) geometric principles underpinning their architecture, including proportion, modules, grids, the geometry of construction and material, in addition to the fundamental elements of architecture, i.e. columns, planes and volume. The fundamental processes of form articulation, such as solid-void relationships were addressed per case-study. With this knowledge at hand, and through an iterative and inductive process, the orders underpinning each building were discovered in the drawing space. Through systematic and successive layering and accretion of geometrical systems, formal orders and line-weights, architectural form began to emerge.

III. "The Construction of Models" or "Negotiating Between Idea and Matter"

Students were instructed to translate drawing into models, which were conceived as built manifestations of the entirety of the geometric, formal, and elemental configurations they unearthed in their drawings. It was required that their models be operable, and that the language of their disassembly and reassembly reflect a reading of the building in both its formal and tectonic formation. In addition, the material selected had to reflect their position, namely, if their case-study exhibited additive or subtractive logic. Students alternately employed wood (in its multiple forms and modules) or plaster. There was often a conflict between what a student was attempting to represent and the structural logic within the actual built edifice. This moment of interpretation confronted students once again with the conflict between the realm of ideas and that of contingencies, and required them to approach their task with the same precision as their drawing sets, but with far greater interpretation on their part. The primary objective for this phase was to address the relationship of idea to matter in architecture, or in other words, the drawing to built form.

IV. "The Construction of Hybrids" or "Negotiating Between Analysis and Synthesis"

Marco Frascari says that "hybrid drawings are powerful factures that set a correlation between form and construction, playing a crucial role in the conceiving of buildings"[3], and as such negotiate between essence (form) and substance (construction). As part of this dialectical engagement, students were instructed to identify a central idea or thesis about their case-study, and to invent a representational system that clearly articulates the conditions in question. They were asked to consider their choice of drawing support (i.e. color, texture, size and density of paper) and instruments (i.e. graphite, ink, charcoal, watercolor and computer software) in relation to the idea being represented.

Additionally students read "The Conventions and Rhetoric of Architectural Drawing," by James Ackerman in which he insists that "sheets of paper are not neutral with respect to the drawings done on them", that "drawing instruments obviously affect not only the appearance of the drawing but the character of the building," and finally that "an architectural drawing may be not just a means to an end, but an end in itself"[4]. Through superimposing various media relative to exploring an architectural idea, students entered into a dialogue about the relationship between essence and substance, and in particular between drawing and building, forming an awareness of the limits and possibilities of representation. The goal was to move students beyond objective, analytical, and conventional limits (i.e. orthographic drawing), and move towards non-conventional representation as a phenomenal and synthetic formulation.

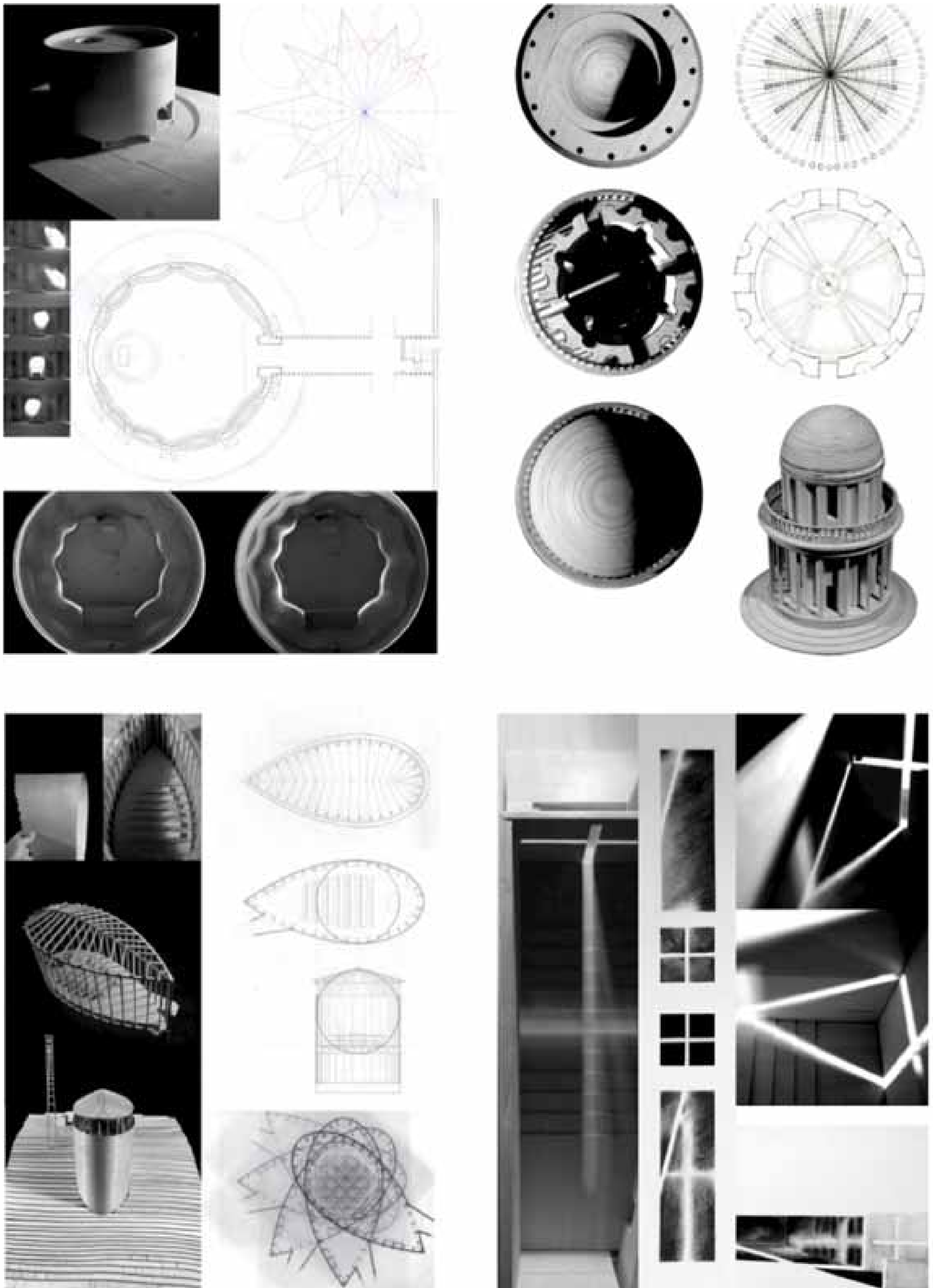


Fig. 1. Clockwise from upper-left: MIT Chapel, Eero Saarinen (students: Anthony DiManno + Patrick DiGiovanni); Tempietto, Donato Bramante (students: Enise Carr + Fahad Alrashoudi); Church of the Light, Tadao Ando (student: Alexandra Sacci); St. Benedict Chapel, Peter Zumthor (students: Alex Parzych + Toni Lem)

Conclusion

Chapels, as a historical building type, are almost always symbolic and lend themselves to such an analysis. From the Tempietto to the Bruder Klaus Feldkapelle, the built edifice is itself a material expression of a transcendent condition, where the architect's desire to inscribe a sacred vessel on earth that achieves sublimity allows for multi-faceted instruction; the buildings are both singularly and collectively examined for their history, form, materials, structure, representational derivations, cultural context and in situ. And just as the drawings began 'thickening' over time, seminar instruction increasingly folded in discourses of the tools, conventions, cultural dispositions, and theories that underpin the built environment and support our discipline. We find great benefit in this long-wave form of engagement, where an extended immersion builds architectural literacy and trains the student to use drawing as a reflexive process of trial and error that requires deep investment as they move through their schooling and into practice.

In “The Anticipation of Architecture,” Raimund Abraham states: "A drawing...is a model that oscillates between the idea and the physical reality of architecture"[5]. Likewise he insists that, “ultimately, the aspiration of an architect is to make something sacred. There has always been a confrontation between the profane and the sacred. Successful architecture carries some degree of sacredness—otherwise it is not architecture” (Abraham, 2001). In both instances Abraham is invoking the great Platonic distinction, and also implicating that drawing is the field in which these two distinct realms communicate. This oscillation between essence and substance defines representation's anticipatory state--a built-reality wherein lines become edges, planes become walls, and textures become material surfaces. Within both of these contexts architecture only realizes itself when it achieves a synthesis resulting from the conflict between essence and substance, idea and matter, the metaphysical and the physical, the sacred and the profane. Without conflict, or in the words of Abraham, “negation and reconciliation,” there can be no architecture.

Notes

[1] Plato., J. Llewelyn (John Llewelyn), 1826-1916, tr Davies, and David James, 1825-1905, tr Vaughan. 1858. *The Republic of Plato, Translated into English, with an Analysis, and Notes.* 2d. ed. Cambridge: Macmillan and Co.

[2] Hendrix, John. 2013. *The Contradiction Between Form and Function in Architecture*. London ;New York: Routledge.

[3] Frascari, Marco. 2011. *Eleven Exercises in the Art of Architectural Drawing: Slow-food for the Architect’s Imagination*. New York, NY: Routledge.

[4] Ackerman, James S. 2002. *Origins, Imitation, Conventions: Representation in the Visual Arts*. Cambridge, Mass.: MIT Press.

[5] Groihofer, Brigitte, 3709104688, and 978-3709104682. 2011. *Raimund Abraham [UN]BUILT*. 2nd revised and enlarged edition. edition. Springer Vienna Architecture.

Beginning Design Process:
Subject To Object

Suzanne Bilbeisi, AIA

Oklahoma State University

The making of architecture is intimately connected to the knowledge that buildings instill within us emotional reactions. They can make us feel and they can also make us think. Architecture begins to matter when it brings delight and sadness and perplexity and awe along with a roof over our heads. It matters when it creates serenity or exhilaration, and it matters just as much, I have to say, when it inspires anxiety, hostility, or fear. Buildings can do all of these things, and more. [1]

Beyond the act of building, the architect is responsible for assembling a collection of inanimate objects – steel framing members, bricks, window units, etc - and with those basic elements create form and space that are expressible to the human spirit. The first architecture design studio is the initial opportunity to explore these actions of making, with the applied framework of a concept to guide the process.

The issue of concept, as a generator of design actions, is elusive and somewhat difficult to explain to the beginning design student. In this first year design studio, we offer a two stage process that allows the student to understand the necessary abstraction (essence) and the necessary application of concept (substance) in the design of architecture.

The Essence of the Subject

"A Concept Can"[2] project brief: Using a familiar, neutral, mass produced, valueless item - the cola can - transform it in five steps though the direct application of an emotion onto the composition. The double entendre of *can* as an action, and *can* as an object, begins the discourse. The goals of the project are to introduce conceptualization as a means towards a physical expression. The project is designed to stretch the imagination, and test the ability to solve complex three dimensional compositional and representational problems. In the one week exercise, the students research, formulate, and narrate their thoughts on the given subject – a human emotional condition – as the precursor to this initial act of making.

Students may be assigned any one of the following human emotions as the vehicle for the transformation study: Anticipation, Awe, Contentment, Curiosity, Envy, Frustration, Grief, Lust, Joy, Hope, Pride, Loneliness, or Suspicion. The selection of both positive and negatively perceived emotional conditions is deliberate, as it attempts to separate convenient reactions from well considered and researched ones. Excerpts from several students' initial research follows:

"**Pride** is a complex secondary emotion developed through self. It can be viewed as a shield, borne of one's accomplishments." A. Mitchell

"**Awe** is the power to inspire with fear or reverence or dread – by authority, genius, beauty, sublimity, or might." C. Patterson

"**Suspicion** is an emotion completely of the mind; it clouds the mind completely." A. Abo-Basha

"To **Hope** is to risk... Hope demands progress and encourages us to strive for improvement in our lives." E. Ashbaugh

"**Joy** is above all emotions, it is inwardly focused and held tight to become long lasting." B. Lee

"**Anticipation** brings the unimagined to life." J. Palacios

While initially the beginning design student may be displeased with the emotion they have been randomly assigned, all must come to terms with the content, and absorb it through design research. Once the initial thinking has been established, the transformational studies begin. The emotional condition must be represented as a transformation in five steps, the first of which is a normal cola can, untouched and with the neutrality normally understood as a quality of the mass produced, throw away item. The final, five frame composition must exhibit qualities of the emotion, by interpreting aspects of that emotion manifested in abstract terms through the actions of the cola can transformative process.

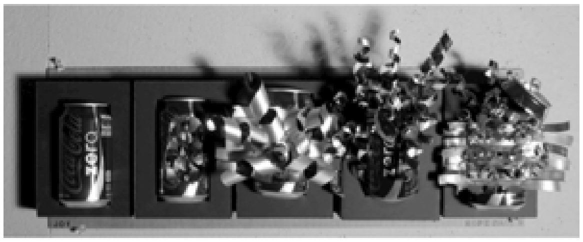


Fig. 1 *Joy*, interpreted by H. Hall

Fig. 2 *Envy*, interpreted by S. Williams

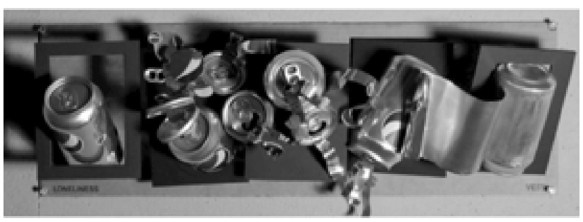


Fig. 3 *Loneliness,* interpreted by V. Vest

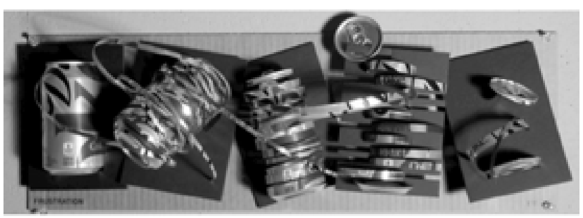


Fig. 4 *Frustration*, interpreted by K. Willis

The can transformation may occur in the formal language angular cuts or applications, curvilinear ones, or via use of linear elements. The narrative may begin within the cola can, or from the outside. The surfacing of the can may be altered, disguised, or transfigured; even the cola company graphics may be used as part of this transformation message. Unity is achieved through repetition and a common design language. Linkages between the stages are important to promote continuity. Focus is achieved through visual emphasis created by a frenetic activity of form, absence of activity, strategic use of cola company graphics or color, changes in scale, repositioning of the can within the composition, etc. These fundamental compositional strategies apply to the essence of this abstract design challenge.

Fig. 5 "A Concept Can" project in process

The black frames also become part of the design problem and discussion as well, serving as a kind of context for the composition. The subject can move in front of, at center, or behind the frame element, as a static datum to which the message can be affixed. Or, the frame itself may not remain static; it can also tilt, move forward or back; in some way it may create motion within the composition. In every case, the frame becomes part of the message

There is investigation and discovery at work. The problem allows for variation yet consistency in design vocabulary. Critiques center on content, reference, analogy, symbol, assemblage, and fabrication. The end goal is to create a meaningful message, the essence of the subject, via the transformation of this basic inanimate object... and to bring value to the previously valueless item.

From the one week "Concept Can" project, students move into the "Vertical Construct" project, a three week intensive study. The four week sequence, occurring mid-semester, constitutes one quarter of the semester's work in the first design studio.

Transformed into the Substance of the Object

"A Vertical Construct"[3] project brief: Create an architectural proposal for a vertical construct (a tower) that responds to the messaging content realized in the "Concept Can" project. The conceptual starting point remains constant – the human emotion, yet elements necessary for human interaction and interpretation must be incorporated through base plane development, structural systems, vertical circulation systems, habitable space at height, and imagery at the skyline. The human has now entered the design problem, to become the receptor of the design messaging. How the vertical construct is perceived from a distance, upon the imagined skyline; how the human enters and moves through the circulation system; what the culminating experience is – these questions are fundamental to the development of the architectural concept.

Fig. 6 V. Vest at work assembling cans and frame

Here the students find themselves at the crossroads of idea and architecture. As in art, intentions are necessary, but they are only a beginning, not an end in themselves. How good intentions become serious ideas which in turn, inspire the creation of built form is the essence of idea to form, subject to object. In the classic text *Experiencing Architecture*, Rasmussen aptly notes that the best buildings have been produced when the architect has been inspired by something in the problem which will give the building a distinctive quality. He further states that such buildings are created in a special spirit and they convey that spirit to others.[4]

While in the 'Concept Can' project, students interrogated their assigned human condition and attempted to give it physical form utilizing a standardized object as the medium, in this iteration of the project students must further investigate the human condition to solve for the human experience and create a meaningful object that is architecture. Literal translations employed in either stage of the project are prohibited, encouraging instead a deeper understanding of what it can mean for a building to embody an idea or message as a human experience.

While some of the initial formal qualities, or design language, and certainly aspects of the message content of the "Concept Can" project may be immediately applied to the "Vertical Construct" design problem, many other issues related to the reality and human experience of architecture require a new interpretation. Additional goals include the investigation of an innovative structural solution – a nod to the population of architectural engineering students in our first design studio. Additionally important is the investigation of several fundamental design principles such as repetition, hierarchy, order, focus, and materiality in terms of color, texture, transparency, solidity, etc. Without the limitation of the media, students must now make selections about materiality that relate to their newly redefined message and concept.

Students begin the design process with a conceptual narrative, perhaps as a description of the desired human experience, as one would approach, enter, and move up and through the tower itself. Poetry is another means of creative writing that may be employed. Or, students may simply write an explanation of how the emotion can be felt in architectural terms as an expression of the tower itself. Excerpts of several students' initial concept search follows:

"**Loneliness** is broken isolation and solitude, and occurs when desire is present – the tower must be alone, perhaps reflected in water, and to reach it is arduous. At the top is a beautiful opening of the heart." T. Pelzel

Something is misaligned,
It is a misplaced idea;
In my fear I distort and twist it;
And without me even realizing it,
It has become the worst possible thing
I could imagine.
Suspicion fills my heart and mind like a disease
Until my composure is shattered.
- J. Martin

Frustration is aspiring for greatness, but brought down by external forces. The tower must surge upwards in spite of gravity, fueled by the desire to defeat an inevitable yet invisible opponent.
- S. Lassman

To promote innovative structural thinking, the first required studies must employ three separate sets of structural concepts – stick system, planar system, and found object system; each must be applied as part of the overall conceptual direction. These systems are evaluated for how well they relate to the conceptual messaging, and one or more are selected for further development. Architectural engineering faculty provide introductory structural presentations, and are included in these initial critiques and throughout the design process, to help guide structural development from an intuitive sense.

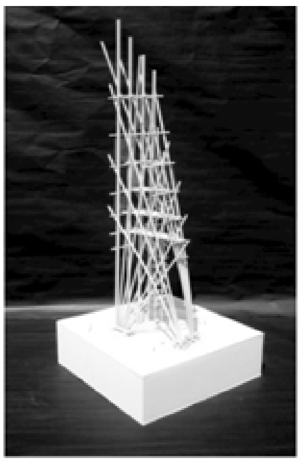


Fig. 7 *Loneliness*, Stick System Initial Study and Final Project, by S. Wilson – inspired by the decayed and abandoned oil field equipment commonly seen in the barren Oklahoma landscape.

Throughout the design development process, the success of the concept is measured against the application of these basic design principles. Form, space, structure, experience, and meaning are equally important in the development of the architectural object.

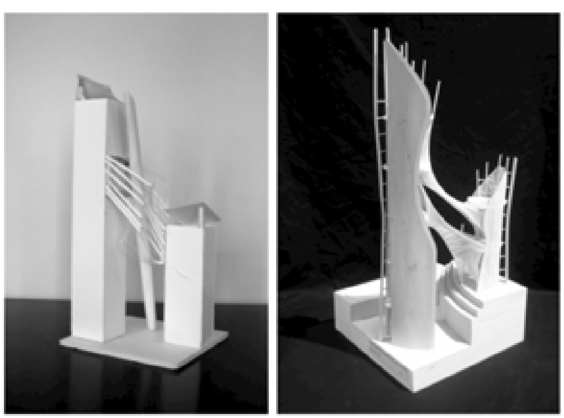


Fig. 8 *Lust,* Planar System Initial Study and Final Project, J. Lane – inspired by the tenuous touch of fingertips between two bodies, one dominant over the other.

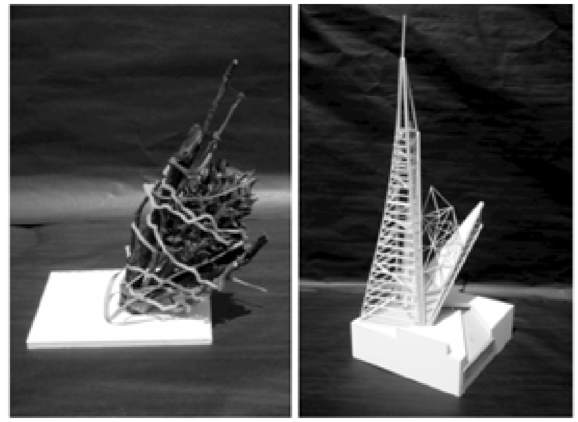


Fig 9 *Contentment,* Found Object Initial System (branches, a magnolia bud, and rubber bands) and Final Project, B. Mitchell – inspired by the precious centrality and inward focus of a contented soul.

Vincent Scully said that we perceive architecture in two ways – associatively and empathetically or, in other words, intellectually and emotionally. We make associations between buildings and other buildings, and we feel buildings as emotional presences. Most buildings affect us both ways, reminding us of other structures and their forms while also evoking certain deeper feelings.[5] While this concept can be easily demonstrated in an architectural history class, illustrated with the wondrous examples of man's accomplishments throughout time and across continents, for the beginning design student in the first studio experience it can be a difficult concept to apply to their own work.

Fig. 10 M. Delp completing her final model

This project sequence is necessarily abstract; it has no particular site, nor client. Rather, it focuses squarely upon design fundamentals related to concept development and bringing meaning to form. This education methodology attempts to bridge the opposing strategies of the essence of the subject - the message, and the substance of the object - the architectural resultant, in the design process for the first year Architecture student.

In the seven years this project sequence has been offered in our program, more than 600 unique solutions have been generated. The "Concept Can" and "Vertical Construct" projects remain favorites among our student population, for the way in which they creatively invoke thought, encourage experimentation, and address meaning in making at the beginning design studio level.

Notes

[1] Paul Goldberger, *Why Architecture Matters* (New Haven: Yale University Press, 2009), x.

[2] "Concept Can" project brief, written by Professors Suzanne Bilbeisi and Mohammed Bilbeisi, 2007.

[3] "A Vertical Construct" project brief, written by Professors Suzanne Bilbeisi and Mohammed Bilbeisi, 2007.

[4] Steen Eiler Rasmussen, *Experiencing Architecture* (Cambridge: MIT Press, first edition 1964), 32.

[5] Paul Goldberger, *Why Architecture Matters* (New Haven: Yale University Press, 2009), 154.

Prototyping Practice

Caryn Brause AIA LEED AP BD+C

University of Massachusetts Amherst

The best things happen when you have to deal with reality.
- Robert Venturi[1]

Architectural design does not end as the tools of fabrication are put into action. On the contrary, making is a discipline that can instigate rather than merely solve ideas – in other words, a design process.
- Bob Sheil[2]

Introduction

A prototype is defined as an early model, built to test a concept or process or to simulate a final product. In many fields, there is great uncertainty as to whether a new design will perform the way it is intended. For vehicles, products, and machines, the prototype is often the first full-size working version, and is produced in small batches to develop future iterations.

Designers use prototypes to explore alternatives, assess user experience, approve aesthetic decisions, and confirm performance prior to starting production. However, a variety of industries from software user interface designs to emerging building technologies, have extended and diversified this definition. Prototypes now include items and experiences in a broad array of mediums, and are no longer limited to physical constructions, digital models, spaces, and interactions.

In architectural practice, the seeming accuracy of virtual digital models makes them an increasingly desirable alternative to full-scale physical mockups. However, for beginning designers, the need to prototype at full scale is crucial. Understanding architectural space is intricately tied to scalar knowledge; the translation of design concepts from the virtual to the physical world is a decisive experiential step. Additionally, the practice of prototyping simulates the decision-making found in the real-world architectural design development process.

Context

This paper examines the employment of both low-resolution and high-resolution prototypes in a variety of fields to explore the applicability of these methods in a beginning design context. It proposes an approach that uses prototyping as an analog to the architectural design development process and examines this approach through student projects and reflections from a digital design and fabrication laboratory course. Taught in the spring semester 2013 at the University of Massachusetts Amherst, the assigned projects employ digital fabrication tools to provide an immediate feedback loop for beginning design investigations. While small projects cannot simulate the construction of large buildings, the logistical concerns precipitated by even simple digital fabrication processes can foster engagement with technical issues of material and assembly.

Low-Resolution Prototypes

Low-resolution prototypes have historically been used iteratively to design, construct, and test physical objects, assemblies, and spaces, increasing the fidelity of the model prior to production. As the design process has been exported to the business and service sector, the practice has become increasingly wide-spread in non-physical design endeavors.

Fig. 1. Steam Engine Boat Toy Prototype on Open IDEO (Photo: Avi Solomon)

Tom Kelley, general manager of the design firm IDEO, values prototyping for its inherent bias toward action. In his 2005 book, the *Ten Faces of Innovation,* Kelley writes that "Experimenting in our world typically means prototyping, and prototyping is central to the IDEO tool set, as essential as a hammer is for a carpenter."[3] As the IDEO business model has expanded from products to experiences, services, and organizational structures, Kelley recognizes "Virtually every step along the ideation path can be prototyped - not just at the development stage, but also marketing, distribution, and even sales."[4]

Scott Berkun, former lead program manager at Microsoft, observes that for software and user interface design, low-resolution prototyping has economic benefits – it saves time and resources. In software and UI design, Berkun notes, "The value of the prototype is that it is a facade, like a Hollywood set, where only the front of the building is constructed."[5] He asserts that since prototypes are relatively inexpensive to produce, "For a minimal investment, you can find usability and design problems and adjust your UI before you invest heavily in the final design and technologies."[6]

The culture of producing many quick prototypes rather than a singular precious response is intended to reduce the fear of failure. In IDEO terminology, this rapid experimentation without material limitations is called Extreme Prototyping. Kelley explains, "We've also learned not to be precious about prototyping....We cycle through prototypes, and our first prototypes can be pretty darned crude."[7] (Fig. 1) Proponents of human-centered design assert that low fidelity prototyping can quickly focus attention on the design features that are most vital to the end user.[8] The prototype thus becomes a valuable tool for communicating with clients who may not share the same vocabulary as the designer. (Fig. 2)

Berkun also cites the importance of prototyping in getting a team to coalesce around a vision for the project.[9] Similarly, Kelley posits that presenting multiple prototypes elevates the possibility of a productive dialogue about design and fends off fruitless reactions to individual design decisions by providing evidence for pros and cons of the design idea.[10]

Fig. 2. Prototype for a mobile app (Photo: Courtesy of Custom Future SA)

High-Resolution Prototypes

In contrast to quick and crude low-resolution prototyping, designers have deployed high-resolution prototyping in architecture, engineering, and industry for a variety of purposes: to test new experimental building and material practices, to extend the limits of known construction methods, to test new assemblies, and to insure quality control in construction.

In the introduction to "Prototyping Architecture," the curator Michael Stacey identifies several prototypes that pushed the boundaries of conventional practice.[11] For example, in Frank Lloyd Wright's Johnson Wax Administration Building, the dendriform columns did not initially conform to the Wisconsin building code in the 1930's. Intended to carry loads varying from two to twenty tons, Wright built a full-scale prototype that withstood a load of sixty tons and enabled the Building Commission to issue a permit when their current formulas could not be applied.[12]

In architecture projects, site construction mockups are a critical prototype to establish clear standards for quality. On a functional level, these prototypes enable the team to determine contractor sequencing, test three-dimensional material transitions, and establish handoffs between the trades. (Fig. 3)

Fig. 3 Site Construction Mockup UMass Amherst

When site built, a construction mockup frames expectations and agreements for aesthetic and tectonic details. For example, in an architectural concrete project, a mockup can give the Design Team and the General Contractor confidence that the concrete subcontractor understands the design intent and has the necessary skill to carry out the contract. It also permits the subcontractor's laborers to become familiar with the specific formwork requirements and joint detailing in advance of the work.

Fig. 4. Apple eMate 300 Industrial Design Model Prototype (Photo: Jim Abeles)

In many product engineering and design workflows, a functional prototype will simulate the look, feel, materials, and usability of the intended design. (Fig. 4) Often made of less expensive materials or process, this final working model is a last check prior to more extensive manufacturing production runs.

Prototyping: an essential beginning design practice

The artificially "neat" division of high-resolution and low-resolution prototypes presented here is, actually, a continuum that maps need and function to material and timeline. The model of prototype as a means of testing prior to full-scale manufacturing still has validity in some modes of practice, but as more processes provide one-off manufacturing opportunities, there is a convergence of prototype and final model. Moreover, prototyping is also now an established design practice for goods as well as services, workflow, processes, and even organizational change. Thus, as architects embrace these design opportunities in an expanded field of practice[13], they can also expand the methods of prototyping in their design toolbox.

In some ways, the role of prototyping – making and testing – in the context of beginning design education is obvious. Design educators likely all agree that making is an essential aspect of learning by doing, as evidenced by the theme of this and previous beginning design conferences. Prototyping is inherently an experiential practice, which is the foundation of design education.

Prototyping: an agenda for beginning digital design

However, in the case of a beginning digital design sequence, these agendas may be more nuanced. First, the architecture and building industry is continually changing and will continue to do so during students' professional careers. This dynamism includes the use of digital design and manufacturing equipment for everything from model making to building fabrication. Thus, a curriculum founded on "making" now also includes teaching students to be comfortable and familiar with these tools early in the design process.

Second, and more critical within a digital sequence, is the experience of creating output from digital to physical as a hedge against the scale-less quality of the digital environment. Beginning designers can gain confidence in their own design decision-making by prototyping at a 1:1 scale. For these designers, the digital world is initially scale-less. Understanding architecture and designing for a real inhabited world are intricately tied to scalar knowledge. Extracting design ideas from the digital world to experience them in real life is a crucial step in all beginning design education, including digital design.

Third is an engagement with technical issues that provides an alternate track to the beginning studio's focus on conceptual design. Some schools bridge this divide with design-build courses, but this is not always feasible in the first year of education. This problem solving is particularly important in the study of an increasingly complex field where students are learning to design buildings but may not personally construct one in the course of their design education.

Lamp

This project provided an introduction to the laser cutter and its associated software. The brief charged students with the task of producing a three-dimensional object that exploited the properties of the tool and the materials, while exploring illumination with a limited palette. Allowable materials included opaque chipboard, mat board, basswood, and thin plywood; translucent and transparent materials were not permitted.

Fig. 5. Lamp during testing (Photo: Ryan Luczkowiak)

Student projects foregrounded sectioning and folding as the predominant strategies for transforming 2d material into 3d objects. Significantly, students struggled with the technical parameters of the light bulb. Choosing the appropriate bulb, managing the fittings, and modulating the light provided challenges that became catalysts for important design decisions.

Students universally recognized that within the digital environment, the possibilities were limitless. However, as the class assembled their first iterations, they encountered the limits presented by the demands of the geometries of specific bulbs and fittings, as well as the contingencies of mounting, hanging, or supporting the fixtures. (Fig. 5) Plugging in the bulbs for the first time in the darkened lab, the students also immediately discovered potential refinements. For students, the imperative to mesh performance - structural, material, light quality - with their previously purely sculptural criteria provided challenging terrain.

One student designed a radially organized pendant fixture intended to mimic the undulations of a mushroom. The student discovered that moving from the digital model into physical space revealed unanticipated structural considerations. (Fig. 6) He found the undulation had an unexpected effect on the lamp, producing an unevenly distributed weight around the central circle which required select "gills" to scale up in order to accommodate this dramatic movement.[15]

Fig. 6. Lamp Iteration (Photo: Nayef Mudawar)

Another student sought to capture the soft glowing qualities and translate the geometries of an existing historic light fixture. (Fig. 7) Through several iterations, he tested different materials, varied the number, size and profiles of the fins, and adjusted the base to provide more even distribution of light and the inner glow he sought. Describing this testing, he wrote, "Concerns that I faced were: Does the material work with the light (bulb) in terms of changes in color and light distribution? Does the material heat up when the light bulb has been on for a while? Is the material durable enough (longevity)?"[16]

A third student focused on the intense infrastructure found in the basement site for his studio project. His lamp design celebrated the space's ever-present plumbing lines by integrating lighting with them. He enjoyed the challenges and constraints that accompany the fabrication's technical parameters writing, "The amount of work required to transform my initial design into a finished product was significant, but it was proportional to the increased satisfaction I felt in turning on my lamp for the first time, and being able to interact with a truly realized project."[17]

Fig. 7. Lamp Final Iteration (Photo: Tom Forker)

Screen

In the second project, students used parametric design tools to explore an element from an architectural studio project at the scale of the component. This exercise prompted them to consider pattern and porosity, which then informed their building scaled projects. Rather than moving in a linear design process from conceptual design in ever-increasing specificity to detail design, this project jumped scales to prototype a highly detailed element which, in turn, advanced their nascent studio work.

Figs. 8, 9. Interior Partition Screen (Photo: Marcel Alvarez)

Students first plotted on paper, producing iterations of the entire screen at ¼" scale, and 12" x 12" sections at full scale. They then produced laser cut prototypes, which they evaluated at both scales.

One student worked on an interior screen partition for a Habitat for Humanity dwelling with a modest square footage. This student found that working both at full and reduced scales enabled him to experience and then adjust the design to achieve the desired level of connection between the dining and living areas. (Figs. 8, 9)

For another student working on an urban apartment building facade, prototyping his screen facilitated testing patterning and appropriate porosity that would achieve interior daylighting while blocking undesirable views. (Fig. 10)

The laser cutter, as a tool, has a particularly entrancing quality. The level of precision that it affords scale models is powerfully seductive. For these students, after reviewing their intricate scaled screens, the shock of the full-scale prototypes was palpable. The ensuing iterations enabled resolution at both experiential and architectural scales.

Conclusion

Digital fabrication projects are pursued in design curriculum for myriad reasons. In this digital skills laboratory, the practice of prototyping specifically strengthens design skills through experiential knowledge acquisition.

How well did these projects provide an introduction to a basic digital fabrication workflow? Working on both two-dimensional and three-dimensional prototypes pushed students to engage the tool's interfaces and explore its potential. As the projects progressed, students fully integrated this workflow into their iterative design process.

How well did prototyping at a 1:1 scale strengthen design decision-making? The lamp project, as a full-scale object, fostered a significant breakthrough from the digital model to the physical artifact. The screen project then furthered students' abilities to relate an architecturally scaled element to their own bodily experience.

Fig. 10. Apartment Building Façade Screen, Reduced Scale (Photo: Spencer Hoyt)

How well did these projects enable students to engage technical parameters? The lamp project was particularly successful in this regard. Not every student achieved project resolution but there were significant discoveries regarding the congruence of conceptual and technical problem-solving. Moreover, students were particularly satisfied with their achievements on this project as evidenced by the work being featured in student portfolios.

One goal for this work is to demonstrate the wide-ranging forms and applicability of prototyping to enable students to integrate this practice into their own workflow at manifold scales and resolutions. To understand how well these projects succeeded will require tracking students through successive studios. Reflecting on this future integration, one student wrote at the end of the course,

As elements of my workflow, exploring fabrication, material, and scale have each yielded unexpected results, and added layers of richness that my studio projects have lacked. Looking forwards, the challenge is to find opportunities to integrate these lessons into my overall design process by finding time to work at this level of detail in my studio projects, either through sourcing actual examples of intended materials or fabricating small moments that are representative of larger schemes.[18]

For beginning designers, it can be difficult to advance studio projects beyond initial schematic design. Through this course, prototyping practices transcend the idealized digital realm for the contingencies of physical space positioning beginning designers to imaginatively engage technical parameters.

Acknowledgements:

Many thanks to my assistants, Silva Kunle and Robert Ramlow-Sachs.

Notes

[1]American Institute of Architects, Architecture Student's Handbook of Professional Practice, 14th edition (Wiley, 2009), p.332.

[2]Bob Sheil, "Design Through Making: Introduction," Architectural Design 75, no. 4 (August 2005): p. 7.

[3] Tom Kelley and Jonathan Littman, Ten Faces of Innovation (London, England: Profile Books, 2006), p.43.

[4] Kelley, Ten Faces, p.43.

[5] Scott Berkun, "The Art of UI Prototyping," accessed January 31, 2014, http://scottberkun.com/essays/12-the-art-of-ui-prototyping/.

[6] Berkun,

[7] Kelley, Ten Faces, p.43.

[8] Matt Franks, "Physical Prototyping" (Austin Center for Design), accessed January 3, 2014, http://library.ac4d.com.

[9] Berkun.

[10] Kelley, Ten Faces, p.55.

[11] Michael Stacey, Prototyping Architecture (Cambridge, Ontario: Riverside Architectural Press, 2013), p. 5-6.

[12] National Park Service National Historic Landmarks, "Program Adminstration Building and Research Tower Statement of Significance," accessed January 31, 2014, http://tps.cr.nps.gov/nhl/detail.cfm?ResourceId=1521&ResourceType=Building.

[13] The 2011 Latrobe Prize report entitled "Wisdom from the Field: Public Interest Architecture in Practice" describes how increased participation in public interest design has created a need for practitioners to cultivate new skills and strategies to support their expanded professional roles to meet the needs of these types of projects.

[14] Mark Burry, "Homo Faber," Architectural Design 75, no. 4 (August 2005): p 34.

[15] Nayef Mudawar, course reflection, April 2013.

[16] Tom Forker, course reflection, April 2013.

[17] Jason Danforth, course reflection, April 2013.

[18] Jason Danforth.

References

Burry, Mark. "Homo Faber." *Architectural Design* 75, no. 4 (August 2005): 30–37.

Coughlan, Peter, Jane Fulton Suri, and Katherine Canales. "Prototypes as (Design) Tools for Behavioral and Organizational Change - A Design-Based Approach to Help Organizations Change Work Behaviors." *The Journal of Applied Behavioral Science* 43, no. 1 (March 2007): 1–13.

Feldman, Roberta M, Palleroni, Sergio, Perkes, David, and Bell, Bryan. "Wisdom from the Field: Public Interest Architecture in Practice." Washington, DC: American Institute of Architects. Accessed December 20, 2013. http://www.aia.org/aiaucmp/groups/aia/documents/document/aiab099531.pdf.

Kelley, Tom. *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm*. New York: Currency Doubleday, 2001.

Kelley, Tom, and Jonathan Littman. *Ten Faces of Innovation*. London, England: Profile Books, 2006.

Perkins, Bradford. "Design Phases." In *Architecture Student's Handbook of Professional Practice,* 330–340. 14th edition. Hoboken, NJ: Wiley, 2009.

Sheil, Bob. "Design Through Making: Introduction." *Architectural Design* 75, no. 4 (August 2005): 5–12.

Stacey, Michael. *Prototyping Architecture.* Cambridge, Ontario: Riverside Architectural Press, 2013.

Willis, Daniel and Todd Woodward. "Diminishing Difficulty: Mass Customization and the Digital Production of Architecture." *Harvard Design Magazine* 23 (2005): 70–83.

Design|Making:
An Approach to Architectural Design Based on the Process of Making Things

Olivier Chamel

Florida A&M School of Architecture

The purpose of this paper is to explore a design methodology based on the value of physically making things. Just as the physical act of building something can lead to the acquisition of valuable technical skills it can also become the vehicle of a powerful design process. The introduction of hands-on design/build type projects where fabrication is conceived as a process rather than an end would provide a counterpoint to the abstract tendencies of architectural design and infuse energy throughout the architecture curricula no matter the course subject.

We will present a series of recent furniture projects designed and built by students and outline a creative methodology which relies primarily on fabrication as a process rather than on representation. We will discuss how Design/Making exercises could be integrated in a variety of ways to courses such as Design Studios, Structures, Materials and Methods, Introduction to Technology and Environmental Systems. The design process in architecture typically relies on a series of representation tools as a means to create, organize and present ideas. Hand-drawn conceptual sketches, design development drawings, construction documents, physical and 3D models to name a few, have become a set of indispensable tools to navigate the design process of increasingly complex projects. These tools rely on a series of graphic conventions to represent things to be physically built in the field. They do belong to a world of representation which lies somewhere besides the physical world. Although representation is and will remain crucial to the production of contemporary architecture this paper focuses on an alternative design process which would introduce or re-introduce students to the physical world of materials, tools and craftsmanship. Despite the obvious disconnect between design and construction in term of process and the fact that architects are not expected to build their own projects, architects are nevertheless expected to understand the properties of the various materials involved in construction as well as their modes of assembly. The process of simultaneously designing and building a project may reveal to students a physical world they may not be familiar with. The understanding of notions such as gravity, structural integrity and the need to provide adequate connections can be a source of limitations but more importantly a source of great opportunities.

The Nature of Making

There is something immediate and rewarding about making things with our hands and at the same time it is hard to explain what goes on while we are engaged in that process. While the act of physically transforming materials with tools relies on a specific set of technical skills it also relies on our intuition. The hand finds, the mind responds. For example our body knows to adjust its strength when applying a rasp to a piece of soft wood and we do not have to actively think about that specific act. Spinoza in his Ethics makes the following observation.

No one hitherto has gained such an accurate knowledge of the bodily mechanism, that he can explain all its functions; nor need I call attention to the fact that many actions are observed in the lower animals, which far transcend human sagacity, and that somnambulists do many things in their sleep, which they would not venture to do when awake: these instances are enough to show, that the body can by the sole laws of its nature do many things which the mind wonders at. [1]

The mechanisms involved when we are physically building something are difficult for someone to describe because they are not primarily controlled by the sole powers of our mind. The process of making belongs to the realm of our body and involves on a complex system of perceptions. While actively engaged in building a piece of furniture we cannot simultaneously engage in elaborate thoughts. Instead we are focused on our perception while working. The act of making requires the focus of many of our senses and the moment we engage in abstract thinking we instantly leave that intuitive mode of operation.

When we perceive we do not speak and when we speak, we do not perceive [2]

In this famous quote Zhuangzi, the 4th century B.C. Chinese philosopher refers to the following fact. When placed in a situation where we focus our attention on the perception of a specific experience, whether external or internal to ourselves, we no longer have access to the language as a faculty. At the same time our perceptions tend to be muted when we are actively using our language skills. Zhuangzi also makes the following observation in an imaginary dialogue between duke Huan and Pien a wheel maker who describes his work as a craftsman.

I look at it from the point of view of my own work. When I chisel a wheel, if the blows of the mallet are too gentle, the chisel slides and won't take hold. But if they're too hard, it bites in and won't budge. Not too gentle, not too hard - you can get it in your hand and feel it in your mind. You can't put it into words, and yet there's a knack to it somehow. I can't teach it to my son, and he can't learn it from me. So I've gone along for seventy years and at my age I'm still chiseling wheels. [2]

In this dialogue Zhuangzi describes the process of acquiring skills that cannot so much be taught as they must be experienced first-hand. According to the author knowhow and true knowledge are gained only through experience. In that context the acquisition of a technique and the understanding of materials' physical properties through the use of tools all come from the experience of fabricating things.

Making as Pedagogy

In a world where the omnipresence of digital tools has created a general disconnect with regard to the physical world, a pedagogy based on design/making would help re-engage the current generation of students. In keeping with the concept of active learning the hands-on approach of making things would help students focus on a single task and allow them to learn by doing. Building concrete things would invite students to care and respect the material world and value the transformative process of working with materials. Such experiences could help shape their future attitudes towards the construction process and help develop an interest for construction related activities in the field of architecture. Designing and building furniture would help students come to the realization that architectural drawings, whether a conceptual sketch or a technical detail, have practical implications. As a matter of fact detailing may be another area of architecture education to benefit from design/making exercises. The relative simplicity of connections involved in furniture design when compared to a complex architectural detail would provide a practical introduction to the concept of creative detailing.

In addition the creative process of making things is enabling in the sense that even though students may have various levels of technical ability, the final outcome of their project does not depend on their sole ability to hand draw or create elaborate digital or physical models. The relative simplicity and straightforwardness of using basic tools may give a fair opportunity to all students to carry out their design regardless of their ability to use representation tools. In addition, providing exposure to a more immediate and accessible process may be a source of motivation for students. Another benefit of physically making things would be to infuse an increased sense of responsibility and design ownership whether the result of the work is a failure or a success. A built design tends to speak for itself and invites students to a certain objectivity when it comes to the quality of their work. The overall process would promote student engagement through physical activity within the design process.

Because the outcome of design/making projects is a physical object with specific requirements in terms of structure, connections and craftsmanship such projects foster the development of problem solving skills as they are tied to the accomplishment of a practical goal. Due to the amount of work typically involved in designing and fabricating even a small piece of furniture, students often work in teams. As a result design becomes a collaborative creative effort which brings additional value to the experience of making. Building something as a team also promotes peer learning. The overall process of building furniture in a shop as opposed to listening to a lecture or designing in a studio environment increases student engagement and empowers them to try new things and take risks. Even though there is a clear objective when constructing a project the overall success depends on the ability to apply ideas to materials and let materials and techniques confirm or contradict the validity of the original design intent.

The need to build something also requires an acute sense of time management on the part of the students to take into account such things as material procurement, modes of assembly, possible failures along the way as well as unexpected events. Time management and scheduling just happen to be highly valuable skills necessary to the successful delivery of any architecture project. Fabrication based projects present students with the opportunity to design, verify the validity of their design intent in the field, make changes during fabrication and oversee a construction process. Design and construction are no longer disconnected but integrated in a creative process where they transform each other.

The Process of Design/Making

The design/making process is not based on abstract thinking alone but rather on the ability of the mind to learn and synthesize from the actions of the body. In other words it is less about organizing ideas than confronting ideas to the reality of the fabrication process. The fabrication phase is a crucial part of any project delivery due to the simple fact that no matter the design intent fabrication has a huge impact on the physical quality of the final product. It can be argued that in situations where fabrication is the result of a series of mechanized operations there is little room for creation in that process. In fact a creative fabrication process is possible only because there is an engaged individual at the center of a dialogue between the world of ideas and the world of materials.

A typical design process for architecture projects in academia or in professional practice relies primarily on representation tools and can be summarized in the diagram on fig. 1. In contrast a fabrication based design process can be outlined on fig. 2. In terms of both process and outcome representation and fabrication based designs have significant differences. The creative process in typical architecture projects and design/making projects is presented in broader terms in fig. 3 and fig. 4. The design/making process can be described as a series of transformative manipulations as seen in fig. 4. Design ideas transform materials through an iterative process and are in turn transformed by the experience of working with materials.

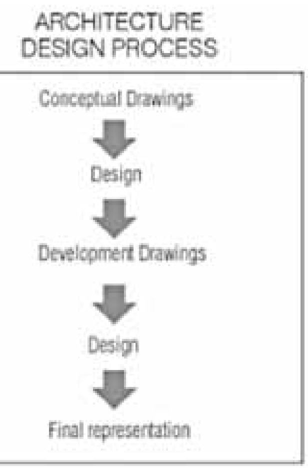


Figure 1

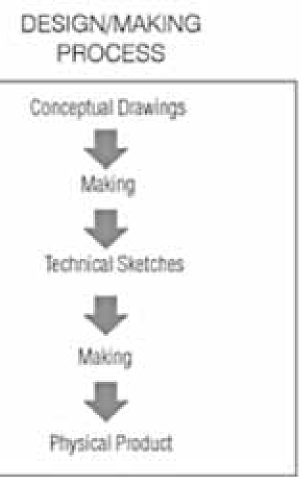


Figure 2

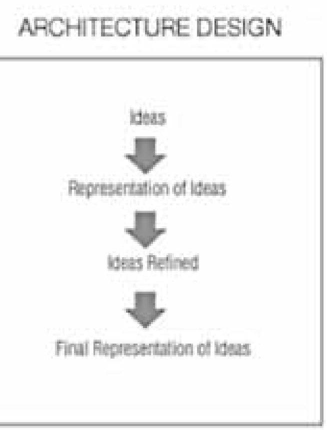


Figure 3

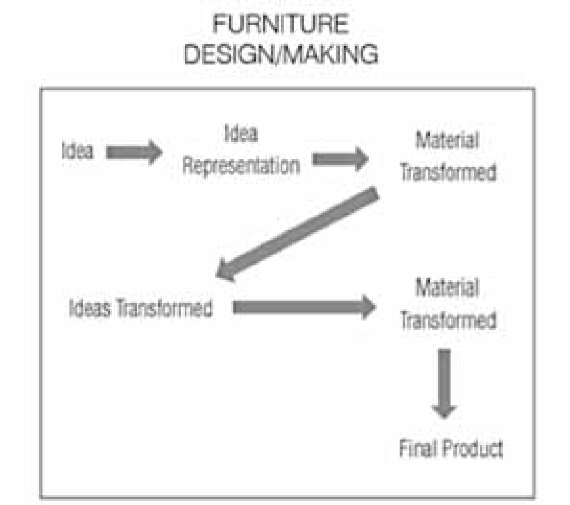


Figure 4

Case Studies

The following case studies present a series of recent design exercises where students designed and fabricated furniture based on a variety of concepts. In some cases students were asked to design furniture using only a limited set of materials and connection techniques and find creative opportunities within these boundaries. In other instances they had to transpose a structural system to a different scale in order to solve technical requirements. They also looked at how construction details can influence design as a whole. Each exercise presented a specific set of educational goals with regards to design as a structured process.

Project Type 1: Furniture Design Based on the Use of Specific Materials

The premise for these exercises was to design and build a piece of furniture using a specific material or combination of materials. In this context students were expected to rely on an in-depth analysis of a material's properties (gypsum wall board, dimensional lumber or corrugated cardboard) in order to generate design ideas. The understanding of a material's properties allowed students to define practical strategies in term of structural systems, connections and finishes. The purpose of this type of exercises was to emphasize the importance of materials within the design process both as a limiting factor but also and more importantly as a source of opportunities.

Project: The Cardboard Chair

Course: 2nd-year Design Studio

Time Frame: 2 weeks

Project Description

The purpose of this exercise was to design and build a chair using corrugated cardboard as the only available material. The chair was required to have a seating surface located at 18" above finished floor and a back. The assembly of the various cardboard parts had to be completed with a custom-made water and flour based glue.

Goals

This project was assigned in the first sequence of the second-year design studio as a two-week long exercise. Students had just completed the design of the semester main architecture project and the goal was to expose them to a different mode of design and production. A short lecture provided students with precedents of successful cardboard chair projects as well as an overview of the structural properties of corrugated cardboard. Following a short presentation, students spent approximately 2 hours brainstorming design ideas which they presented in sketch form at the end of the class session. Students worked in teams of two and were responsible for obtaining enough cardboard to build their chair. Once their conceptual design was approved by faculty, students built their chairs with limited supervision. Access to commercial-grade band saws at the school of architecture workshop allowed students to cut several layers of cardboard at a time. The assembly of the various pieces was completed in the studio space.

Outcome

The assignment was successful in the sense that all teams were able to build a chair within the time frame imposed. The overall design quality of the chairs seemed in line with the level of work displayed in the studio's previous assignments. Nevertheless some of the weak students seemed more involved and performed better on this particular project when compared to previous representation based architecture projects. The less successful chairs lacked a true constructive concept based on the physical properties of the material assigned. As a side note students managed their time efficiently and were able to obtain enough recycled cardboard to carry-out their design.

Project: The Drywall Chair

Course: Elective "Making Furniture and Upcycling" (3rd-year students)

Time Frame: 3 weeks

Project Description

Students were asked to design and build a lounge chair using a combination of ½" sheet of gypsum wall board and 2x2 nominal size-lumber with drywall or wood screws for assembly.

Goals

As the final assignment of an elective class the purpose of this project was to design and build a chair using construction materials which typically produce large amounts of waste. The construction of the chairs would present an opportunity to divert waste through upcycling.

The drywall chair project was preceded by a week-long exercise during which students built a replica of the famous Red and Blue Chair designed by Gerrit Rietveld in 1918. The constructive concept of the Red and Blue Chair, a combination of timber frames supporting two planes was to serve as inspiration for their chair design. Students built the original red and Blue Chair using ½" veneer plywood for the seat and back and 2x2 and 2x4 nominal lumber for the frames. From that point students were given two choices. They could design their chair based on the structural concept of the original Red and Blue Chair; plans supported by a frame of define a concept of their own choosing. An obvious challenge was to address the limited resistance of a ½" sheet of gypsum wall board in flexion. Therefore designs were to take advantage of the shear properties of gypsum board as a sheathing material and the ability of wood to perform well in flexion. In order to arrive at a successful solution the two materials had to work together.

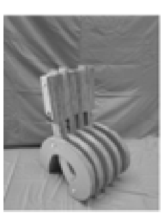


Fig. 5. Cardboard Chairs Fig. 6. Drywall Chair

Outcome

The proposed requirement to combine wood and gypsum wall board in a meaningful structural system produced projects that were either quite successful or quite weak with very few "in betweens". One of the successful designs proposed to create two shear planes supporting 2x2 pieces of lumber which in turn carried the seat and back surfaces of the chair (fig. 7). Another strong proposition combined gypsum wall board and wood to create the equivalent of a wood I-beam using the sheathing material in lieu of ½" OSB (fig. 6). This was especially interesting as a creative solution combining the two materials together. A third chair more closely inspired by the original Red and Blue Chair proposed a system of light frames supporting 3 planes (fig. 8).

In some of the less successful projects students planned to use ½" drywall as if it were ½" plywood only to realize they had to come back and add additional support to the drywall in the form of several layers of gypsum board or wood framing.

Fig. 7.

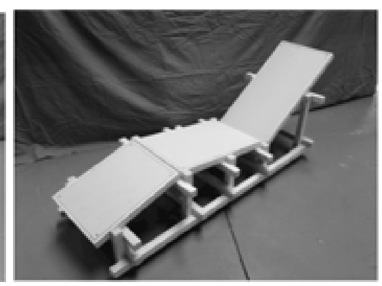


Fig. 8.

Project Type 2: Furniture Design Based on Limited Resources

Project: The 248 Chair

Course: Elective "The Efficient House" (2nd and 3rd year Students)

Time Frame: 2 weeks

Project Description

The purpose of this particular assignment was to design and build a chair using as only resource one 8 feet long 2x4 wood stud. The chair seating surface was set at 18" above finish floor and the chair was required to have a back.

Goals

This project found its way in an elective course titled “The Efficient House” focused on efficient design strategies for residential construction. Building a piece of furniture with a limited amount of resources became an opportunity to provide a real example of what it means to be efficient in terms of resource availability. This exercise was also an opportunity to break the monotony of a lecture-based class. Students started the assignment by submitting an axonometric sketch including material notes and a detailed list of all parts with dimensions. The submission of these drawings was required to help students verify the feasibility of their design on the basis of their limited resources. Design proposal were reviewed by faculty and marked-up if necessary, after which students built their chair in the school of architecture workshop. Although students produced an initial document indicating design intent it was made clear to them that designs could be modified during the fabrication process as a result of specific problems or opportunities.

Outcome

This project was initially received with some level of skepticism by students although they quickly turned that apprehension into a desire to successfully complete a challenge. Students were given a presentation on traditional and contemporary wood joinery in the hope that they would apply these principles to the fabrication of their chair. Unfortunately and due to the relative short schedule of the project no one was able to incorporate such details. Assembly of the various wood pieces was accomplished either with wood glue alone or a combination of wood glue and brad nails. Everyone was able to build the basic structure of their chair given the limited resources allowed. Approximately half of the final chairs built were structurally sound while the other half presented structural weaknesses in term of the overall structure itself, bracing or connection quality.

Project Type 3: Furniture Design Based on Structural Systems

Project: The Truss Bench

Course: Elective Course “Making Furniture and Up-cycling” (3rd-year students)

Time Frame: 3 weeks

Project Description

Students had to design and build a bench based on the structural principle of a bridge truss.

This exercise challenged students to design a truss system composed of cables and bars in order to allow a 12”x96” piece of ¾” plywood to span 8 feet and successfully support four people. The bench seating height was set at 18” above finish floor. Students were given a choice to use either a Fink or Bollman truss to achieve the required span.

Goals

This project had a very structured set of requirements so that opportunities for creative design lied in the specific definition of a truss system, its size, spacing of its components and connection details. A series of connections between various elements (cables to bars, cables to bench top, bars to bench top and bench legs to bench top) was identified as critical to the success of the project.

Fig. 9. Truss Bench Details.

Following a presentation of the project requirements to students, the class met at a large home improvement store where faculty pointed out possible materials and assembly systems available. Following the “materials and methods” shopping trip each team was asked to produce an axonometric view of their bench with material notes along with a complete kit of parts and projected budget. After review of these documents students spent the rest of the allotted time building and refining their design in the workshop at the school. Class meetings occurred in the shop from there on.

Outcome

Some students expressed disappointment about the perceived lack of design freedom associated with this project. They argued that design, in their opinion, had to be shape forming. Despite the very structured guidelines of the assignment the final benches were all different. Each team provided a unique interpretation of the original truss concepts with solutions involving various level of prefabrication.

Notable challenges during construction included the adequate termination and tying of the tension cable ends using crimp sleeves and a crimp tool. Although all teams understood how the cable ends were to pass through a sleeve and create a loop they had to find out how to effectively crimp the sleeve in order for the cable to be firmly anchored. All built benches demonstrated a good understanding of the original truss system. The level of craftsmanship was high overall. Variations in the size, spacing and connections for each truss system resulted in the fact that the rigidity and weight carrying capacity of each bench varied. The very structured nature of this assignment seemed to explain, at least in part, the high quality of the work produced by students.

Project Type 4: Furniture Design Based on Connection Details

Project: "A Connected Coffee Table"

Course: Elective Course "Making Furniture and Up-cycling" (3rd-year students)

Time Frame: 3 weeks

Project description

Students were asked to design and build an 18"x36" coffee table using wood from recycled pallets and pay special attention to the mode of assembly of the various table components. The table top surface was set at 18" above finish floor and apart from specific connections elements the table was to be built entirely from recycled pallet wood.

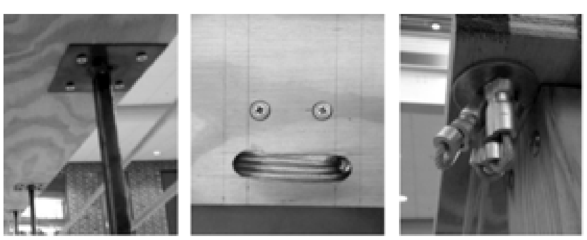


Fig. 10. Connection Details.

Goals

This exercise was divided in two phases. First students were asked to design and build one table leg and focus their attention on the connections between the leg and both the ground plane and the table top. The leg itself had to be built with recycled pallet wood but its configuration and design was left to the discretion of the students. In addition, the wooden leg had to be connected to the ground and table top by means of a material other than wood. The purpose of this project was to identify critical joints within a piece of furniture where forces were changing directions and resolve these joints through the design of creative details. The connections had to express their practical functions and contribute to the esthetic unity and structural integrity of the overall structure of the table. The design of the table leg and its connections was compared to that of a column connected to a floor at its base and a roof system at its top.

The second part of the assignment consisted in designing the table top based on the previously designed table leg and connections. The design and construction of the table leg alone was completed in approximately one week while the fabrication of the rest of the table took an additional two weeks. The end result was a complete functioning coffee table.

Outcome

The assignment stipulated that the connections at the bottom and top of the table legs could be of any material except wood. With no exceptions students opted to develop connections details using metal components. The most successful connections were highly customized and involved cutting and drilling metal plates as well as welding other metal components such as rebars or rods. Less successful projects relied on slightly modified off-the-shelf components found at a hardwood store.

Overall students responded better to the first part of the assignment dealing with connections but few were able to design a table top based on the design of the leg and connection details.

As a general note to all the projects presented we observed a direct correlation between the quality of the work produced by students and the structured nature of assignments. The more structured the assignments, the better students were able to come up with creative solutions.

Similarly students responded creatively to projects perceived as highly challenging.

Curricula Application

Fabrication based design projects such as the ones we described may be typically undertaken in a design studio environment. Nevertheless these exercises, due to their scale and scope, have the potential to be integrated in courses typically taught in a lecture format. Furniture is large enough to physically engage students but remains at a scale that is manageable by individuals or small teams of students over short periods of time. Therefore furniture making projects can be developed as short assignments ranging from a week to a month. Although the projects outlined in this paper were introduced in elective and design studio courses they would seem particularly well suited for architecture courses such as Materials and Methods, Structures, Introduction to Technology and Environmental Systems. Projects like the cardboard and drywall chair would benefit a Materials and Methods or Structures course and provide an opportunity for students to become more familiar with material properties and invite them to consider the use of materials as a source of inspiration. The 248 chair which deals with design in a context of limited resources may be relevant for an Environmental Systems course. The truss bench exercise, as a structural system applied to furniture would also be a good fit for a Structure course. The coffee table project with its emphasis on assembly and connections would provide an appropriate introduction to creative detailing within a Material and Method course. Other skills like construction management and the acquisition of good craftsmanship would prove valuable to students as part of their overall architecture education.

Fabrication based projects have an important place in the current active learning environment as they invite students to gain knowledge through the invigorating process of resolving a series of concrete challenges.

The inherent qualities of a design/making process could provide balance to the virtual tendencies of most areas of human activity including architecture education. Design/making projects would also give students confidence based on tangible things as opposed to the sometime false confidence of resolving issues graphically. Such projects may prove especially beneficial to students struggling with a design process heavily based on representation tools. It is not to say that hands-on projects should replace the current design tools used in architecture education but we should acknowledge their creative value as an alternate design methodology.

Notes

[1] Spinoza, "*Ethics*", Part 3, proposition 2. Traduction by R.M. Elwes. Dover publications. 1883

[2] Zhuanzi, *"The complete work of Chuang Tzu, Burton Watson"*, Columbia University Press. New York. 1968. Book 13

Casting Concrete:

Material Response and Embodied Knowledge

Eleanor D'Aponte, AIA

School of Architecture+ Art, Norwich University

Introduction

The semester's course work strives to synthesize the interrelationship between analysis, process and materiality, and representation. Students cast 3 full-scale concrete units for a theoretical modular wall within a larger design project. The casting process is haptic for the student, both in the physicality of the pour and the final hand drawn representation of the wall in situ.

The traditional beginning design student kit-of-parts exercise aims to deflect student pre-conceptions and direct the design focus to spatial sequences and assembly of architectural elements. [1] However it also de-emphasizes the material aspects of architecture[2] as well as cultural or contextual exigencies of design. This first-year project attempts to 'ground' the kit-of-parts in the physical world within the cultural and historic context of a specific city and a specific site. The strong potential for the material expression of the concrete cast balances the highly abstract architectural language of the kit-of-parts. The casting project interjects a "learning by making" experience where the student builds a full-scale wall unit that is a physical 'real-time' extension of their theoretical design.[3]

Historical Background

The student designs are influenced by investigations of modular architecture especially Frank Lloyd Wright's textile houses and Erwin Hauer's geometric architectural screens. An array of poetic works by architects such as architects such as Tadao Ando, Herzog and DeMeuron, Peter Zumthor, and Caruso St. John serve as precedent for considering the tectonic potential of concrete.

In the early 20th century American architects Frank Lloyd Wright (1867-1959) and Louis I. Kahn (1901-1974) recognized the expressive potential of the surface of concrete. They utilized the imprint of joints, plywood and liners to contribute to the aesthetic appearance of a pour. [4] Wright was influenced by the lectures and writings of Gottfried Semper who espoused four stages of building: marking the ground and constructing the foundation, making the hearth, erecting the structural frame, and cladding the frame with a woven fabric to enclose the walls and the roof. [5]

Semper's aesthetic-formal consideration of 'stereotomy' or 'stone construction' describes the opposite roles of two types of wall foundations: 'cyclopean blocks' and 'regular rectangular ashlar work'. [6] The latter category, he describes, is more about aesthetic values than pure structural performance [7] Following late Roman precedents, the Renaissance builders designed ashlar walls as "a malleable symbol of every nuance of architectural character and expression". [8] They utilized and manipulated the dimension, proportion, adjacencies, rhythms, arrangements, and technical details of the blocks to achieve visually dynamic and culturally symbolic effects.[9]

Semper analyzes the stonework as a single element as well as the 'effect they make collectively'.

Units do not induce visual effects merely as geometric entities but also as masses in a dynamic sense; they work on the mind through the eyes. Such impressions can be significantly enhanced by the formal treatment applied and by the way in which the units are assembled. [10]

Patterns from weaving, pottery and tectonics were integrated into the stonework for decorative purposes. He describes the emotional effects of the resulting forms as expressing 'resistance', 'might', or 'felicitousness'. [11]

Project Background

In this project the structure and frame are assembled using the walls, columns, beams and trusses of the kit-of-parts. One space is chosen for further articulation and is enclosed with a modular wall system developed from an arrangement of units.

Initially students analyze the structural geometries and growth patterns of an assigned city and communicate their research with graphic diagrams employing digital representation tools. Their diagrams strive to frame a specific event or pattern. For instance the analysis below relates the scale and layout of building construction to both time period and topography. Fig. 1.

Fig. 1. City Analysis, Katie Anderson

Students choose a ½ acre minimum to 3-acre maximum sized site that has street level pedestrian activity or the potential for such as to promote the idea of pedestrian connection, as well as retreat, in the city. The site must be within a ¼ mile of urban amenities such as libraries, retail, and housing and must have access to public transportation such as light rail, commuter rail, subway, or bus. Significant outdoor civic spaces as well as enclosed spaces have varying requirements of permeability with the public and surrounding environment. This encourages the development of a layering or hierarchy of spaces in the designs. The students are given a kit-of-parts to design the building(s) and outdoor spaces. The primary enclosure is a 3,000 square foot visitor's center. The kit-of-parts includes columns, panels, and truss systems which generally work on an 8 foot module. The kit also includes trees, water, landforms, stairs and ramps, which have less restrictive dimensions. Fig. 2. The concrete modular wall may enclose any significant space. Therefore the initial design context of the modular wall is to determine the nature of the wall and whether it will promote spatial connection, light, and visibility to the surrounding spaces and city fabric. It also can provide a thermal mass and a tactile surface.

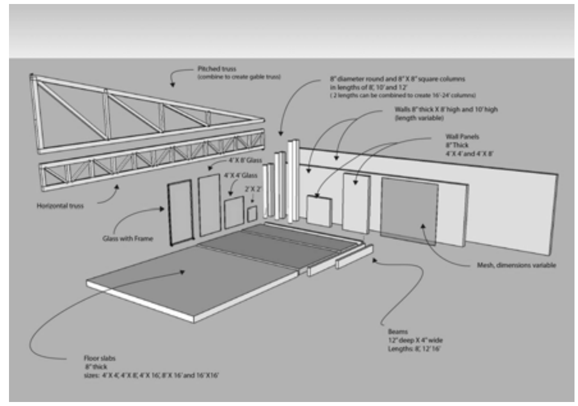


Fig. 2. Kit of Parts

Material Response

The formwork for the casts is constructed from plywood, foam, melamine, fabric and other found objects and materials chosen to provide support and to create shapes and surface patterns in the concrete imprint. A direct relationship between the construction process and the tectonics of the final cast occurs.[12] The structural potential, the shape and the surface pattern of the cast are all directed by the design of the form. Students are encouraged to experiment with different materials to generate unique material responses during the iterative process. These can be manipulated; stretched, fastened, draped and otherwise constrained to produce a variety of desired effects and shapes. The pattern and characteristics of the materials, how they are constrained and placed, is imprinted on the surface of the concrete. Fig. 3 The ambiguity of combining the hardness of concrete with the visual experience of the aesthetic quality of the textile imprint challenges observers conceptions of concrete and "draws [observers] into a dialogue about the potentials of concrete". [13]

The relationship between the formwork design and the final cast is a strong educational tool for teaching first-year students about tectonics through making. The concrete responds directly to the student's choices of formwork material and is exacting in its reaction to their varying degrees of accuracy and craftsmanship. The concrete is both "process and material".[14] The cast at both the scale of the 'real' unit and the theoretical wall manifests their construction choices. The plasticity of the block is defined by the reversal of positive and negative spaces of the formwork. [15]

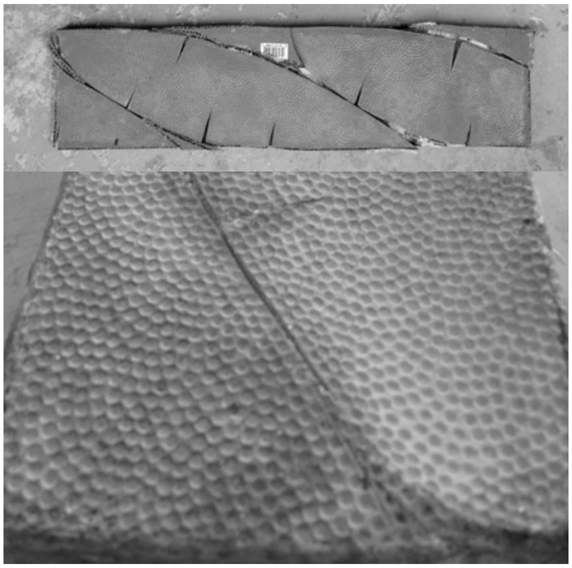


Fig. 3 Jason Budde, cast with unfolded basket ball

Often the starting point for the pattern of the unit is the students' site parti or an encapsulation of a conceptual theme. *"Is the city organized in a grid pattern or a radial pattern?"* Fig. 4 This connection offers an opportunity to physically experience and express in three dimensions an idea about spatial organization that has only been analyzed visually and in two dimensions. The trial and error of building the formwork, witnessing the chemical process of the mixing the concrete and pouring the cast requires an engagement with the forces of the materials in a direct and physical way.

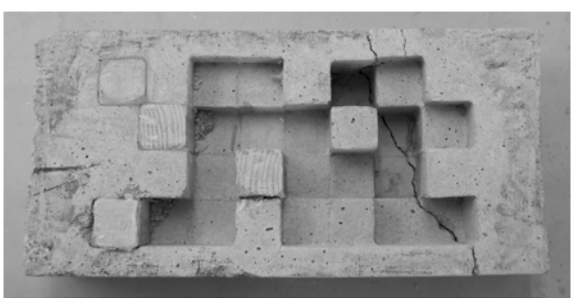


Fig. 4 Rachel Sweeny, city grid inspiration

When they begin to build the formwork, the exigencies of the construction process necessitates clarification of the idea. *"How should I craft this corner detail to get the effect I desire?"* The dialogue between the imagined outcome of the block design and the steps needed to cut, fasten, sand, drill, jig - saw, rabbet or otherwise shape the formwork enriches design thinking and can foster a more discriminating attitude. The iterative process supports an awareness of the dialogue between the design intent of the desired unit and wall. The desire to create voids or impressions in the unit in order to allow light in the selected space must be measured against material and physical forces like gravity as experienced via the stability of the formwork.

There is a potential for expression of the final block unit to embody and express the construction process of the formwork. There is the potential for the single unit of the block design to transform the expression of the wall, and there is the potential for the representation of the final wall in situ to galvanize a haptic response in the viewer because of it's tactile and plastic sensibility. Fig. 5 + 6

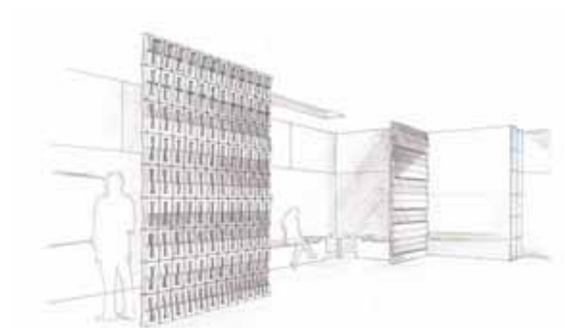


Fig. 5 Sarah Bedard, modular wall

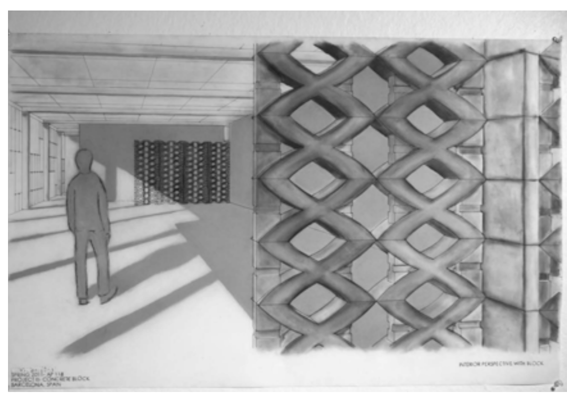


Fig. 6 Katie Anderson, modular wall

Embodied Knowledge

Students identify with the tactile and physical process of casting and the effort often serves to bridge the physical with their theoretical design work. Casts are poured concurrently with design development of the kit-of-parts project and refinements to the proposed building and modular wall system are ongoing. Each cast measures 8" x 16" x 4" and a variety of combinations for the units is studied. Since each unit is something one can hold, it has an immediate palpability.

The plasticity or surface texture of the cast animates the theoretical wall. As in Semper's analysis each decision about the unit design contributes to the overall 'dynamic' effect of the wall. The design of the individual unit can transcend its' individuality in the overall wall composition. Fig. 7

Fig. 7 Jess Dahline, study for unit pattern in wall

In his discourse about sight Juhani Pallasmaa expresses the need for haptic experiences in architecture to re-ignite our senses and thus reground us in time and space.[16] As technology has allowed us to 'see' farther into the atmosphere and deeper into the nanosphere, vision is the only sense that can easily keep stride.[17] He argues that architecture has been reduced to a visual experience, one that can be captured photographically, but that it has not played an important role since primitive times in bridging human biorhythms with the temporal space of the universe via our sensory and thus bodily engagement.[18] The traces of the construction process are embedded in the casts and therefore stimulate, through vision, our other senses.

Pallasmaa, referring to Merleau Ponty states that we know the world through our bodies. [19] Vision is an extension of the other senses. Hence the visual plasticity of the concrete wall triggers our sense of touch because of its plastic nature which embodies its' construction process.

Students have a strong memory of the project in later years, because they have embodied the process by engaging haptically. They have a body-memory of the event as well as an intellectual memory. Fig. 8

Fig. 8 Pouring, vibrating and trowelling

As they begin working on the casts while still refining their building design, the experience of casting a successful block (one where draft angles are tapered enough, so the concrete doesn't chip upon removal, or where enough layers of sealant are applied and the resulting surface is smooth, or the desired positive and negative shapes and imprints were achieved) can be transferred back to animate building details with a changed perspective about materiality and detail. *"Can the roof panels overhang? Should the wall panels be flush with the columns or should they project to create rhythm along a pathway?"* Fig. 9

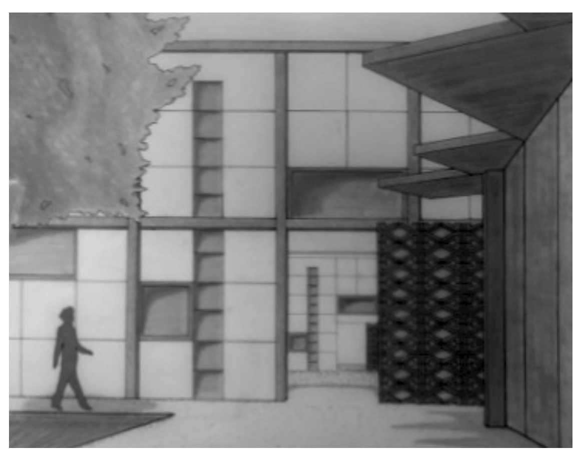


Fig. 9 Deandra Musial, evolution of building details

Conclusion

Lastly, Pallasmaa speaks of the need for the 'reversal' of our self-image in the world in the making and living process. In casting the concrete unit and developing a modular wall, students have to negotiate the 'intelligence' of the material. They cannot design from a purely occularcentric position, because the physical properties of the concrete take center stage. The poetic potential of the material comes from the inventions of this negotiation or interaction.[20] Merleau Ponty emphasized that the self and the world 'interpenetrate' and mutually define each other. [21]The process of manipulating stone that Semper describes and the casting of the concrete units are similar in that the designer must both define the form of the final cast, but his/her decisions are shaped and defined by the material constraints and properties.

Notes

1 Timothy Love, "Kit of Parts Conceptualism: Abstracting Architecture in the American Academy", *The Harvard Design Magazine*, Fall 2003/Winter 2004, Number 19, p. 2

2 Ibid p. 3

3 Ibid p. 3

4 Todd Williams and Bille Tsien "Surface as Substance." Liquid Stone: New Architecture in Concrete. Ed. Jean-Louis Cohen and G. Martin Moeller, Jr., Princeton Architectural Press p. 106

5 Robert McCarter, *Frank Lloyd Wright - (Critical Lives)*, (London, England, Reaktion Books, Ltd, 2006), p. 36

6 Gottfried Semper, Style: Style in the Technical and Tectonic Arts; or Practical Aesthetics, (Los Angeles, California, Getty Research Institute, 2004) p. 729

7 ibid p. 729

8 ibid p. 703

9 Gottfried Semper, Style: Style in the Technical and Tectonic Arts; or Practical Aesthetics, (Los Angeles, California, Getty Research Institute, 2004) p. 730

10 Ibid p. 736

11 Ibid p. 734

12 Anne-Mette Manelius, 'Fabric Formwork: Protoyping Concrete as Material, Process, and Context'. Prototyping Architecture: The Conference Papers Ed. Michael Stacey: The Architecture and Urbanism Research Division at the University of Nottingham 2013 p. 14

13 Anne-Mette Manelius, *Fabric Formwork for Concrete – Investigations into Formwork Tectonics and Stereogeneity in Architectural Constructions* PhD dissertation @2012 Royal Danish Academy of Fine Arts School of Architecture, Institute of Architectural Technology p.193

14 Ibid p.51

15 Ibid p.69

16 Juhani Pallasmaa, *The Eyes of The Skin*, (West Sussex, England: John Wiley and Sons, 2005), p. 17

17 Ibid p. 21

18 Ibid p. 21

19 Ibid p. 20

20 Ibid p. 29

21 Ibid, p. 20

Making Space
for Design and Construction in the First Year

Ann Gerondelis, AIA

Director, Common First Year, College of Architecture, Georgia Institute of Technology

Introduction

How might beginning design students practice their role not only as thinkers, but as makers and embodied learners in the designed, built and lived environment? Should curricular space be made for full-scale construction even in the midst of increasing time demands for learning new modes of representation? What strategies might support a learning environment of integrated thinking and making, one where testing and failing feeds an iterative design feedback loop?

This paper investigates moves in the Common First Year studio in Georgia Tech's College of Architecture associated with the introduction of a comprehensive full-scale design and construction project for First Year students. Related curricular shifts are supporting beginning-design-student learning not only in fundamental design principles and representation strategies, but also in integrated thinking and making, authentically at full-scale. The results reveal students' increased engagement with and knowledge of materiality, tactility and fabrication processes. This is paired with valuable skills in collaborative problem-solving and communication methods, helping to lay the groundwork for students' future roles on productive inter-disciplinary teams.

If we understand the significance of full-body engaged learning as integral to the design process, the value of a student design/build project becomes clear. This is especially true for our group of approximately one hundred pre-architecture and pre-industrial design students. In this first year together, students learn shared skills and approaches to the problems and challenges of the designed, built and lived environment.

This past year, in their Spring semester, students worked collaboratively to design and build a vertical garden of eastern pine, erected on the front porch of the College of Architecture. Space and time constraints proved surprisingly fruitful, encouraging direct integration between often-disparate activities of analog and digital drawing, modeling and constructing. Material knowledge was sharpened by limited shop access that required students to learn and build with only hand woodworking tools. Student engagement was heightened as each actively participated in multiple roles beyond that of former design thinker and communicator. The students served as full-scale mappers, tool operators, material assemblers, communicative collaborators, cost estimators, master schedulers, and more.

Fig. 1. Hand woodworking tools facilitate student/ material dialogue.

This paper explores the essential learning emerging from the design/build project, and lays the strategic groundwork for employing design/build material practices most effectively in the beginning design studio.

Essential Learning

Material Dialogue

One important objective of the beginning design studio is supporting student confidence and agency. Too often this takes the form of intention, framed in the mind, then projected onto an external material world.

Emerging theories of material engagement foreground the significance of the body not just as thinker then maker, but as receptor in full-body engaged learning. Consider Lambros Malfouris's proposition. "The hand is not simply an instrument for manipulating an externally given objective world by carrying out the orders issued to it by the brain; it is instead one of the main perturbatory channels through which the world touches us, and it has a great deal to do with how this world is perceived and classified."[1] (Malfouris, 2013). Through dialogic material experiments, students build a correspondence with the material, and a sense of agency that comes from thinking in action. Conversations and posted reflections note students' categorical learning.

Fig. 2. Students use eastern white pine and chisels to think through the material in these material dialogue experiments.[2]

With the material engagement demanded of the design/build project, dialogic thinking and making take center stage. Confidence grows from students thinking *through* the material, from immersion in the cyclical activities of thinking and making and re-thinking and re-making – with each activity fueling the design feedback loop.

Social Anthropologist Tim Ingold articulates making's expanded value. "I want to think of making, ... as a process of *growth*. This is to place the maker from the outset as a participant in amongst a world of active materials. These materials are what he has to work with, and in the process of making, he 'joins forces' with them, bringing them together or splitting them apart, synthesizing and distilling, in anticipation of what might emerge. ... Far from standing aloof, imposing his designs on a world that is ready and waiting to receive them, the most he can do is to intervene in worldly processes that are already going on, and which give rise to the forms of the living world that we see all around us..."[3] (Ingold, 2013).

Through multiple means of engaging the physical world, including its material nature, students can discover a breadth of possibilities. Architect Peter Zumthor articulates the potential. "Take a stone: you can saw it, grind it, drill into it, or polish it – it will be a different thing each time. ... There are a thousand different possibilities in one material alone." [4] (Zumthor, 2006). The skill of thinking through the materials in a designer's toolkit can build students' divergent thinking experiences and expand their design agency.

Consider successes from Common First Year (CFY) students' engagement not only with construction materials, but with plant materials that would later occupy their vertical garden design/build projects. Students documented the activities of growing and tending the plants during the design process. Through these direct and engaged activities over time, multiple plant qualities were discovered that would not have been possible from theoretical research alone. The red sedum plant, for example, came to be exploited in different designs for a range of different qualities: as a contrasting color in one design's composed patterns, as a resilient dense plant, used as a pillowing surface for another. Still another project pushed the limits of its interwoven root structure to create a vertical monolithic plant surface, while others exploited its value as a low maintenance, minimum height growth groundcover.

Fig. 3. Andrew Alvarez looks closely at the Gelsemium Sempervirens during tending and growing activities that run parallel to garden design activities.

Fall semester's close-looking sketchbooks, and material studies in corrugated cardboard set the stage for Spring semester's direct material engagement.

This learning through direct engagement across the CFY coursework, tied to strategic design decision-making played a key role in Spring semester's increased student confidence and sense of agency. A student writes at semester's end "The best aspect of this course is definitely the degree of learning and improvement that we have developed over the past semester. I have found so much value in going through the entire design process through this course, which in years past and in high school courses is something that rarely ever happens - the design process is more of a theory that we learn, and not necessarily something that we put into practice in its entirety." Other student comments reiterate the value the students place on authentic learning through direct engaged thinking through making.

Situated Bodies

Fall semester studies in the CFY foreground the body as the center of the designed experience, as material in the material world.

The city and my body supplement and define each other. I dwell in the city and the city dwells in me. [5]
-Pallasmaa, 2005

This emphasis on the situated body draws relationships between the diverse scales but common interests of our students' future disciplines, architecture and industrial design. Fall semester exercises invite students to read the body through a range of scales and mark-making activities, mapping its proportions, tones, textures, mass, movements, spaces, etc. through drawings and models. Categorical knowing comes from specific engaged inquiry.

The resultant knowledge informs students' Spring semester design build work in multiple ways. First, throughout the design process, students are often found devising quick full-scale experiments. They use these to test if a reach is too high, a seat too deep, or an intimate space is too open. Students deploy the full range of representation skills developed in the Fall to strategically test in response to focused inquiries.

Also of note are the design build project ambitions in respect to the body's centrality. This is especially true given the Spring semester's emphasis on construction, and the open-ended competition brief that frames the design/build project.

In one project entitled *Urban Solitude*, students design the garden around the experience of reading David Thoreau's "Walden". The design creates a refuge, cradles the body, and frames the natural views. Another project creates an oculus for the viewer to gaze through while lying on one's back. Bent wood arms articulate the perspectival view. Interaction between two plays a central role in the design of one team's *Secret Garden*[6]. An active garden wall between two seats is designed to be opened and closed, seen, touched, smelled, and even tasted. Another project, *Homegrown*[7], takes the form of stacked modular units and recalls the farmer's experience of harvesting edible crops, displaying them for sale, and relaxing after their labors, recapturing the homegrown experience.

Fig.4. The garden postures the body to gaze vertically through an oculus in this design by Fadi Aoude, Aislinn Ayres, Alex Bandes, Alex Gillette and Maren Sonne.

Design details of each scheme respond to the body's dimensions, exploiting what can and cannot be seen, touched, heard, and tasted.

Fabrication and Construction

It is precisely where the reach of the imagination meets the friction of materials, or where the forces of ambition rub up against the rough edges of the world, that human life is lived.[8]
-Ingold, 1973

It was indeed with ambitious imaginations that the CFY team transitioned from scaled design-learning through drawn and modeled artifacts to those of full scale fabrication and construction. This was especially challenging given our large student numbers. The design shop and its power tools were not accessible to this group of approximately 100 students. Instead, the CFY studio transitioned to became a temporary construction zone using only hand woodworking tools made available during studio hours and limited bench hours after class. Literally making space for tools, workbenches, moving bodies, wood, plants and finally gardens in this hot-desk studio proved challenging at many points in the process. Success would not have been possible without a highly coordinated logistics system, and the cooperation of our committed team of faculty and students[9]. Indeed, evidence suggests that systems initially perceived as limiting, especially in regards to construction resources, proved beneficial for student collaborative learning.

Fall studio emphases on procedural learning laid the groundwork for the procedures of not only designing, but also fabrication and construction. Across both semesters, students developed effective procedures in strategically reframing problems, in testing possibilities, and in making decisions collaboratively.

During the design/build project, students could no longer work alone, but needed to build teams for this large-scale effort. Initial team making was facilitated by individual reflective skill self-assessment followed by strategic personnel interviews. Teams self-organized and developed working contracts based on understandings of the broad range of activities to be performed, and the skills each individual would bring to the group. Collaboration was key to continually monitor responsibilities and performance throughout the extended design and build process.

Could students complete the projects in time for the competition jury without 24/7 shop access and tools for all? These limitations actually proved most beneficial, as teams developed strategies for measuring time and materials throughout the project, and budgeting appropriately. Design time-management methods long-discussed were now truly activated and visible. Teams were most efficient in their preparation work as well, knowing that tool and bench time was limited. When the workbench was available, students quickly learned to arrive with boards already measured and marked, ready to cut.

While waiting for bench time, students devised ways of testing both fabrication and construction systems to ensure successful implementation in time for the competition jury.

Fig. 5. Students Michelle Bunch, Ashley Clifton, Juyeon Lee, Chandni Patel, and Abigail Smith test material assembly sequences in the College of Architecture atrium.

Two significant Fall experiences prepared students for design and construction in the Spring. The first was a simple, brief 2-hour charrette design/build project. The challenge was to design and construct a simple pressed button that transformed the experience of introducing themselves as designers. It helped all to experience first-hand some of the opportunities and challenges that might confront them in a design/build project, including strategic decision making, construction margins of error, design representation scale differences, invention beyond the formal, the precision of craft, and the value of designing for multiple audiences.

Additional preparation came from Fall exercises requiring students to analyze objects and buildings as materials, and parts systematically assembled. This gave students both a verbal and visual language later to articulate the garden design/build systems.

Some teams also deployed interesting material manipulation methods from former material experiments. These included wood bending, soaking, and burning. Students also cited the design competition[10], with awards of over $4,000 as an important inspiration to explore beyond the norm.

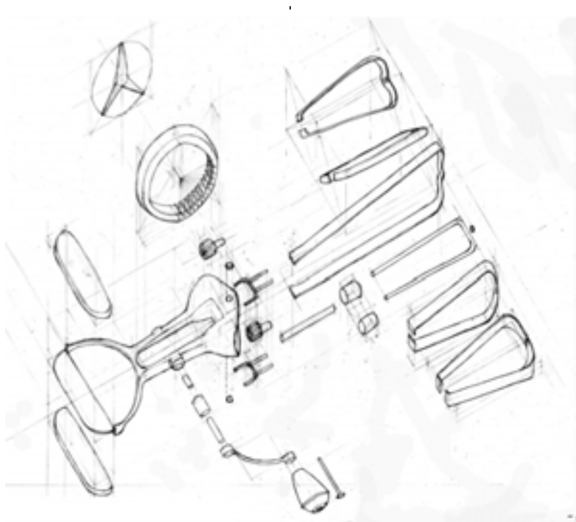


Fig 6. Kai Wen's exploded axonometric of an egg beater in the Fall semester lays the groundwork for understanding more complex objects as strategic assemblages in the Spring.

Through the process of material engagement and fabrication processes, students' interest in designs' changing nature over time was heightened. Of particular note is one team's design for a garden to overgrow onto the existing site's column, allowing the wood garden framing to gradually decay and deconstruct over time.[11]

Team Sixty Six[12] developed another example of fabrication and construction informing design ideas. They designed and built an intelligent self-supporting garden whose design focused on a system of detailed joints that allowed the garden to be easily disassembled, transported and reassembled. Their understandings of design's relationship to weight, structure and changes over time were noteworthy.

Design Representation

Before this year's design/build project, First year student design efforts had been developed and critiqued through a range of representative models and drawings. Now with the full-scale constructed project itself, students are discovering anew the multiple roles that design representations can play. Drawings and models are well deployed throughout the projects to test design ideas for oneself and others, to clarify and to expand the narrative of design ideas beyond the situated object itself.

Fig. 7. The *Urban Solitude* project[13] is powerfully rendered as a woodland refuge on this post-construction competition poster.

The Common First Year studio serves more students than can work in the room at one time. This tight space supports multiple modes of representation – digital, analog drawing and modeling, and full scale construction. Students have been maximizing the studio's spaces to activate a full range of media and genre to develop, test, build, and promote their design ideas. It was not uncommon for student groups to be pulling out their clamps and saws amidst discussions of "Where's that axon sketch?" and requests for other drawings to help to figure things out and support their decision-making. Groups moved naturally and easily between digital drawings and freehand sketches to explore options and make decisions together. Some conventional drawing genres facilitated decisions, while at times, other more inventive descriptions and tagging methods emerged as productive for the different problems being solved. This strategic innovative making, beyond the precedent, and beyond the conventional norms, has empowered a renewed sense of agency in the First Year studio.

In conclusion

It was with a truly ambitious spirit that we strategized curricular shifts necessary to make space for a design/build project in the Common First Year. The task was not small. Still, the values that we, and the students, have gained have arguably far outweighed the costs of time and effort required.

This paper has articulated key aspects of the essential learning emerging from the design/build project, and in turn, laid the groundwork for employing design/build material practices most effectively in the beginning design studio. Significant gains from the design/build project include learning regarding the power of design in dialogue with material, the central role of the material body, attention to fabrication and construction processes, and the significant role of strategic representation to both the design process and feedback loop and product.

Fig. 8. Construction activities expand on the College of Architecture porch, above. Below, The Mike Rice Design Competition first place team with their project: *Homegrown*[14]

Supplemental Lessons Learned

Additional discoveries from an initial First Year design build/project are worth noting briefly here as well. 1) Building big can attract attention. It was a benefit for First Year students to be engaged in conversations about their work with upper level students, faculty and especially alumni on a rather regular basis. 2) Solving problems together can build strong bonds. Apprehensive at first, each team grew throughout the semester to appreciate the value of working with others, and celebrating the diverse skills each brings to the team. 3) Competitions can spur innovation in multiple ways. The drive for students to win the jury's favor in their competition posters surfaced some of the strongest unique representation skills we've seen in the First Year. Videos proved as a productive addition. 4) The scope of critique in design/build projects can expand significantly. Students were less engaged in word-wars during critique sessions, but grew more interested in actually expanding the project critique criteria beyond simple form and function in the moment. For example: some teams with plants thriving after two-weeks called for modified assessment criteria that rewarded a project's performance over time, from multiple viewpoints. 5) Design/build exercises require new skills of all involved. The CFY design faculty grew to learn new skills in carpentry, team facilitation, and more. All on the team appreciated this professional development. 6) Material knowledge gained through embodied learning often does transfer. Industrial design students' sophomore chair designs after this First Year show strong evidence of increased sensitivity in material design and construction, now working with plywood and power tools.

We look forward to continued post-mortem assessments with both faculty and students to continue refining our design/build efforts to more deeply cultivate embodied design knowledge-building in the First Year.

Notes

[1] Malfouris, Lambros. *How Things Shape the Mind*. Cambridge, Massachusetts: MIT Press, 2013. p 60.

[2] Note: Students worked under the direction of Instructors Joseph Minatta and Clint Zeagler.

[3] Ingold, Tim. *Making*. New York, New York: Routledge, 2013. p 21.

[4] Zumthor, Peter. *Atmospheres*. Berlin, Germany: Birkhauser, 2006. p 25.

[5] Pallasmaa, Juhanni. *The Eyes of the Skin: Architecture and the Senses*. Hoboken, New Jersey: Wiley, 2005. 2005. p 40.

[6] *Secret Garden* was designed and constructed by Michelle Bunch, Ashley Clifton, Juyeon Lee, Chandni Patel and Abigail Smith, with support from Instructor Linda Duncan.

[7] *Homegrown* was designed and constructed by Kevin Lam, Lauren Boudreau, Hannah Goldstein, Meghan Doring, Julie Echeverri, with support from Instructor Catherine Muller.

[8] Ingold, 2013. p 73.

[9] Note: Dean Alan Balfour initiated conversations regarding these changes while Jihan Sherman, CFY Curriculum Coordinator took a lead role in strategizing logistics.

[10] Note: The *Mike Rice Design Competition* is a First Year Design Competition sponsored by Georgia Tech Alumni Ron Stang, Bill Lincicome, and Janice Wittschiebe in honor of their former classmate, Mike Rice.

[11] Note: *Wood From a Tree* Project was designed and constructed by Josh Dycus, Ryan Meiser, Zack Fisher, Sarah Kate Somers and Kendall Putmon, with support from Instructor Linda Duncan.

[12] Note: The *Team Sixty Six* design and construction team included Haley Fordham, Courtney Gruber, Taylor Kelly, Justeen Lee and Chelsea Pursley, with support from Instructor Joseph Minatta.

[13] *Urban Solitude* was designed and constructed by Chiara Ruiu, Lauren Liou, Travis Howes, Son Vu, and Anna Jenkins, with support from Instructor Andrew Ruff.

[14] *Homegrown* was designed and constructed by Kevin Lam, Lauren Boudreau, Hannah Goldstein, Meghan Doring, Julie Echeverri, with support from Instructor Catherine Muller. Project video can be viewed at http://vimeo.com/63977062

Artifacts of Non-Representation:
Inverting the Design Paradigm

Jacob A. Gines

Mississippi State University

Introduction

The objective of this paper is to challenge the role of the "artifact" in architectural education as simply a means of representing a "fixed", or "ideal" condition. Questioning such a position requires rethinking the design paradigm commonly used in studio based teaching of generating relics that are primarily representational. To do this we must remove referential representation all together.

Architectural artifacts are typically produced in design settings with the intent to provide evidence of, or a vision for, a desired future reality. In the beginning, objectives and intentions of this pursuit are clearly outlined in a project statement and the "design problem" is to solve the question(s) posed. Each participant is then uniquely situated to respond and generate artifacts that seek to solve, bring clarity, or further question the objective(s). The result is a demonstration, or representation, of a reality that is either embedded in the present or a projection of a future condition. Outcomes of this sort, are often viewed by their owners as THE SOLUTION or what may be termed as a utopian ideal.

There is strong evidence that many have been reassured and rewarded for their utopian consciousness and have thus been deemed as progressive thinkers because of their proposals for the ideal. Their defense of a perfect solution is evidenced in the words of Anatole France and Oscar Wilde.

Without Utopias of other times, men would still live in caves, miserable and naked. It was Utopians who traced the lines of the first city.... Out of generous dreams come beneficial realities. Utopia is the principle of progress, and the essay into a better future. [1]
– Anatole France

A map (of the world) that does not include Utopia is not worth glancing at, for it leaves out one country at which Humanity is always landing. And when Humanity lands there, it looks out, and seeing a better country, sets sail. Progress is the realization of Utopias. [2]
– Oscar Wilde

It is not my objective in this paper to challenge utopian thought or it's relevance in a progressive society, it is simply to question the creation of the artifacts of such a pursuit in that they are representational, and lack the ability to perform any other action.

Problems with the Utopian Object

K. Michael Hays, in his summation of Manfredo Tafuri's, "Toward a Critique of Architectural Ideology" exposes the problem of utopia, which is "to plan the disappearance of the subject, to dissolve architecture into the structure of the metropolis, wherein it turns into pure object".[3] When artifacts are constructed as objects, they are prohibited in their ability to manifest the subject of humanity and rarely exceed expectations of the "real" when they are built in their intended and habitable scale. Utopias thus become *dreams without reason*.[4]

It is the same with artifacts that are meant to be purely representational – they produce vague and blurred realities, and in their attempt to make real they become unreal and are a lie. Peter Zumthor argues that these objects of representation, and we as designers, must move beyond the symbols. "The world is full of signs and information, which stand for things that no one fully understands because they, too, turn out to be mere signs for other things. Yet the real thing remains hidden. No one ever gets to see it. Nevertheless, I am convinced that real things do exist, however endangered they may be."[5]

The Gift

Artifacts of non-representation cannot be compelled into existence or driven by ulterior motives. They are not depictions of something that already exists, nor are they projections of what is to come; yet they are real things. It is compulsory for an artifact of non-representation to only be – to exist within itself and not as a narrative to some distant vestige of reality or dreams.

Artifacts of non-representation originate from a given or gifted condition that allows for the examination of the objects and subjects simultaneously and without prejudice. Gifts, by their definition, are presented to another with no expectation or compensation on behalf of the giver or the receiver. In this way, the gift is freely given and is freely received. Because of the lack of expectation the recipient must accept the gift 'as is'. But a curious condition occurs within the recipient - the desire to re-gift. This is not a re-packaging of what was already given, for such an act would be fruitless.

World cities are much the same – while many of them have utopian beginnings or utopian futures, we accept them as gifts and inhabit them 'as is'. These dense urban centers exhibit all the heterotopian misgivings and failures of our post-industrial lives and thus provide a richly inhabited palimpsest of complexity and contradictions. Systems and networks are constructed to provide clean water and evacuate sewage while transportation corridors carve through our cities providing definition to urbanity and at the same time divide us. Cities spring up inside of cities and sprawl continually redefines boundaries and provides an altered landscape. We have been gifted this condition and now are compelled to regift.

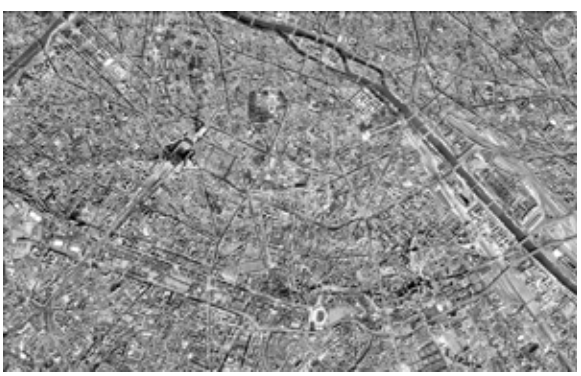


Fig. 1. City of Paris, France at 24,000 feet (image courtesy Google Earth).

Micromegas: An Inquiry Into Non-Representation

Inspired by the work of Voltaire[6] and Daniel Libeskind's[7] didactic constructions of the same name, *Micromegas* is a first year project that attempts to engage the given condition of the city and explore the creation of artifacts of non-representation. *Micromegas* is not a representation of the city or a critique of its inhabitants, but an altogether new artifact; an altogether new landscape if you will.

Fig. 2. Paris-Orly International Airport at 24,000 feet (image courtesy Google Earth).

The Search for Intelligent Inhabitation: A World Tour

On one of the planets that orbits the star named Sirius there lived a spirited young man, who I had the honor of meeting on the last voyage he made to our little ant hill. He was called Micromegas, a fitting name for anyone so great.[8]
- Voltaire

Sirius' greatness is exhibited in his intellectual superiority and his physical enormity; measuring in at 20,000 feet from head to toe. Along with his dwarf companion, Sirius visits earth to examine its surfaces and seek out the existence of intelligent life. After spending a great deal of time treading earth's oceans and walking earth's landscape, Sirius's companion is left bewildered.

But, replied the dwarf, this planet is poorly constructed. It is so irregular and has such a ridiculous shape! Everything here seems to be in chaos: you see these little rivulets, none of which run in a straight line, these pools of water that are neither round, nor square, nor oval, nor regular by any measure. To tell the truth, what really makes me think it is uninhabited is that it seems that no one of good sense would want to stay.[9]

It is not until Sirius notices a whale moving in the ocean and places it on his fingernail that he and his companion begin to realize that there is life on planet earth.

Similarly, beginning design students were asked to act as proxy for Micromegas and circumnavigate the globe at 20,000 feet above sea level employing satellite imagery software, aka Google Earth, to seek out evidence of intellectual inhabitation, while focusing on urban centers and their mega-infrastructures, the international airport. They would then produce and present their findings from their world tour for group discussion. As a result, students expressed an overwhelming sense of complexity and disorder to our world. In many instances the order that was observed was found in relatively small pockets and became difficult to reconcile when juxtaposed or situated next to natural or manmade systems.

Fig. 3. Micromegas world tour at 20,000 feet (images courtesy Google Earth).

For Steven Johnson complexity of urban environments is a given condition and must be accepted for what it is and the way it is perceived or experienced.

Complexity is a word that has frequently appeared in critical accounts of metropolitan space, but there are really two kinds of complexity fundamental to the city, two experiences with very different implications for the individuals trying to make sense of them. There is, first, the more conventional sense of complexity as sensory overload, the city stretching the human nervous system to its very extremes, and in the process teaching it a new series of reflexes – and leading the way for a complementary series of aesthetic values, which develop out like a scab around the original wound… There is also the sense of complexity as a self-organizing system. This sort of complexity lives up one level: it describes the system of the city itself, and not its experiential reception by the city dweller.[10]

Collaging

To make matters more complex students were then asked to generate collages from their collection of images, combining the aerial photography of urban centers and neighboring international airports (altering the images digitally through transparency and saturation) and arranging the images in an analog format. Students were to organize their collages using the compositional principles of balance, dissonance, repetition, and threshold, and to construct using a variety of transformative techniques – folding, compressing, expanding, eroding, separating, entwining, slicing, touching, accumulating, and binding.

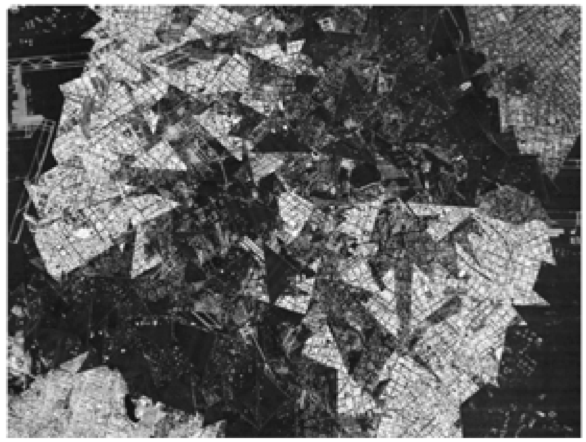


Fig. 4. Micromegas collage, Xerox on bond (Celia Garcia).

Thus beginning the process of detaching the image of the city from the creation of a new artifact that would become non-referential and non-representational to a particular place, situation, or condition. What resulted was a series of artifacts that organized themselves through the application of procedural and transformative forces.

It can be argued that the new constructions became evermore complex and provided no organizational clarity to the object of the city. This is because the representation of the city was never the primary aim; the image of the city served only as the means to achieving an entirely new artifact. However, in the end the collages still hinted toward and were in part referential of their beginnings – not yet becoming fully non-representational. Further abstraction would be required to ensure the artifacts ambiguity.

Tooling and Defining

Using mylar as an overlayment and graphite as the primary devise, tooled drawings were developed to extract the prominent, hidden, and layered geometries that existed within the given conditions of the selected collage. Initially, these drawings were constructed of only a single line

Fig. 5. Micromegas drawings, graphite and ink on mylar (Ria Bennett).

weight with the primary focus on giving spatial and geometric definition to the developing palimpsest.

Later came the establishment of primary, secondary, and tertiary ground conditions through the use of a single texture and no more than 2 values. Geometries were then elevated or submerged relative to the established ground plane through the use of line weight and a black (or nearly black) cast shadow.

The collage presented itself as another given condition and students were challenged to draw everything that was revealed through the mylar. Yet with the addition of line and value there was a conscious and/or subconscious subtraction of information that furthered efforts in seeking for the non-representational artifact. During the hours of hunched-back laboring with multiple graphite sticks and ink pens exhausted, there emerged out of the canvas a moment, or series of moments, wherein the drawing became self-referential. They were no longer drawings of something else, but unique expressions of themselves – something new and undiscovered. They weren't representations of other things, they just were what they were - no pretense, no ego, no projected narrative. To talk about them was at first difficult because they contained their own realness, a quality that is not often found. To find their meaning was perhaps escapable and unobtainable. They became real artifacts of non-representation.

Fig. 6. Micromegas collages and drawings.

Conclusion

To summarize, artifacts of non-representation are not referential of a present condition nor are they projections of a future utopian ideal. They must not be anything but themselves. They find their origins in a gifted condition and proceed to regift themselves as a new and real artifact. Ambiguity and abstraction are requisite for artifacts to realize their full non-representational existence.

It is important to note here that the *Micromegas* project continued on through the creation of a series of representational artifacts – projected cross-sections and a series of physical models in cardboard and plaster. However, these artifacts became mere vestiges of what was created on the mylar. It seems that as soon as we capture a non-representational artifact our representational selves take over and corrupt the purity of the initial inquiry, proving the difficulty of such an endeavor.

Notes

[1] Marie-Louise Berneri. *Journey Through Utopia* (New York, NY: Schocken Books, 1971).

[2] Vernon Louis Parrington, Jr. *American Dreams: A Study of American Utopias* (New York, NY: Russell & Russell Pub, 1964),viii.

[3] K. Michael Hays. "Toward a Critique of Architectural Ideology." in *Architecture Theory Since 1968,* edited by K. Michael Hays (Cambridge, MA: MIT Press, 2000), 2-5.

[4] Constanantinos A. Doxiadis. *Between Dystopia and Utopia* (Hartford, CT: The Trinity College Press, 1966), 49.

[5] Peter Zumthor. *Thinking Architecture* (Basel: Birkhäuser, 2010), 16.

[6] Francois Voltaire. *Micromegas and Other Short Fictions*. Translated by Theo Cuffe. (New York, NY: Penguin Putnam, 2002). Original work published in 1752.

[7] Daniel Libeskind. *Micromegas: The Architecture of End Space* (drawings). Accessed at http://daniel-libeskind.com/projects/micromegas/images.

[8] Francois Voltaire. *Micromegas and Other Short Fictions*. Translated by Theo Cuffe. (New York, NY: Penguin Putnam, 2002). Original work published in 1752.

[9] Ibid.

[10] Steven Johnson. "Emergence." in *Theories and Manifestoes of Contemporary Architecture*, edited by Charles Jencks and Karl Kropf (Chichester, West Sussex: Wiley-Academy, 1997), 343.

Constructing the Construction Sequence

Mari Michael Glassell + Peter S. Raab

Texas Tech University, Lubbock Texas

Abstract

Two aspects of modern architectural education are causing ripples within the architectural practice. First; the rapid move into the digital era has left many a graduate lacking any carnal knowledge of the real materials that impact architectural practice. Second; the construction sequence within architectural schools has primarily been taught by engineers, providing an "engineering-lite" for future architects – one that neither affords them the knowledge of the engineer, nor the needed understanding of how architecture and engineering can work collaboratively in practice. With the advent of modern architectural practice, the link between conceptual design and structural design has broadened from simple delineation of building designs to more multi-faceted approaches, blurring the lines between design, fabrication and construction. The developing construction sequence at Texas Tech University aims to place more emphasis on the construction sequence through a more substantial parallel to design studios, providing students with more applicable material knowledge, scalar design intent, project-centric iteration, and continual dialogue about the potential the architect has within the design of construction.

Changing Trajectory

At its inception in 1927, architectural education at Texas Tech University was taught within the College of Engineering. The first Bachelor degree was offered in 1933, followed in 1957 with NAAB accreditation. While a formal separation of the College of Architecture from the College of Engineering occurred some 80 years ago, infrastructural overlap and lingering influences accompanied the transition. The shift from a focus on engineering to design, from pure structure to architecture, happened slowly. As recently as 2004, a degree in architecture at Texas Tech University still required students to take their construction courses within the College of Engineering, which were primarily taught by engineers. Then, in 2004, the College of Architecture developed its own specialized Architectural Construction sequence geared to architecture students during their second and third year of undergraduate education.

With such a substantial curricular shift, there were many aspects that demanded attention. During the first few years, the construction courses relied on a traditional lecturing approach that focused on mathematical problem solving via one-directional discourse. The lack of interaction, such as that which design students receive in studio settings, rendered application intangible. In the past two years, efforts have been made through cross-coordination to align the construction courses with the design studio sequence as a way to specify the role of the architect within construction. This shift has tried to substantiate a methodology for intertwining structural thinking with project-based empirical testing to force students to synthesize lessons in construction through work in design studios and visa versa. By utilizing similar methodology to design studios (specifically a hands-on project-centric approach and iterative process), the shift from engineering is intended to teach the architecture student how to critically question the design of structural systems conceptually, rather than merely through structural analysis.

Much has been written about the need to integrate structures with design studios. Ali İhsan Ünay and Cengiz Özmen, in their essay from 2006, considered building structure education as an integral part of architectural design education, since without integration "the acquisition of knowledge is isolated and temporary."[1] Regarding structural design, architects should "possess...a combination of intuition and theoretical knowledge."[2] Without practiced application of how structural design works, how can these students begin to intuit connections between architecture and engineering? By shifting the narrative from the construction course as an isolated event within the required curriculum, to one with coursework integrated within the larger studio program, the beginning design student constructs cross-dialogues between the fields, allowing them access to more innovative and comprehensive projects.

While acknowledging that conventional systems, materiality, and mathematics are still an essential part of learning how to construct buildings, the aim over the last two years has been to implement an evidenced-based approach to construction education that reintegrates principles of structural systems with conceptual design. As Schön states, "students learn not by assimilation but by trial-and-error practice...a reflective conversation with the materials of the situation."[3]

The three courses taught to second and third year design students attempt to present material investigation iteratively, paralleling the actual construction design process. As each material is discussed throughout the sequence, the scalar complexity at which the student visualizes and understands the material's qualitative and quantitative role in structural design progresses: Construction I acts as the broad stroke of assessing materiality through general assembly, Construction II introduces statics through systems of assembly, and Construction III addresses connection thru envelope assembly.

Changing Language: Analogue to Social Media

The intent of reconstructing the construction sequence at Texas Tech University is to not only employ project-centric, hands-on methodology, but to also innovate ways in which this pedagogy engages the student in a lecture course setting. While each of the three Construction Courses within the new sequence offer different levels of sophistication of iteration and synthesis of concept and construction, all three employ two similar tools intended to parallel the dialogue, collaboration, and open critique found in studios: the feedback loop and the sketchbook.

Large lecture courses, especially those that deal with more technical information, make it difficult to create the level of dialogue found in design studios; the feedback loop employed by most project-centric learning is hard to manage with ten dozen students simultaneously. Digital technologies and social media, however, have presented opportunities to bridge this gap in a very real way. By utilizing social media platforms, such as Instagram, both students and professor can monitor the iterative process of design, much like one would do in a studio setting. Instagram hash tags also facilitate a digital discussion between the whole class; providing a platform for students to comment on each other's work, like posts, and create social loops of dialogue. This medium is utilized during each project, with required comments, likes, and images posted on a daily basis – forcing students to self-edit, peer review, and openly discuss a variety of solutions being resolved in one project prompt. Additionally, the use of wiki web applications within all three courses provides open-edit communication and information sharing for student reference and review. #Collaboration.

The analogue sketchbook, evaluated weekly, demands students keep an active log of both technical and conceptual means of representing, understanding, and synthesizing the constructed world around them. Each assignment varies in the orthographic nature of construction representation and employs the use of small parti diagrams, vignettes, sketches, and technical drawings to promote variety in the ways students see the built environment. Focusing on more haptic recording processes also eases the transition into the tactile nature of physical craft within the education of construction. As an on-going assignment, the sketchbook acts as a reinforcement of ideas, a generator of individual understanding, and a record of the potential the architect has in designing at the scale of construction.

Construction I: Iterating Materials + Methods

Taught in tandem to second year design studio, the role of the Construction I course within the new trajectory is to allow the "poche" to be more thoroughly investigated in terms of materially, assembly, and connection. As students are just beginning to address the process of design in studio, the challenge of this course is to layer a more innovative dialogue about materiality, or more specifically, the role conceptual design has in construction – not merely space, form, and program. What's in the poche?

As Victoria Ballard Bell suggests in the introduction of her book, Materials for Design: "Materials are often chosen at the end of the design process or even during generation of construction documents for a building design, as if they are a mere afterthought, a color of paint applied to the building after the design has been formulated. Whether in the classroom or in practice, to consider design without regard to material can only result in a less successful building project." [4]

To initiate a more architectural-centric discussion, the course pedagogy establishes a reflexive conversation between Tectonics and Stereotomics to prompt larger questions about the role of each material and its ability to structurally assemble. By outlining this larger course objective through six major materials (wood, masonry, glass, concrete, steel, metals/plastics), students are taught to see how each material can be applied both stereotomically and tectonically promoting critical reasoning in their design decisions. While students may associate the aggregate knowledge of each material with the poche of their current studio projects, the course layers its own project-centric methods to continually reinforce ideas of construction and design in a holistic manner. Tested through five projects, materials discussed in class are charged with positing scalar change, iteration, critical thinking, and design intent rather than strictly demonstrative assemblages.

Project Sequence / Exploration and Application

Each of the five projects within Construction I oscillate between the theories of tectonics or stereotomics, terminating in a single project that demands both. The parameters of each project require documentation of intent, development, and execution -- or conceptual goals, iterative making, and structural integrity -- through the use of Instagram, hand-drawing, or sketching. The integration and reinforcement of construction principles thus not only happens within the lecture course, but through a re-alignment of curriculum – aligning iteration, intent, and execution taught within the studio setting to be happening simultaneously in the lecture course, and visa versa. The challenge of this approach is to integrate more material testing within the studio course, and the success has come with the implementation of conceptual rigor, variety of recording, and a feedback loop in both. Students begin to see how design can be valued at the scale of a wood joint just as critically as the scale of a fully constructed building.

Project One thru Four: Iterative Aggregation

As students are just beginning the discussion of material force, *Project 01_Bridge* challenges students to work in groups, over forty-eight hours, to design a bridge made of drinking straws and straight pins. The aim of this project is to force quick design decisions through rapid iteration using materials not conventional to architectural construction, yet yielding to tension and compression under strain (a single brick). During the "live testing" students are allowed to present their design goals and see immediate evidence of their own design intent versus structural success. Each bridge is pushed to fail by adding more bricks to indicate areas of strengths and weakness, both in terms of structural failing as well as areas of superfluous design.

Project 02_Pack is presented during the introduction of wood construction and aims to teach students the haptic nature of standardized lumber as a stereotomic material. Charged with carrying a "Pet 2x4" for seven days, students are to test the 2x4 and record their findings directly on the lumber – using the material itself as evidence of its potential. Students are asked to learn every aspect of the 2x4 in terms of the technical (weight, actual size, density, grade), the practical (What can it hold? What does it absorb or repel? How hard is it to split? To bolt?), and the conceptual (How does iterative testing change the quality of the material? Does it still retain structural integrity?). Via Instagram, students then document these tests as they happen (ten images a day), creating a seven-day discussion between one hundred students and one professor. The iterative testing, which is then evident on the actual 2x4, is displayed during grading for all students to compare and contrast the effects of various investigations.

For iteration purposes, the Pet 2x4 is put to use again in *Project 03_Join*, which asks students to design, construct, and execute two hand-made wood joints expressing two different types of connection – kinetic and static. With only one week to execute, this project is intended to build on the testing and understanding of a standard 2x4 from *Project 02* as well as forces displayed in *Project 01*. *Project 03* thus acts as the first moment of aggregation and iteration pursuing the ideas of materiality in terms of tectonic connection and iterative material use. What else can wood do in construction?

Moving into a more stereotomic procedure, *Project 04_Cast*, takes advantage of the students' newfound grasp of tactility in construction. In teams of two, students cast found objects in a 2' x 3' x 3" concrete panel to understand both the formal and structural values of the material thru its interaction with an unconventional, external material. By aggregating materials discussed during the lecture with student- sourced materials, design intent, potential, and exploration become more tangible. Stereotomically, the found object acts as a carving agent within an orthogonal concrete form, allowing the concrete itself to exhibit its qualitative nature through molding, and its compressional nature through breakage, dryness, and formwork failings.

Project Five: Diagrammatic Assembly

Construction I terminates with a project called *Diagrammatic Assemblies*. As students have, at this point in the course, been exposed to all six materials via project and/or lecture, this project shifts the question to the potential of materials in terms of operation: foundation, insulation, waterproofing, structure, skin, and finish. *Project 05* posits that if all materials can perform tectonically and stereotomically, then they can all operate within a structural assembly in a myriad of ways. Rather than limiting the students to prescribed materials, the project limits the number of operational layers in the proposed diagrammatic structural system. Thus, the Diagrammatic Assembly is not intended to be representational of a wall or roof assembly, but rather stand as a 48” x 16” x 12” independent object; investigating materials in terms of how they can perform in limitless executions – both qualitatively and quantitatively.

It is intentional that no distinctions within the prompt define the assembly as “wall” or “roof” or even “horizontal” or “vertical”; rather it is the student’s responsibility to synthesis ideas of “assembly” learned throughout the course within a developed and intentional agenda. The project does require that a portion of the assembly be stereotomic, a portion be tectonic, and a clear connection of the two be shown [Fig. 1]. The materials used, either those discussed during the course or those recycled/found by students, are then intended to demonstrate the individual student’s knowledge, and hopeful innovation, of materiality and how to assemble materials within construction.

All fifty diagrammatic assemblies, done over three weeks, are exhibited during studio reviews. The critical mass of projects collectively evidence a wide range of understanding and exploration substantiated through the diversity of materials chosen, the various combinations of operations, the strength of conceptual articulation, and the physical craft of the final products. As a final aggregate to iterative material methodology, *Project 05* illustrates how the Construction I course prepares students for both Construction II, and perhaps more immediately, their sequential studios via physical dialogue about materiality and the role conceptual design has in construction.

Fig. 1 FA 2013 Project 05_Diagrammatic Assembly / Jonah Hubbard, Nathan Havens / Detail and Overall

Construction II: Statics and Systems

The second course in the sequence builds upon the iterative process developed in Construction I, while introducing a mathematical basis for structural analysis. Still utilizing a project-centric approach, statics, preliminary member analysis, and system design are incorporated into dialogue between Construction II and the third year “structural” studio. During this studio, students are asked to implement a long-span structural system within the semester-long design project. While the construction course lecture focuses on the mechanics of structure through the lens of equilibrium, using mathematical basis to achieve this understanding, these complex concepts are additionally reinforced through demonstrative physical constructs to illustrate the forces present.

Each of the three projects within Construction II, through tangible application, builds sequentially on the principles introduced in lecture. The making of models that physically and visually exhibit forces at play within the various structural systems allow for the student to examine, test, and prove the very same concepts that are being worked out mathematically. By creating physical models, the investigation and iterative process can begin to inform a practical innovation for their own designs.

Project One: Systems

The first project is a team exploration. Groups of two construct small models to test structural principles of tension, compression, bending, deflection, torsion and rudimentary connection design. Each of the models, measuring 8” x 8” x 24”, must exemplify and embody the principles in a variety of trussed shapes, simple and cantilever beam systems, laminated and stacked spanning elements, triangulation, and tetrahedron modules. One student in the group tests, deforms, and sometimes fails the system, while the others measure and document results. Through these empirical model-based experiments, the students test materials, spans, and connections, and thus internalize an understanding of equilibrium and material strength. These physical iterations give the students an intuitive sense of action and reaction of internal and external forces upon a system.

The success of the project is less about making a beautiful component and more about whether or not the group can demonstrate a measureable response to graduated loading of their specific system. Each iteration is documented and posted to Instagram, while the final project submission includes specific mathematical proofs such as those covered in lecture, and is presented orally within their lab session and digitally to the class Wiki. The multi-faceted feedback loop of Instagram, the Wiki, and oral presentation initiates and frames the discussions regarding structural systems that concurrently happen within the design studio.

Project Two: Long Span Precedent Study

This intermediate project is a shared endeavor between the construction course and studio. Several exemplary architectural precedents employing a long-span structural system are chosen within the studio and studied in detail. Students execute detail drawings describing connection details, as well as structural bay models that are used to test the responses to loads. The systems analysis from the first project is now applied to actual architectural design. Real materials are often employed in the models as a way to test material performances such as tensional balance within a cable-stayed system, or the compressive resilience of the column. Successful projects exhibit forces and show understanding of how gravity and lateral loads are mitigated through structural design. The precedents chosen also emphasize a high-level of integration between architect and engineer, not only to utilize long span, but to also create a transcendent occupiable space below.

Alongside the physical analysis, drawings, developed in studio and critiqued in construction lab, are constructed to replicate the fabrication process. Utilizing this cross-course collaboration, the project will act as a transition from the site and program analysis happening within studio, to the final project building design. Construction lectures during this project reinforce principles of connection and equilibrium, while labs assist load-tracing and structural analysis of each project. Therefore the lecture course provides the designer base knowledge of structural assemblies while the coordination reinforces how instrumental structure is to the design of architectural space.

Project Three: Synthesis

Of paramount importance to any architectural student's learning is the ability to synthesize knowledge from various sources into one product. Through a series of discussions within the construction labs, each student begins to develop their structural models in tandem with their studio projects. Within the studio, the long-span (50 feet or greater) must be accomplished through a singular structural system. Many of the proposals are influenced by the material and long-span investigations of Project Two, but the actual synthesis of these systems, as they embody and influence their own designs, is critical to the success of this final project. Choosing the right system, and then adapting it to substantiate the student's integration of site and program (such as a theater, a boathouse, or library - sample programs from last year) raises critical issues of span, depth, materiality, and space.

While the examination of long span structures and integration of these concepts into studio is a driving factor of the curriculum, the multi-scalar approach to design iteration and structural implementation is available to all students in the course. Students not enrolled in a design studio simultaneously to Construction II are given the option to synthesize through full-scale iterative design. This option allows the student to build upon past studios by utilizing a similar design process, but widens the focus of the project to that of material connection and structural capacity. The synthesis options have been incorporated for full-scale investigation; either at the scale of a chair, or at the scale of habitation [Fig. 2]. Apparent in these projects is the crucial involvement of the labs as a testing ground for the student's concepts. The majority of these full-scale synthesis projects rely heavily on the shop services available within the architecture school. Extra time is incorporated to familiarize students with the wood, metal, and digital fabrication shops, which include a CNC machine and laser cutters. These tools make available to students rapid-prototyping processes to further their designs through iteration, and incorporate these machines in their final, full-scale fabrication.

Fig. 2 FA 2013 Synthesis / Sergio Elizondo, Fabiola Vazquez, Luis Murillo, Jacob Prado

In all of the synthesis projects, the act of building models, which test structural connections, materials, and assemblies, occurs in multiple iterations. These iterations are shared constantly through the class wiki page and presented during the lab sessions and lessons reinforced during studio and within lecture. Using these physical constructions to invigorate studio discussion and the empirical application of structural principle literally manifests integration between the construction and studio courses.

Construction III: Connections and Envelopes

The last course within the construction sequence parallels the final sixteen-week undergraduate studio. The focus of the studio is envelope design. The construction course delves further into member sizing, connections, and lateral resistive systems, before concluding with a coordinated envelope study of the student's studio project.

Project 01: Envelopes

Envelopes is set within the construction class and designed as a thorough investigation of architectural envelopes. Categorized by various building skin materials, each group investigates the systems from outside-in. Beginning with a series of mock-ups, materials are researched from the scale of chemical properties, to the unit, to the component, and then finally how the envelope is connected back to the structure. These investigations are followed closely using social media – Instagram and class Wiki – to create feedback loops on the initial studies through the completion of this project.

These projects culminate with an exhibition of a large-scale envelope model and accompanying drawings and process explorations, on display within the school's gallery four weeks prior to the end of the semester. Not only does this display energize and educate the greater student body, but it also provides a shared index of salient examples for the studio professors and students to enhance the discussion of technical information within the design studio. In addition, formal class presentations further discussion and understanding of these forty-five different envelopes – any of which can be applied into the studio projects under current development.

Project 02: Application

The final project has an abbreviated timeframe, yet offers an opportunity to for each student to apply knowledge gained from the envelope project directly into the studio project. Building on this tangible construction and material knowledge, studio projects are brought into the construction lab to develop connection details, wall sections and physical mock-ups of the design. The final design is a hybrid of their design intentions from their studio and the technical knowledge from their construction sequence is presented through drawn documents and physical models. While these documents are graded within the construction class, they are also utilized as part of the final studio review. This integration between construction courses and design studio intertwines and reinforces the connection between structural development and the design process and hones skills of collaboration for the future.

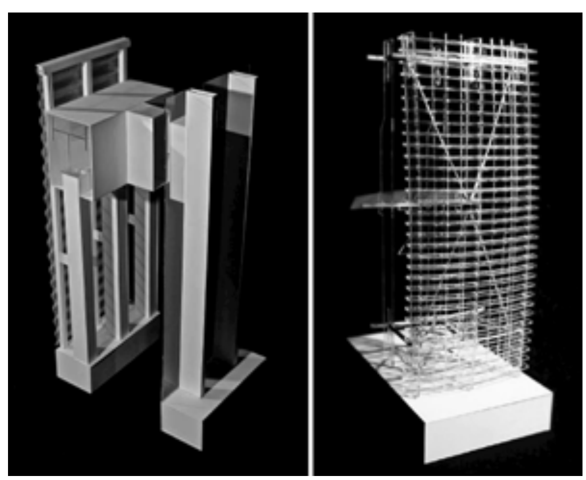


Fig. 3. SP 2013 Envelope / Marc Anderson, Shane Daves, Kyle Norton, Steven Collard

Constructing the Construction Sequence

The development of this construction sequence is only two years young at Texas Tech University, and there are probably as many failures as successes occurring during this transition. One of the most rewarding aspects of the construction course is the application and realization of the student's structural knowledge as it impacts his/her studio project, yet there is a danger of the professor-led studio coursework staying too shallow for structural innovation to happen at these early levels. Striking a balance between a site and program investigation that is level appropriate while also providing enough complexity to spark structural innovation is an ongoing challenge that requires a willingness to coordinate across all faculty. Coordination is key to the success of this integrated model, and without thorough participation from all studio faculty, the construction professors, and the students, this model has the potential for an unbalanced execution across studios. However, even with this initial implementation already there is evidence of the strength of curriculum realignment as some students begin to exhibit greater internalization of structural understanding.

As we have learned from practice, the reinforcement of concepts throughout the curriculum is an effective way to establish a lasting effect on the student. Conversation, iteration, and physical craft are the methods this new trajectory has focused on strengthening in hopes for establishing a more holistic approach to the construction education for the architecture student. It is important to grab these design students during their formative years to ensure that we instill a lasting appreciation of the intertwining of structural and material thinking with studio practice. We will continue to develop and refine these courses for the beginning design student in the hopes of educating a new breed of investigative and knowledgeable architects of the future.

Notes

1 Ünay, Ali İhsan and Cengiz Özmen. "Building Structure Design as an Integral Part of Architecture: A Teaching Model for Students of Architecture" " in *International Journal of Technology and Design Education*. Sep 2006, Volume 16, Issue 3. p 259.

2 Ibid, p 264.

3 Schön, D.A. "Toward a Marriage of Artistry and Applied Science in the Architectural Design Studio." Journal of Architectural Education, Vol. 41.4 (1988) 4-10. JSTOR. Web. 10 July 2013.

4 Bell, Victoria Ballard. "Introduction" " in Materials for Design Princeton Architectural Press: New York, NY. 2006. p 9.

Good Liars

Matthew Hall

Auburn University College of Architecture, Design and Construction

Polemic:

It could be argued that the ability to construct a conceptually and physically honest architecture is no longer possible. Due to modernist failures and postmodern global realities the profession creates architecture with skins upon layers with mysterious innards and in the academy architectural models are often volumetric and plastic abstractions of formal infatuation. Students construct relationships with sticks and planes of flat pressed paper and wood products and call their buildings "concrete," while in practice concrete is rarely even exposed. This default to a plastic material, or the desire to conceal it, results in both an excessive freedom to formalize and an ignorance of the measure and mark of material and process. Infatuation with space seems to only go skin deep into the elements that define it. Surface becomes hierarchical for immediate satisfaction in a demanding and impatient world.

Preposterous formal pursuits result in compositions that fail to balance the imaginatively abstract with the obvious givens. Panels of this or that signify, yet nothing truly is. As a provocation I suggest that the worth of architectural material choices as conceptual drivers (and their inherent properties, measure, and sensibilities) are steadily declining and are more resultant of formal desires rather than instigators. Such being the case, values still persist regarding material honesty and structural expression in design schools that are sadly antithetical to the standard methods of current construction. We may be past the time where the honest and integral are valued, but that does not mean that the relationship between material essence and substance, and a potential for meaningful expression is a lost cause. It seems that in the wake of the dismal prospect of ever again producing a clear an honest architecture, we have accomplished the opposite, which invests wholeheartedly in form and spectacle. If architecture is now a lie, have we resorted to training students to lie well? This polemic proposes that we have indeed, and have done so without their permission based on an assumption that there is no other way. This paper, and the project that propagated it, suggest that perhaps there is a somewhat obvious yet overlooked strategy that begins with a dialog rather than a drawing or model.

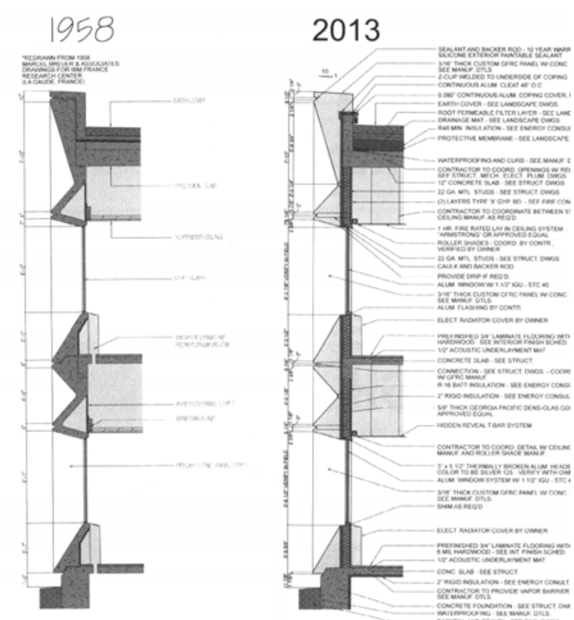


Fig. 1. An "honest" building reimagined with today's standards for detailing and thermal performance. Kyle May, *Breuer Turns 55*. 2013. From: Clog, Brutalism, Clog. New York, 2013

Fig. 2. Architectural "makeup" fading at the end of the party . Peter Eisenman, Aronoff Center For Design and Art façade repairs, Cincinnati, Ohio. Photo/Collage, M. Hall, 2012

I propose that we can critically excavate a dialog on materials that neither carries the baggage of modernist dogma, nor surrender to the status quo. This discussion is only possible if students are persuaded to formulate unique attitudes towards material value with a potential to establish them as equal drivers amongst many for design endeavors. Whether form is dictated by material, or is later influenced by it is not the debate. The dilemma is how to at the least establish the essence and substance of material as something of value worth considering with deliberate and precise action. The subject of this brief paper is to offer a starting point for such a dialog in the foundation materials and methods curriculum by encouraging young students to craft logical positions on material value. I seek to articulate this argument by interpreting material concerns as equally conceptual and substantial while being products of individual and ever-changing value systems. While I open with my own polemic, I do so not to be didactic, but more incendiary in the hopes to spark students to reciprocate with their own fiery agenda.

Mutually Defining: Essence and Substance

The term material relates to having existence and substance. Originating in the Romans' Latin translation of the Greek term *hyle*, the word *materia* was the result of the struggle to find a term opposite to the word form, or *morphe,* in Greek[1]. This inherent separation between material and form is deliberate, allowing a meaningful relationship where the material "inhabits" the form, or takes the unimaginable ideal archetype and "fills" it to provide a comprehensible reality. In this sense, the conceptual and substantive worlds are related and mutually defining. This relationship between the conceptual essence and the objective substance is potentially powerful if the filling is conceptualized as a driver for the filled; as if the fluid provides shape for the container based on its properties rather than the other way around.

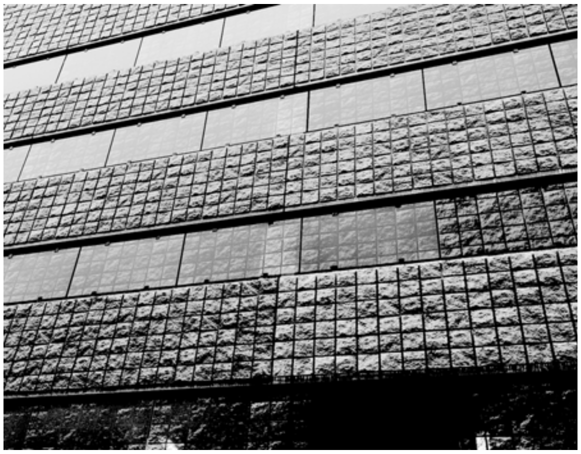


Fig. 3. Screen-printed stone texture on glass juxtaposing falsity against clarity. Wiel Arets, Hoge Heren Housing, Rotterdam Netherlands 2001. Photo: M. Hall 2006

The essence of material can be thought of as its true nature or what is essential to it. This suggests that there is something inherent within each material that is set free upon combination with others in order to serve both the pragmatic and conceptual desires for the design at hand. This suggests that essence is more than merely quantitative properties, but if one considers values, the notion of a material's essence and what is proper to it becomes highly subjective and intangible. The substantive can be interpreted as the point when materials become tangible and combine to shape forms. The substantive could be considered an operative version of essence. If one is going to build, they have no choice but to deal with substance. It is simply a matter of to what degree substance is driven by which is essential, meaning the tightness of the connection between the two yielding an integral whole, or "honest" expression. Polarized as a general argument, we can see two camps: the honest, clear, and tangible vs. the fake, mysterious, and intangible (not to exclude everything in between and complex hybrids.)

This codependency of the terms material and form suggests a precise balance between them, yet material cogitation recurrently takes a backseat to form. Therein lies heartache for the students' ability to make informed decisions, as they are often left to shape space with abstract volumes and planes to be developed later by forcing material into them as filling or applying them as surface. In some situations application may align perfectly with conceptual goals, but it could be argued that an additive or referential notion of material is all they can be expected to accomplish. Given that representation is the aim and result of their work, they are essentially creating symbols as a means to an end where material becomes a texture and the deployment of that texture is an additive operation. If this were intentional like Arets' facade strategy for the Hoge Heren (Fig.3) It would be a different case, but it is more often due to lack of a clear attitude towards the nature of material expression. These problems are exacerbated by computer software, allowing them to "paint by number" in order to render material quality.

The ultimate pedagogical goal was to bring this dialog to the forefront of foundation materials and methods courses paired with exercises in studio that align attitudes regarding the essence of material with the substantive deployment of them in support of design concepts. This would allow a more critical approach to representation where the tectonics of a model or measure of a material have greater basis in reality. Before such could be achieved, it needed the definitive articulation as a valued agenda.

Values: Crafting an Agenda

A specific set of values in regards to design cannot be forced, but rather thoughtfully cultivated so that students can develop their own individual positions. The concept of a value or belief system is a central question for all designers. If we know what we believe, and it can be clearly articulated, there is perhaps a concept of right and wrong in architecture and a position towards appropriateness of not only materials and methods but also form and its instigators. After all, most every designer has tendencies. The real question is where do they originate and how are they refined? I propose that they come from a balance of individual and cultural/experiential notions of value, and teasing this out would bring greater attention to the true intent behind a young designer's moves giving the critic a basis for both understanding and advising.

Second year Materials and Methods students at Auburn University School or Architecture were tasked with crafting an argument in the form of a manifesto. The manifesto format was chosen to encourage polemical statement on making and material to be articulated with purpose and conviction. A discussion topic regarding the conflict between honesty and lies was introduced, but a direct attitude towards material was left open. The goal was not to indoctrinate based on set views, but to provide a vehicle for them to express their own. As educators we often ask students to develop an agenda in regards to space and form in design projects, but what about pure material value arguments? This assignment, couched within a discussion of history and precedent, was an opportunity for students to express an agenda as a series of operative statements. Manifestos vary in terms of the strength of their declarations, but what they have in common is a tone of action.

There is a desire within our curriculum to better relate issues of materiality to projects in the design studio, and emboldened students with fiery manifestos had the potential to enliven the dialog. Second year studio is too early a context for the application of specific technical knowledge of materials and methods, but perhaps not early enough for material ideas to play a greater part in design concepts. If students are pressured to take a position about the essence of what it is they will be shaping, then there is the possibility they will take more time to investigate the consequences of material choice on formal expression and potentially base concepts on material ideas.

Fig. 4. Aesthetics and Consequences, Savannah Branum, Brian Schlosser, ARCH 4320, 2013

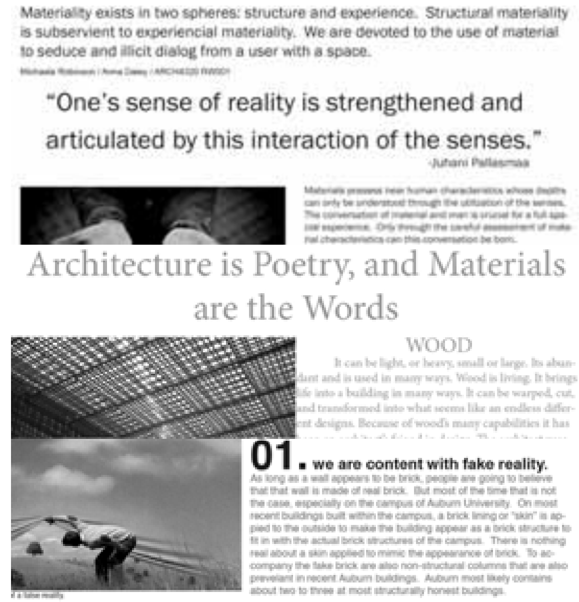


Fig. 5. Senses and Poetics, Manifesto excerpts, Michaela Robinson, Anna Daley, Austin Haikes. ARCH 4320, 2013

My findings from this assignment were that most students harbored a sentimental attachment to some idea of the authentic but refused to personify architecture in a way that equated human honesty to the integrity of inanimate material. Albeit anecdotal, it was intriguing to see the number of references to specific positions It is remarkable that instances valuing dishonesty and spectacle numbered far less than arguments for the authentic. Notions of workmanship, necessity, and function were also rarely mentioned compared to other issues.

Fig. 6. Meaning and Service, Manifesto excerpts, Ben Malaier, Asa Porter, ARCH 4320, 2013

An overwhelming number of manifestos dealt with a valuation of material based on appropriateness to client, site, and other contextual drivers. The only burning issue to score anywhere near as high were arguments for simply making things beautiful, be it in the eyes of the creator or for the constituency it serves. Upon presenting the drafts we found that aesthetics were too shallow a goal, and the didactic black and white generalization of an honest or dishonest expression was an oversimplification. These students imagined a much more complex world in an infinite grey area. Integrity, or excessive clarity, was too simplistic. A problematic world demanded a challenging architecture that was more dialogic than discursive. Ultimately, it was completely acceptable for architecture to lie, but it had to lie well (or at least subtly.) A good lie is a mystery yet to be uncovered, and a brutal truth was just that- a one-liner that can be respected but rarely admired. While they sought evidence for their forms in material logic, there was a line in the sand as to how far they intended to take it.

Fig. 7. Critical Polemics, Manifesto excerpts, Kevin Bryant, Jordan Wood, ARCH 4320, 2013

Persist or Evolve?

Attitudes towards material or procedural truth in architecture persist as a steadfast dialog in the academy. It is often the genesis for design critique in efforts to suggest simplification or teach fundamental lessons. A clear composition based on a set of rules is always easier to critique, and it is no surprise that countless initial design projects for incoming freshman are just that. It begs the query of what rules the compositions are based on, and that perhaps the module of a material could be just as good as any other proportional system. On the other hand, one may propose that we evolve our dialog with the student from expressing and registering truth to simply becoming a good liar. If authentic architecture is a dying breed, perhaps architects are relegated to building theater sets. Even if truth were in fashion, which truth would we articulate? Can meaning be had even when honesty cannot? If we cannot express or even discern truth, are we left only to play with the nonsense? I argue that it all comes down to a statement of value, and if one decides to let material be resultant rather than compelling, methods must be established to ease the transition from the abstract to a suggestive reality regardless of whether it is clear or mysterious.

We refuse to recognize problems of form, but only problems of building. Form is not the aim of our work, but only the result.[2]

There was a time when Mies' words not only meant something but also often became something. Building was much simpler back then, with sustainability being a non-issue and a unified ethic for how the methods and means of architecture should be expressed. While there still may be a sentiment (though not as extreme as Mies suggests) towards the "clear and understandable," one cannot build that way anymore, and values regarding such issues vary wildly. While I do not suggest a return to past ways or an irrational loyalty to outdated notions of purity, it seems reasonable to confront students with issues of material value to determine where exactly they stand.

Even though attitudes evolve quickly in the mind of a young design student, a clear articulation of values will assist in the development of tactics placing material essence and substance into a dialog with formal and spatial arguments. While a manifesto may perhaps result in didactic statements of opinion, to have an opinion is better than to have nothing. Young designers have their entire career to struggle with a balance of their subjective self with an equally subjective world. I fully expect that a student's values regarding material use (or misuse) may very well evolve, flip, or be subverted with each project. In a process of searching for legitimacy for one's process and work, the struggle must begin immediately if one truly values a material basis for form.

Notes

[1] Vilem Flusser, "About the Word Design" *The Shape of Things* (London: Reaktion Books Ltd. 1999)

[2]Mies van der Rohe *G: Materials for Elemental Form-Creation*, No. 2, 1923

Avoiding Seamlessness

Sallie Hambright-Belue

Clemson University

Introduction

All architects must have an understanding of program – it is one of the necessities of building. Presented here is the work of one beginning graduate architecture studio at the Georgia Institute of Technology which was developed and implemented by the author. The studio focused on understanding program through material mixing investigations. Greg Lynn's theoretical framework presented in *The Folded, the Pliant and the Supple* was used as the basis for the design process:

Neither the reactionary call for unity nor the avant-garde dismantling of it through the identification of internal contradiction seems adequate as a model for contemporary architecture and urbanism. Instead, an alternative smoothness is being formulated that may escape these dialectically opposed strategies.[1]

The students used the process of mapping/diagramming/drawing/modeling to investigate material, program, and site as separate entities in order to understand each. Only then did the students begin to combine them. This fusion of material, form, fabrication, and understanding was the project objective: combining disparate elements to make a new thing. The project highlighted the struggles which arise in architecture from trying to reconcile differing requirements like program, function, material, and site. The objective was to teach that designing "does not eradicate differences but incorporates full intensities through fluid tactics of mixing and blending."[2] The studio was not about seamlessness in architecture but about the seams.

Problem Statement

Architecture for most embodies the creation of something more than functional space, the proper function of structural systems and environmental systems, the proper placement of a building on a particular site, and the adherence to zoning and code requirements. In a semester that is focused upon one of the more mundane requirements of architecture, the functional distribution of program in a building, this studio project attempted to re-think and propose an alternative way of teaching program.

Why Mixing?

Mixing various materials offers limitless possibilities. It is also inherently different from programming. Programming is clean, organized, precise, and orderly. Mixing is messy, imprecise, and physical. Re-thinking program through material mixing is not a seemingly natural fit; but seamlessness was not the ambition. The studio attempted to teach program with a hands on approach placing making at the core of the process.

The Project Proposal

Proposed Program

The studio used a juvenile courthouse as the focus for the project for three reasons. First, the courthouse is mid-sized and a complicated organization of different uses and circulation patterns. The building brings three user groups together and is very specific in terms of space requirements. The program required separate and shared spaces which allowed the students to use all aspects of their mixing studies. Courthouses are often times exercises in space planning, and the goal of the studio was to reconceptualize a way of working with program.

Second, most courthouses look like a courthouse. The design process proposed challenged the imagery associated with courthouses. The process pushed the students to withhold their preconceived notions of what makes a courthouse.

Third, the juvenile courthouse has an inherent relationship to site and the surrounding community. Juvenile courts serve many purposes including protecting, restoring, redirecting, and supporting children and families. The students were asked to take a position relative to these varying missions in order to ground their understanding of the program.

Design Process

The process was prescribed for the students in order to deliver certain learning outcomes. The learning outcomes were to enable students to use process-based design methods to develop a building proposal, to enable students to overcome preconceived notions of what a courthouse would look like, and the ability to use an overarching idea such as mixing to develop a design project.

The first step in the design process was to mix two materials. The students were asked to document the mixing process through photos, two-dimensional diagrams, and three-dimensional diagrams. The mixing was presented using the framework described by Greg Lynn which is based in culinary theory:

The first involves the manipulation of homogeneous elements; beating, whisking and whipping change the volume, but not the nature of a liquid agitation. The second method of incorporation mixes two or more disparate elements; chopping, dicing, grinding, grating, slicing, shredding and mincing eviscerate elements into fragments. The first method agitates a single uniform ingredient, the second eviscerates disparate ingredients. Folding, creaming and blending mix smoothly multiple ingredients 'through repeated gentle overturnings without stirring or beating' in such a way that their individual characteristics are maintained.[3]

Second, the students diagrammed the program. This portion of the process was meant as an introduction to the ideas of program. Koolhaas' Delirious New York was used to explain program diagrammatically where the formal strategy of stacked dissimilar programs is made possible by the use of the elevator in the The Downtown Athletic Club. The text also touched on the cultural landscape the building draws upon and enables. The students were asked to do the same in their projects.[4]

Third, the students used the material mixing as a way to develop the program diagram. They mixed the material ideas with the program ideas. The culmination of this part of the process was a site-less building.

Last, the students were asked to choose a site in the city of Atlanta. The site was chosen with only 2-3 weeks left in the semester allowing students to see how a site can change architecture and how architecture can change a site. Just as two materials are mixed and create interstitial relationships, the architecture and site are mixed to create new interstitial conditions: "Folded, pliant and supple architectural forms invite exigencies and contingencies in both their deformation and their reception."[5]

Four Projects

Below are four projects completed by pairs of graduate students from the Georgia Institute of Technology School of Architecture.

Merged Towers by Matthew Belt & Mats Nilsson

Merged Towers began with a material study involving expanding foam insulation and a shower loofah. The mixing was characterized by the force exerted on the expanding foam by the shower loofa mesh. The mixture began with the foam only existing within the loofah then expanding and squeezing through the mesh separating the foam into linear modules. In the end, the students found that the foam enveloped the loofah completely. The students analyzed the process of change and chose to focus their attention on certain moments within the mixing process (Fig. 1).

Fig. 1. Merged Towers Material Mixing

The program for Merged Towers was understood as vertically separated programs connected by large connection spaces which would double as circulation and used space. The program was stacked with the most public space located at the lowest level and the most secure spaces located at the top. With this understanding was a desire to make the surrounding streetscape a part of the building. The vertical connection spaces included the lobby, courtroom spaces, and prisoner staging spaces.

The mixing of the program analysis and material analysis worked quite well in that the material investigation provided a formal strategy of spatial division that could accommodate the vertical program strategy. The forms the students worked with morphed from large shared spaces into smaller cellular spaces which created the defining element of the project, merged tower forms (Fig. 2).

The site for the proposal had a similar organization as the program. The building was placed at a fork in the road where two roads converge into one. The towers were able to be placed as a cluster which allowed the ground plane to be divided where needed and ooze where possible so that the public program could blend with the surrounding city spaces.

This site, like so many others located at a fork in a road, is difficult to accommodate buildings because of the odd shape. This project, because of its cellular nature and soft edges was able to fit well into the site.

Fig. 2. Merged Towers Final Design

Non-Newtonian Courthouse by Will Gravlee & Barbara Nowak

Non-Newtonian Courthouse began with a material investigation mixing cornstarch and water which created a non-Newtonian fluid. The students noticed that without resistance the mixture flowed and was flexible; but, when pressure was applied, the mixture became firm. The constantly changing relationship between pressure and no pressure fascinated the students and affected their way of interpreting the program into form (Fig. 3).

Fig. 3. Non-Newtonian Courthouse Material Mixing

The students' program analysis began by dividing the spaces by user group: public space, employee space, judge space, and prisoner space. Certain shared program spaces could not be placed within a particular user group such as the courtroom, court library, court clerk, and parking space. Instead of understanding these spaces as separate program blocks, the students understood these as void spaces made visible by the other program spaces organized around the shared space. In many ways, these shared spaces were given form by the pressures applied by the other programs just like their mixture was able to create form through outside force.

The site chosen for the project was a large lot with seemingly disparate identities. On one side of the site was a power facility, on another was a residential neighborhood, on another was a church, and on another were a couple of retail stores. The students saw their project as the space that could connect all of these different types of programs just like the shared spaces within the building. With the lessons the students learned from the material mixing, they were able to employ soft edges, hard edges, and all the conditions in-between fitting into the site and addressing all of the various conditions found (Fig. 4).

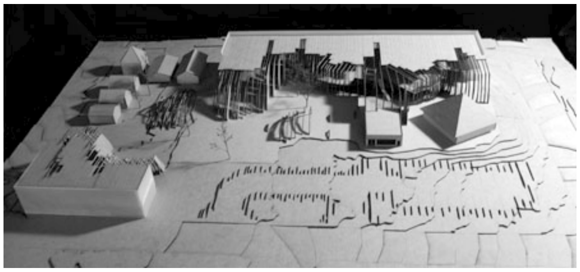


Fig. 4. Non-Newtonian Courthouse Final Design

The proposal was characterized by ribs that enabled the students to mediate the edges. The exterior cladding changed from opaque to translucent to transparent depending upon the site adjacencies. The rib technique extended into the exterior spaces and helped define those spaces as well.

Structured Reticulation by Kelly Darby & Robert Woodhurst

Structured Reticulation began as a material investigation using spackle and a dryer sheet. The students were focused on the dependence each material had on the other in order to give form. For instance, without the spackle the dryer sheet was limp and formless and the spackle without the dryer sheet was the same. Only when the two were combined could the materials hold a shape (Fig. 5).

Fig. 5. Structured Reticulation Material Mixing

The program analysis the students developed understood the courthouse as a mutually dependent space just as the material mixing was based upon mutual dependence. The students wanted to reinforce the idea that the court serves the public and the defendants equally. They viewed the juvenile court as a rehabilitative space instead of a punitive space. The students understood that only through the involvement of the public and surrounding community can rehabilitation take place; therefore, much of the program falls outside the secure courthouse proper and in the public space. Only those programs where security is of high priority are located within the courthouse.

In the end, the students sited their building in the heart of the city on a corner lot that created a grand city plaza surrounded by other buildings. The courthouse supported the exterior space programmatically and formally but only with the help of the surrounding city.

The building was very open at the ground floor and was characterized by vertical lacy structure which dominated the interior space and held important program elements just like the original mixing study. The proposal was very open and transparent whenever the program allowed (Fig. 6).

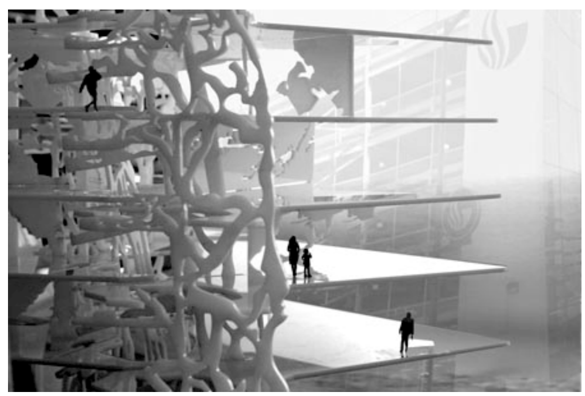


Fig. 6. Structured Reticulation Final Design

Suspended Spaces by Travis Hampton & Emily Marvel

Suspended Spaces began with a material investigation mixing oil and water. The students were focused upon the process of pouring the oil into the water. Their analysis involved understanding the suspension of the oil masses within the water which floated and flowed through the water volume (Fig. 7).

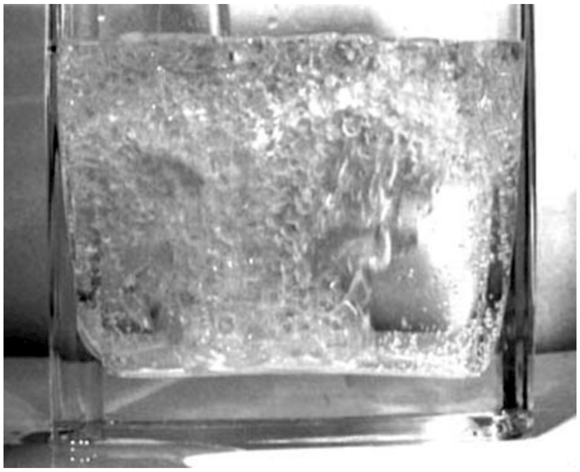


Fig. 7. Suspended Spaces Material Mixing

These students analyzed the program as a series of spaces which support the juvenile. Just like the water supported the pockets of oil in the material mixture, the spaces in the building supported the juvenile spaces. These students proposed adding additional spaces which were not only for juveniles charged with crimes. These spaces allowed additional support for community children and teens such as activity spaces including music rooms and art studios.

The project was sited within close proximity to other community facilities which support the community's youth including a school, The King Center, and several churches. The students were attempting to make the courthouse a place of support for local children rather than only a place of punitive judgment. The building inhabits a corner of a park which is anchored on opposite corners by the school and the Visitor Center for the King Center. The courthouse provides a covered entrance to the park and King Center showing its physical support of the local community.

The proposal was characterized by an opaque building block in the rear which supported a suspended transparent building atrium in the front. In the atrium, suspended bubbles like spaces held the activity spaces and were visible to the outside community. The more private and support spaces were held in the opaque building block (Fig. 8).

Reflection

The greatest short-coming of the studio was the unresolved nature of the technical aspects of the projects. Most of the projects were unable to get to a technical resolution that would make the proposals believable. All of the projects could have addressed the incorporation of building systems and would have benefited from the process. While this was a short-coming, below are the some of the successes of the studio.

Fig. 8. Suspended Spaces Final Design

First, the project was successful in delivering an understanding of program that was more than a mere distribution of space. The students were able to understand program from its cultural implications and through a more tactile mixing. These lessons were easily communicated and grasped by the students because it followed a material investigation.

Second, the process encouraged the development of an idea that ran through material, program, and site development. Many times, young designers have a plethora of ideas in one project. The process used in this studio kept this tendency at bay because the students were led in a particular direction. The students learned that the idea for a building should be supported on many levels, in this case material, program, and site.

Third, the project required the development of the project through models and drawings. These were used throughout at each stage of development. While in some studios students are left to choose their medium, in this studio the medium was given. The process required students to develop both skills, drawing and modeling, not just the one they felt most comfortable using.

Fourth, the studio encouraged the use of atypical modeling materials. The modeling exercises encouraged students to use methods and machines they had never used before expanding their knowledge of material and techniques that hopefully helped them in their upper level studios.

Finally, the diversity of projects in the studio was refreshing. Because the students began with diverse material mixings, the proposed final designs were quite different. The site selections the students made were also diverse considering they were all within the downtown of Atlanta. Some of the sites were in the extremely dense urban core, others were at the periphery of the downtown where the city is beginning to unravel into a more suburban condition, and still others were in the in-between. The sites were in-fill, open, and a combination of these.

Overall, the studio was successful in delivering a well-rounded understanding of program which ensured students could meet the functional criteria of program distribution as well as the ability to create a conceptual framework for a building program. The atypical delivery using messy materials kept the students engaged and challenged because they were never sure of the next step – simply because they had never worked in this manner. From the results in this studio, material mixing can be a successful way of teaching program that also teaches other lessons in the periphery.

Notes

[1-3, and 5] Lynn, Greg. “The Folded, the Pliant and the Supple,” Folds, Bodies & Blobs (Brussels: La Lettre Volee, 2004).

[4] Koolhaas, Rem. “Definitive Instability: The Downtown Athletic Club,” Delirious New York: A Retroactive Manifesto for Manhattan (New York: Monacelli Press, 1994).

Embracing Failure:
Developing a Critical Process of Material Engagement

Lisa Huang

University of Florida

[T]he exercise of what Gaston Bachelard calls the material imagination does lead into chaos, but it is chaos in its ancient Greek signification of gap or opening, a realm ripe for transformation under the aegis of Eros. There is reciprocity between creativity and the materials that creativity works upon: to be workable these materials must also be creative.
- Paul Carter, Materials Thinking

Introduction

A fear of taking risks or making mistakes often paralyzes beginning design students when they are faced with assignments that challenge what they know. They do not immediately understand that design process benefits from discovery and experimentation. The emergence of architecture requires testing the material presence of design ideas. In addition, the materials utilized have to address the scale of the material at hand and of its larger implications. In our beginning design courses, students are given material parameters to limit issues that may be encountered during the design process. These parameters are not intended to dictate design; they are open- ended to allow new interpretations and possibilities. In parallel, the work of post-Minimalist sculptors focused on the potentiality of materials and on discovery by redefining the process of working with its material properties. Robert Morris writes “I believe there are ‘forms’ to be found within the activity of making as much as within the end product. These are forms of behavior aimed at testing the limits and possibilities involved in that particular interaction between one’s actions and the materials of the environments.” The creative process through the act of making and the materialization of design concepts is a critical testing ground for the development of architectural ideas. In our design curriculum, architectural design is produced at representative scales where the understanding of materiality at a 1:1 scale is often a remote horizon. There exists a gap between understanding building material as a theoretical construct and as a practical application. Is there a way to pedagogically incorporate applied material operations as a tangible contribution within speculative design processes?

This paper examines the development of material thinking in the creative design process through work produced in the first semester design studios and in an advanced workshop seminar on material explorations. Both courses engage materiality through 1:1 scaled constructs and concentrate on the material at hand. Our beginning design studios probe material systems and assemblies within given parameters, while the seminar centers on material investigation that occupy the gap or opening that encourage transformation and discovery discussed by Carter. The seminar operates in a laboratory format where students work directly with building material by empirically testing its parameters and behaviors in an attempt to discover new ways to engage with these materials. What is the impact of working hands-on with full-scale materials in a critical design process and the consequent speculations on its architectural implications?

The Beginning Design Student Mindset

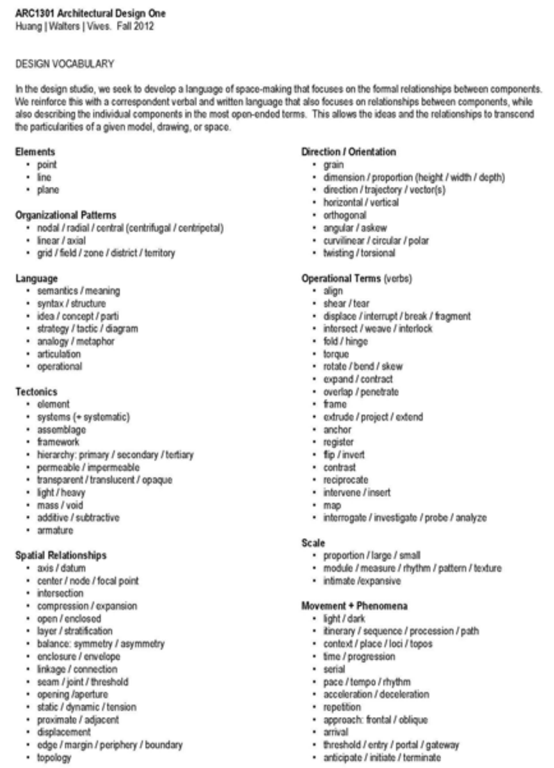
Most of our beginning design students struggle with taking risks and have a fear of being wrong. They often think they have to solve design problems or figure out the right answers in their head before they can materialize ideas consequently paralyzing the act of making. Once they finally make something, they can be easily discouraged when it does not come out exactly as they imagined. It is necessary to readjust their expectations particularly in cases where students are disappointed when they realize that they cannot solve a design problem in one attempt.

Our design students need to instill the desire to investigate every possible option and an acceptance that each attempt will undoubtedly need refinement. They have to embrace the design process that in turn requires them to embrace the possibility of failures. Design ideas need to materialize in order to be evaluated and interrogated. Students have a tendency to think that everything they make should be pristine and precious. They don't think about it as a means to achieving the "right' answer. The uncertainly of where this process will lead is not an easy adjustment. The translation from theoretical idea to physical construct then ultimately to full-scale fabrication is a process that is charged with chaos. How do we encourage students to not be afraid of taking risks, making a mess, and working outside of their comfort zone?

Instilling Process and Material Thinking in Beginning Design

An appreciation for design process has to be ingrained early in design education through structuring projects around iterative making. In our beginning design curriculum, students are introduced to space-making through an approach that draws a parallel with Richard Serra's *Verb List*.[3] Serra's list of over a hundred action words or contexts provided a vehicle for experimenting with the nature of process with materials in his sculptures. His work with rubber and lead reflects the actions imposed on the material and the process of making becomes visible and identifiable. First year design students build upon a given design vocabulary that provides them a strategy or process to engage materiality and define space in their work. (Fig. 1) The vocabulary list enables the students to visualize space making and manipulate materials to create identifiable spatial actions.

An iterative process of making is a key strategy for students to let go of their fears. For most projects, students start with smaller studies and work their way up in scale. When a scale increase occurs, their instinct is to build an exact blow-up of their smaller models that consequently look awkward and simplistic. They learn to realize that each increase of scale requires investigating and testing new layers of information. Quick in-class models or drawings help to jumpstart stalled efforts in production. When they are given time constraints to produce, there is less of a tendency to overthink or hesitate in their process of making. There is always a constant struggle to visually communicate their design ideas. To adjust their mindset regarding risks, students must learn to value failures and interrogate flawed attempts as necessary steps to advance their design work.



ARC1301 Architectural Design One
Huang | Walters | Vives. Fall 2012

DESIGN VOCABULARY

In the design studio, we seek to develop a language of space-making that focuses on the formal relationships between components. We reinforce this with a correspondent verbal and written language that also focuses on relationships between components, while also describing the individual components in the most open-ended terms. This allows the ideas and the relationships to transcend the particularities of a given model, drawing, or space.

Elements
- point
- line
- plane

Organizational Patterns
- nodal / radial / central (centrifugal / centripetal)
- linear / axial
- grid / field / zone / district / territory

Language
- semantics / meaning
- syntax / structure
- idea / concept / parti
- strategy / tactic / diagram
- analogy / metaphor
- articulation
- operational

Tectonics
- element
- systems (+ systematic)
- assemblage
- framework
- hierarchy: primary / secondary / tertiary
- permeable / impermeable
- transparent / translucent / opaque
- light / heavy
- mass / void
- additive / subtractive
- armature

Spatial Relationships
- axis / datum
- center / node / focal point
- intersection
- compression / expansion
- open / enclosed
- layer / stratification
- balance: symmetry / asymmetry
- enclosure / envelope
- linkage / connection
- seam / joint / threshold
- opening /aperture
- static / dynamic / tension
- proximate / adjacent
- displacement
- edge / margin / periphery / boundary
- topology

Direction / Orientation
- grain
- dimension / proportion (height / width / depth)
- direction / trajectory / vector(s)
- horizontal / vertical
- orthogonal
- angular / askew
- curvilinear / circular / polar
- twisting / torsional

Operational Terms (verbs)
- align
- shear / tear
- displace / interrupt / break / fragment
- intersect / weave / interlock
- fold / hinge
- torque
- rotate / bend / skew
- expand / contract
- overlap / penetrate
- frame
- extrude / project / extend
- anchor
- register
- flip / invert
- contrast
- reciprocate
- intervene / insert
- map
- interrogate / investigate / probe / analyze

Scale
- proportion / large / small
- module / measure / rhythm / pattern / texture
- intimate /expansive

Movement + Phenomena
- light / dark
- itinerary / sequence / procession / path
- context / place / loci / topos
- time / progression
- serial
- pace / tempo / rhythm
- acceleration / deceleration
- repetition
- approach: frontal / oblique
- arrival
- threshold / entry / portal / gateway
- anticipate / initiate / terminate

Figure 1. Typical design vocabulary list provided to first year beginning design students at University of Florida.

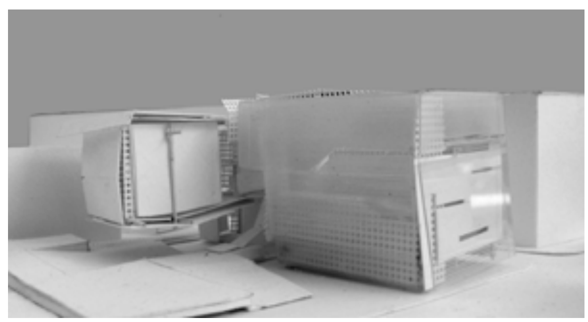


Figure 2. Process model using representative materials to achieve material effects. (Architectural Design 6 - Anastasia Hiller)

Designers have to make messy things before it becomes more refined. Material engagement in the typical studio design project relies on using materials at a representative scale. (Fig. 2) In our undergraduate design curriculum, there is rarely an opportunity to physically work with actual building materials. Our beginning design students often work with physical models and typically utilize materials such as basswood, plastics, chipboard, paper, and metal wire. Even though they are working with materials at representative scales, the students are confronted with the struggle in negotiating varying material qualities and characteristics. Each material has its limitations and requires very different approaches for assembly and processes of manipulating it. When working with basswood in the form of planes and linear elements, they learn that the orientation of their components has to work with directional grains for added strength. The transparency and translucency of Plexiglas can be manipulated and Plexiglas can be welded together, but joining it with other materials is difficult with adhesives and requires interlocked assemblies. So they have to contend with alternative techniques of joinery such as creating a basswood framework to hold Plexiglas pieces or cutting notches into Plexiglas to intersect basswood to the acrylic. (Fig. 3)

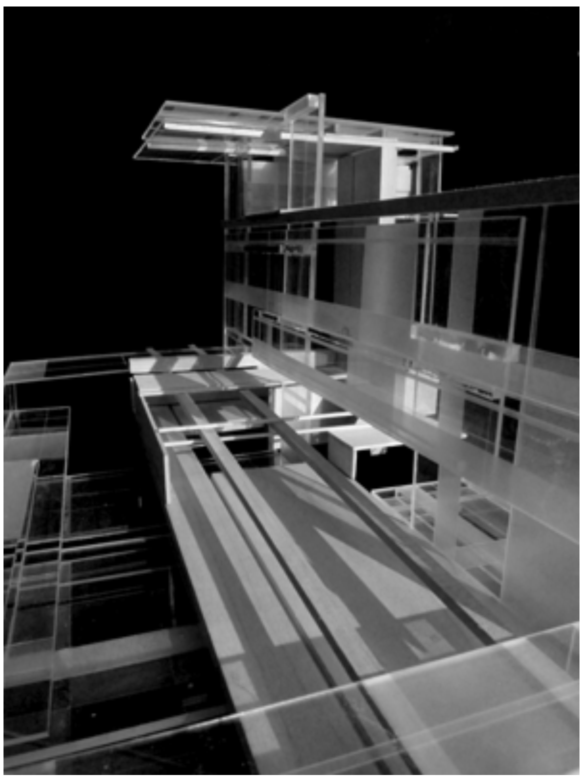


Figure 3. Plexiglas and basswood construct working with the properties of the materials. (Architectural Design 1 - Rachel Mathis)

Materiality in drawing constructs is typically expressed through thickness or the expressions of a tectonic language. Project renderings tend to idealize material conditions in that materials are wallpapered or scale-less in appearance. When students are questioned regarding the materials they are using in the project, concrete is the popular material of choice because they understand it as a material that can be formed into anything. A disconnect exists between what they design through drawing and material realities at full-scale. This disconnect is amplified since increasingly student design work is created exclusively using 3d modeling software. As students isolate their design work in the computer, there is a concern that they avoid contending with matter and consequently there are further detachments of design work from material realities. Although 3d programs and digital tools are incredible platforms for creativity, there is a danger that the distance between theoretical construct and material understanding widens. Therefore, there is a necessity for a balance in the design process where students directly and physically interact with matter.

A Strategy for Material Engagement

The work of post-Minimalist artists such as Robert Morris, Richard Serra and Eva Hesse emphasized the process of working with materials as the subject of their artwork. In his book *Artists, Critics, Context*, Paul Fabozzi discusses these artists and writes "…the characteristics of this diverse group of artists is the rejection of the assumption that artists create order out of chaos by giving form to particular materials. The work of these artists challenge this notion by prioritizing process and materials over the creation of conventionally self-contained sculptures, which had been done in the past." [4] The behavior of the material is the focus of the artwork. The process of making these artists worked with their medium revealed the character of the materials. In Morris's Felt Works series, form emerges from a process of experimentation regarding the material's behaviors and characteristics of pliability, resistance and heft. With every iteration, Morris changes a variable in working with industrial felt to see how the material behaves - where it's cut, how it's hung, the thickness of the material, the use of reinforcing components (grommet). The unpredictable behavior of industrial felt meant that form could not be first anticipated through drawings or models.[5] A refinement of form and meaning in Morris's work emerged from the experimentation leading to an intimate understanding of material behavior and constraints.

In the Fall 2013 and Spring 2014 semesters, a materials workshop seminar was offered to provide a platform for students to experiment with materials at a 1:1 scale and to cultivate thought processes that would mediate between their design work and material realities. Students in the course selected one or two materials of their choice to investigate and were immediately confronted with critical issues that impacted design decisions: material behaviors and characteristics (flexible, brittle, delicate, directional....), process of working with the materials (casting, forming, layering, stacking, ...), and issues of assembly or joining of materials (exposed, hidden, loose, tight, interlocked, stitched....). The students posed questions generated from their curiosity about the material(s) they had chosen and then experimented with material qualities to discover characteristics and constraints. The students started very simply with learning how to work with the materials and changing variables in each iteration to uncover material behaviors. (Fig. 4)

Figure 4. Disassembling formworks for concrete blocks (Materials workshop – Jonathan Arcila-Garcia)

A few weeks later, the students continued to test material qualities and simultaneously test methods of assembling and joining two materials together in two configurations: turning a corner and adjacent to each other. They researched standard methods of building construction to understand conventions – students researching ceramics looked at ceramic wall tile assemblies and tiled roofs and students interested in metal panels looked at standing seam roofs, exterior wall panels. These building techniques provided a starting point that they then modified in each iteration. The premise of the course was to test constraints and parameters of selected materials and processes and then use empirical feedback to uncover new and possibly innovative ways to work with these materials. The end goal was to generate a larger assembly from these material and joinery investigations. (Fig. 5)

These material investigations were not intended as experiments in engineering new materials. The final assemblies had architectural and spatial design intent, but did not have to be watertight and practical assemblies. This course proposed a process of working that was contradictory to how design studios typically operate. Instead of starting a design project with the development of an overall proposal, they had to let a design project evolve from grappling with fundamental issues of materiality. This process of starting from the part instead of the whole was difficult for most students to engage. Their first instinct was to jump to designing complex constructions or assemblies rather than make simple material tests. The students were uncomfortable without an overall design proposal as a guide. Since most students did not have experience working with materials

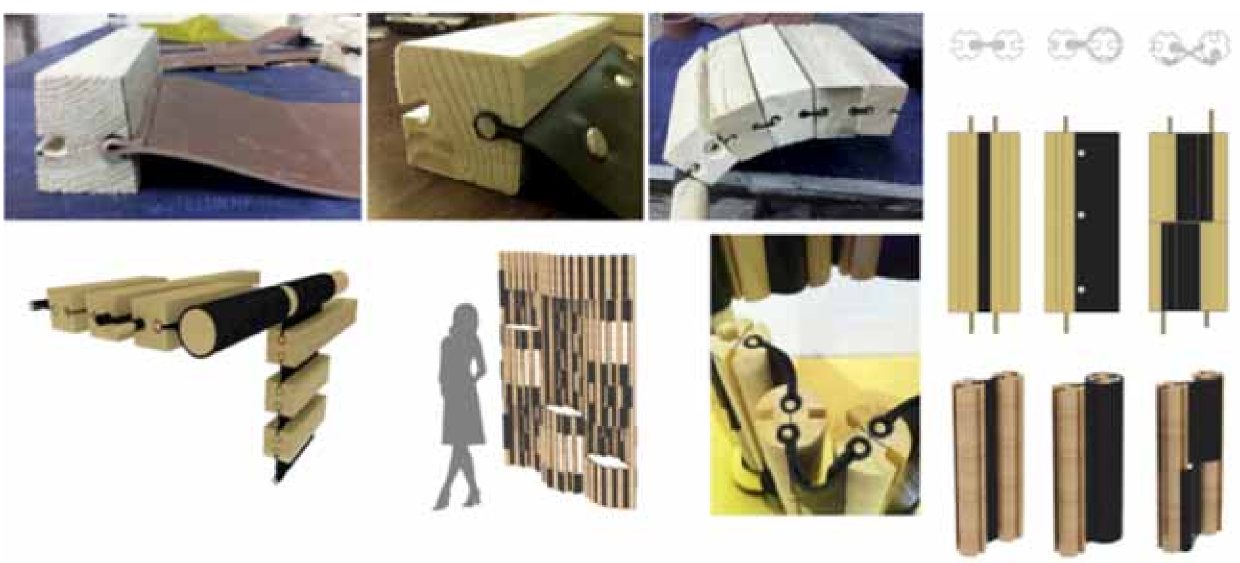


Figure 5. Studies developing ways to join rubber with wood to create a flexible assembly (Materials workshop – Huajing Huang)

at a 1:1 scale, there was an avoidance of the issue of making because they were not sure how to begin. In addition, they postponed the start of physically working with materials because they were unwilling to try and then fail. One student who was interested in casting resin, initially delayed making a mold for weeks because she believe it was necessary to know in advance every aspect of making the perfect mold. She was thoroughly embarrassed by her preliminary molds that were indeed naïve and unsuccessful in producing casts, but through a series of improvements, she created complex and refined molds that in itself were well-designed constructions. Students needed to understand the necessity of making ugly and simple things before it can become perfect. Students were reluctant to show unsuccessful experiments, not understanding that broken material pieces were necessary to determine the limitations and failure points of the materials and also had the potential to expose new possibilities. The intention of the process was to get students to work directly with materials in order to understand the nature of the material, to develop a dexterity of mind, and to cultivate creative tactics of working with materials hands-on. The potential for innovative material strategies emerges from an awareness of material parameters and limitations.

Yielding to Chaos

The process of experimenting and working hands-on with materials contributes to a critical process of material thinking that infiltrates speculative design processes. Our design students learn about materials and methods of construction in lecture courses, but when they design, their understanding of the building material is purely theoretical and removed from real constraints and processes that have an impact on design. When they try to cast concrete, they realize that the formwork has a critical impact; therefore they must struggle with factors regarding formwork materials, releasing agents, agitation techniques, and limits of thinness in the material. Ultimately, this experience provides an intimate knowledge of working with the material. Applied research with materials bridges the relationship between their academic studies and the associated understanding of material realities. In their studio work, they are accustomed to using adhesives to joining one material to another. When they attempt to assemble two materials together at a 1:1 scale, they recognize the need to use fasteners. In their research, they discover there are numerous options for fastening and techniques for joining. In order to know which fastener works best for their application, they need to test the possibilities.

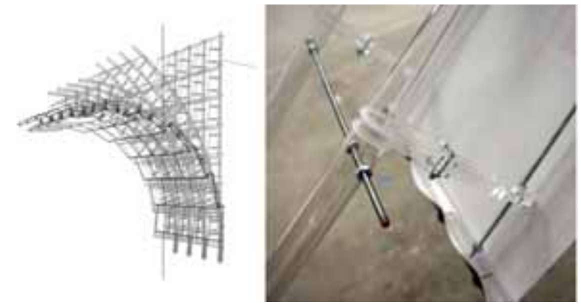


Figure 6. Speculative drawing and prototype for a polycarbonate assembly. Connections were unable to accommodate the anticipated flexibility (Materials workshop – Michael Porter)

Throughout the course, students worked back and forth between drawings and physical experiments in order to test and understand that speculations in drawings or small-scaled models do not anticipate how material behaviors impact a built construct. When they had to construct their proposals, the students were always surprised that their material tests did not come out as they anticipated it would. (Fig. 6) Drawings are a valuable investigative step to clarify and propel research in new directions, but many students realized that in drawings they didn't have to contend with the physical resistances that accompany working with the actual material. Working hands-on with materials provides awareness and understanding of material constraints and tendencies that impact design decisions and the design itself. In professional practice, the design phases of an architectural project is an iterative process that allows for the development of specificity and refinement in order to narrow the possibility of failures when constructing a building project. Working hands on with materials at full scale helps to narrow that gap. In interacting with materials, they are immediately confronted with how to work with it, how to handle it, what are the effective processes. The experience of struggling with material resistances helps the design student develop a sensitivity to materiality and enhances their understanding of the building medium that therefore leads to more intelligent and informed design processes.

Conclusion

The development of this materials workshop course is on-going research that also experienced failures and chaos in attempting to cultivate material thinking. It is offered as just one approach, presented for discussion, in need of improvement and refinement.

As design educators, we must evaluate methods to help students fearlessly engage design process and value experimentation. In addition, we must critically examine if we are doing things to hinder them in their struggle to develop skills and ingenuity in critical thinking and making. In design education, as architectural studio work becomes increasingly computer-based and anonymous in material presence, there is an urgency to reconnect a material thinking into the creative design process. Architecture has a material presence, so students should develop a foundation for a design process that contemplates the implications of materiality in architecture. In order to encourage a creative process, students must accept the chaos of unpredictability and failure as critical aspects of discovery in the design process. Hands-on experimentation with materials bridges the gap between theoretical idea and its potential as a built construct. This process provides an alternative approach to the evolution of design work through the exploration and transformation of its materiality.

Acknowledgements

At the University of Florida, the curriculum is a shared project of the entire faculty. Those of us who have taught beginning design in recent years have built upon the work of preceding faculty. Many thanks to the students in the materials workshop seminar and the beginning design studios for the effort and work produced during the semester. This research project would not have been possible without the wonderful support of the faculty at the University of Florida School of Architecture. Special thanks to Martin Gundersen, Adeline 'Nina' Hofer, Bradley Walters, Mark McGlothlin for their generosity, sage advice and sense of humor contributing to the development of this research.

Notes

1 Carter, Paul. *Material Thinking*. Carlton, Australia: Melbourne University Press, 2004. p 183.

2 Morris, Robert. *Continued Projects Altered Daily: The Writings of Robert Morris.* Cambridge, MA: MIT Press. 1993, p. 73.

3 Richard Serra's *Verb List* was first published in 1972 in Gregoire Muller's *book The New Avant-Garde: Issues for the Art of the Seventies.*

4 Fabozzi, Paul F. *Artists, Critics, Context: Readings in and Around American Art since 1945*. Upper Saddle River, NJ: Pearson Education, 2001, p. 235.

5 Karmel, Pepe. "'The Body is in the World': A Prehistory of the Felt Works". *Robert Morris: The Felt Works*. New York, NY: Grey Gallery of Art and Study Center, 1989, p. 1-17.

Building Blocks:
Constructing a Coordinated Introduction to the Material of Architecture

Michael Hughes

American University of Sharjah

This paper presents the initial steps in the on-going development of an integrated learning model formulated to introduce and extend tactile, full-scale learning opportunities across the beginning of the architecture curriculum. The two pedagogical experiments presented attempt to distill lessons from advanced hands-on courses associated with design-build pedagogy and distribute those lessons throughout the traditional core courses in order to better prepare students for the complexities of full-scale projects introduced in the upper-level, 4th and 5th year design studios. Modest in size, scope and duration these first efforts mark the initial, incremental steps toward the development of a more comprehensive curricular approach to experiential learning. At the same time these modest exercises served to reveal significant logistic and operational challenges inherent to the structure of contemporary, disciplinary education.

The projects discussed below were located in the second semester of the student's second year in the professional B.Arch program. At that point in the curriculum students have completed a one-year, multi-disciplinary foundation co-taught by

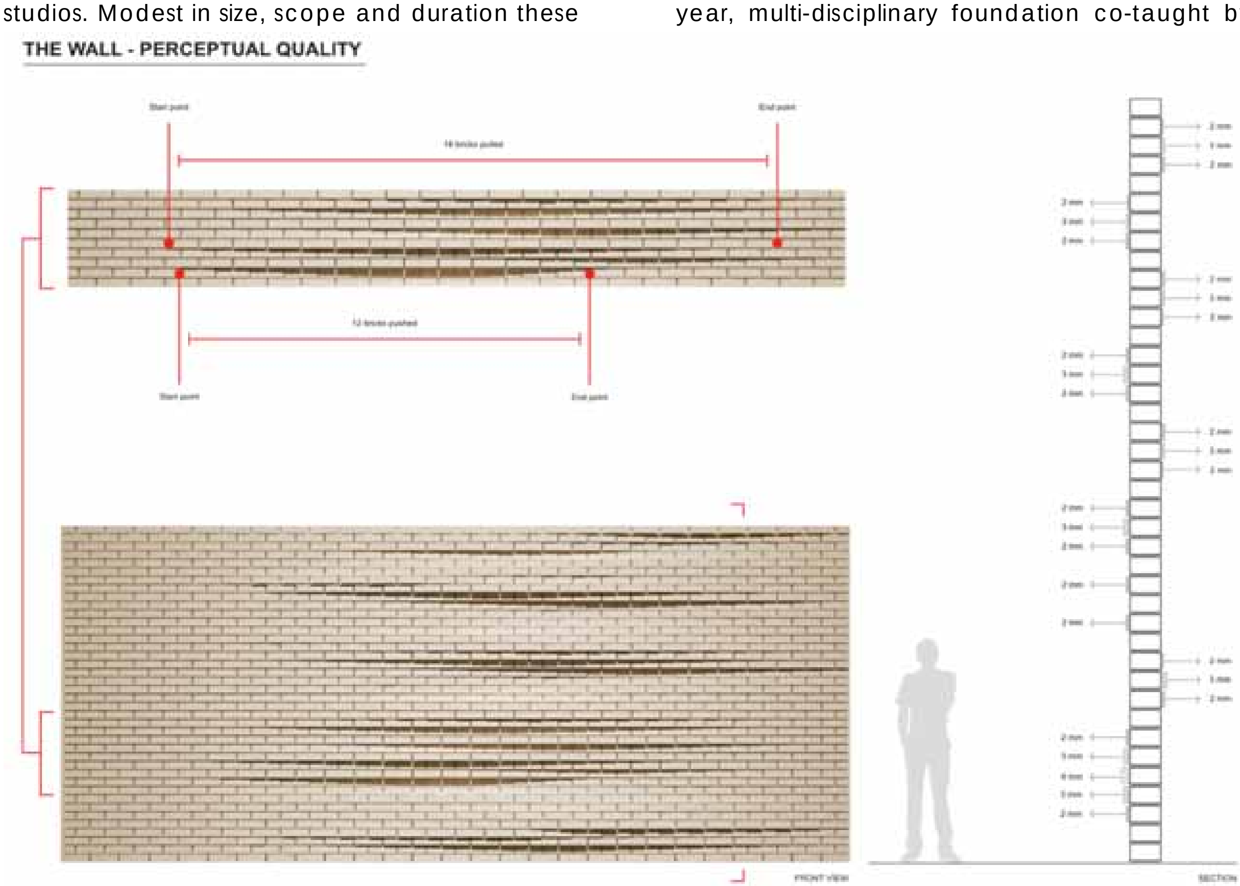


Fig. 1. The Wall Exercise: Abstract Modules

faculty in Architecture, Interior Design, Visual Communications, Art, and Multi-Media Design as well as the first discipline-specific semester devoted to architectural principles, (formal composition, organizational strategies, and spatial relationships). Specifically, the projects explore opportunities for direct integration between ARC 202, the second architecture design studio, and ARC 231 Materials and Methods of Construction 1. Introductory elective offerings in material fabrication, digital fabrication and ceramics augment the required course work and extend the experiential macrocosm.

Integrated Learning Initiative

The isolation between core design education and the now common, upper level design-build experience exacerbates a disjunction between the expectations for qualitative sophistication in the design-build studio and the near total lack of disciplinary preparation, in terms of both material and contingent experience, required to produce architecture at full-scale. The reliance on large lecture courses in the technology sequence, tends to segregate book knowledge from direct material engagement. As a result, students who have completed a full sequence of material and construction-based coursework typically lack exposure to knowledge gained through direct, hands-on experience.

A group of faculty members at the American University of Sharjah are working to develop an integrated, cross-curricular approach that combines thinking about design with direct experience in the material properties of design. The goal is to augment the prevailing reliance on abstract studio projects and lecture-based instruction that Paolo Freire calls the "*narrative* character" of oppressive pedagogy.

The teacher talks about reality as if it were motionless, static, compartmentalized, and predictable. Or else he expounds on a topic completely alien tot the existential experience of the students.[1]

The Integrated Learning Initiative combines aspects of the learn-by-doing ethos championed by John Dewey[2] with subsequent developments in Experience Based Learning Systems modeled by David Kolb. Kolb highlights the importance of direct experience in relation to abstract concepts by saying,

...emphasis on here-and-now concrete experience to validate and test abstract concepts. Immediate personal experience is the focal point for learning, giving life, texture and subjective personal meaning to abstract concepts...[3]

This balanced, reciprocal relationship between concrete experience and abstract concepts underpins the Initiative's effort to improve, rather than supplant, existing passive learning models. Specifically, the effort seeks to repair the fragmentary nature of disciplinary education in which design and technology, as well as drawing and making, are too often seen as separate, codified realms of isolated expertise. Following David Kolb,

...the aim of this work is not to pose experiential learning theory as a third alternative to behavioral and cognitive learning theories, but rather to suggest through experiential learning theory a holistic integrative perspective on learning that combines experience, perception, cognition, and behavior.[4]

The combinatory approach operates as a supplement the existing curriculum and is thereby distinct from the immersive models, exemplified by the Bahaus, Black Mountain College and the Rural Studio. Instead of immersion opportunities for direct, material exploration are woven into existing learning objectives of the required classes in the core, disciplinary curriculum.

Associated Skill Development

In addition to the primary lessons involving material engagement the Integrated Learning Initiative seeks to introduce students to the contingent character of the discipline. Distinct from the relative isolation and singular focus on schematic design encountered in the studio, contingent pedagogy foregrounds the unknown and unforeseen common to upper-level design-build projects.

As preparation for future, full-scale design-build projects, as well as professional practice, the incremental introduction of contingent conditions exposes students to multiple, simultaneous variables and unpredictable outcomes.

Embracing the contingent character of contemporary architectural practice would introduce students to a complex and realistic realm of inter-personal and inter-professional dependence. In this context simultaneous engagement with multiple variables develops improvisational skills that hone decision-making skills.[5]

Processes related to project management, material acquisition and team coordination are seldom addressed in an academic setting, but these fundamental components, common to any professional, architectural endeavor, offer ample opportunities for skill development in communication, coordination, planning and negotiation. Within the small-scale, relatively simple hands-on exercises implemented to date students are exposed to direct encounters with gravity, material resistance and coordinated assembly processes while also confronting the unpredictable nature of collaborative team work, clients and/or constituents, and budgets.

Coordinated Exercises

Complementing the technology lecture class, relatively small, hands-on exercises of short duration have been introduced in the second-year design studio. The projects range from one to six weeks in duration and are explicitly linked to issues being addressed in the Introduction to Materials and Methods class. For example, within a studio devoted, in part, to unit-based repetition, (Fig. 1), students in a second-year core studio spent two weeks translating their abstract drawing-based exercises into a full-scale masonry wall, (Fig. 2), as part of a joint project for both studio and the Materials and Methods lecture class. In parallel, studio discussion related to the haptic aspects spatial experience led a group of second-year students to spend one week on the design and fabrication of two full-scale benches. In another example, the abstract module introduced in the studio was engaged in the technology course through an exercise focused on the study of material properties, (Fig. 3).

Fig. 2. The Wall Exercise: Full-scale Masonry Wall

In each case, the translation from drawing and computer modeling to full-scale, haptic engagement exposed students to potential subtleties in the material reality, which were difficult to see or assess through the learning structure common to either the studio or lecture environment. As a result, in the subsequent return to standard coursework students may be better able to modulate and articulate their work with a greater degree of material and tectonic specificity.

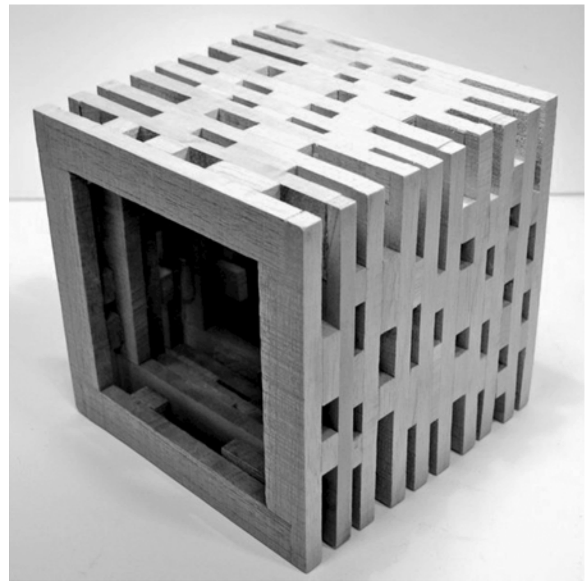


Fig. 3. 20cm Cube

Exercise 01: Material Exploration

Initial exercises in the ARC 202 design studio focus on modular systems and variation through masonry patterns and assembly. The abstract nature of the exercise emphasized the aggregation of modules to create surface or field conditions influenced by variable-dependent organizational strategies and resulting in a range of alternative patterns and textures. Students were introduced to specific variables, (push/pull, shift, and rotate) one by one before moving to multi-variable interaction across a 3m x 10m surface.

At the same time students in ARC 231 Materials and Methods 1 doing a complimentary project exploring the potential for material specificity at the scale of an individual module. In this way the character of the individual unit is introduced as another variable in the pattern/texture development.

Working in teams of four students were asked to combine thinking and making in a process of engaged discovery. Half of the fourteen teams explored concrete and half explored wood. Deliverables included an *exquisite* 20cm cube highlighting the essential character of the mate-

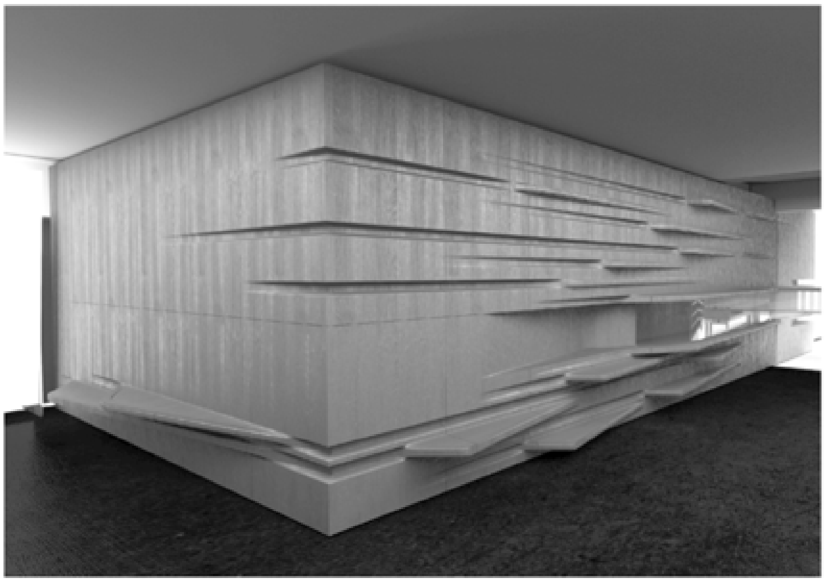



Fig. 4. Display Wall Design-Build Project at the A.U.S.. College of Architecture, Art and Design

rial along with a portfolio documenting the full scope of research, experiments and prototypes engaged during the six-week exercise. In each case teams were responsible for research leading to a broad, general knowledge of the material, in terms of the history, conventional applications and normative material characteristics, while simultaneously delving into a particular aspect of the material character.

Teams working with concrete were asked to explore the variables related to formwork, aggregate mix, additives and casting methods that affect the character of the final product. Specifically, students were asked to investigate formwork by examining the impact of different assembly methods and materials, (wood, plastic, metal and fabric). Similarly, casting processes explored the role of voids, reinforcement, and alternative aggregates affecting transparency, weight, and color.

Teams working with wood were expected to explore the range of species-specific material properties, the role of assembly techniques, and the tools associated with machining the material. In-depth study focused on developing skills and techniques to highlight characteristics unique to the material. Topics included additive and subtractive processes, grain and color, as well as joinery.

The macro/abstract modular and micro/specific material exercises conspired to inform a final studio exercise that focused on contemporary interpretations on vernacular masonry buildings indigenous to the region.

Exercise 02: DesignWeek

During the biannual DesignWeek that occurs every other year the College of Architecture, Art and Design sponsors visiting architects and designers run week-long, cross-disciplinary workshops on a variety of topics. The typical DesignWeek offers twelve to fifteen workshop options in a variety of formats. Some workshops are modeled on seminars while others take on a full studio cohort of 48 students. Classes in the College are suspended for the week and students devote seven full days to a single project unburdened by external distractions. Occurring in the spring semester the schedule for DesignWeek corresponds to the ARC 202 design studio and the ARC 231 Materials and Methods of Construction 1 course.

Building on the exercises in the studio and materials courses 16 2nd year students participated in full-scale fabrication workshops during DesignWeek 2013 where they produced a masonry wall, including the foundation, modeled on the studio exercise. A second group of 16 students investigated the material properties and fabrication techniques relevant to wood and steel in the creation of two benches,

Faculty members teaching the 2nd year studio and materials course in conjunction with visiting architect Jason Wright of Mobius Architects coordinated the workshops. Jason shared his extensive professional experience in design-build and fabrication with the students and faculty.

Crafting the Context

These exercises mark the initial steps toward a more comprehensive approach to the integration of full-scale, hands-on experiential learning in required course. Despite the modest size, short duration and inconsistent application these experiments highlight broad structural, operational, and logistical challenges associated with the implementation of curricular innovation. Beyond the scope of the individual classes the long-term viability of the initiative, as a sustainable component embedded in the curriculum, requires a cohesive, infrastructural response. At a very basic level, to be successful integrated learning requires coordination between faculty members. This means faculty have to be willing to work together, to talk, and to prepare. It helps if the participating faculty members actually like one another as this leads to more, and more natural, conversation.

In addition, faculty must be willing to devote time and energy to actually doing the projects with the students. Installation and residential-scale design-build projects can easily demand 50+ hours per week from the participating faculty. Even these modest exercises carried significant additional burdens. For example, the Material Exploration exercise required a series of critiques and reviews outside normal class times as it was not possible to provide adequate feedback to the dozen teams within the 50 minute class time. The DesignWeek masonry wall required two weeks of advance work gathering permissions, sourcing materials, and making preparations so the students could begin work at the beginning of the week. During the week the faculty and students worked eight to twelve hours per day in high temperatures. And at the end of the week there was little time to recuperate before returning to the normal class schedule.

The Integrated Learning Initiative has required extensive administrative coordination. Staffing the full slate of courses with appropriate faculty expertise while also aligning willing faculty with the coordinated courses and providing them all with the necessary resources can be a complicated, puzzle-like, process. It becomes even more complicated when faculty who do not participate in the initiative see resources deployed to support this type of work.

Over the past four years the College has begun to build capacity and develop the necessary infrastructure. Capital investment at the level of the College and University provided new labs, tools, and equipment for both analog and digital fabrication. The University provided a new, annual budget line dedicated to full-scale projects and equipment. In addition, the University has agreed to build a new 30,000sf fabrication and assembly lab on campus.

Strategic planning revealed a collective will to pursue ‘making’ as a core, fundamental value. Hiring at the level of faculty has expanded capacity in the classroom and new departmental leadership provided substantial design-build experience.

The department is now experimenting with new teaching-load models that allow for increased integration while also acknowledging the fundamental differences in time, scope and commitment associated design-build pedagogy. For example, faculty can now group a 6-credit fabrication studio with a 3-credit elective focused on some skill-set associated with the studio.

Similarly, curricular revision created new course alignments and altered the course sequence to provide opportunities for collaborative and/or cross-disciplinary teaching models. New elective courses introduced wide range of hands-on options. Introduction to Material Fabrication, Introduction to Digital Fabrication, and Introduction to Ceramics each mark the beginning of a three-course sequence based on an incremental approach to hands-on learning. These classes build on an existing furniture design class that marked the beginning of the department’s move toward fabrication in 2007.[6]

Students who have moved through these courses have now begun to populate upper-level design-build studios introduced in the past year, (Fig. 4). Following the incremental approach adopted in the curriculum the first experiments with design-build has focused on relatively small interior installations sited throughout the College.

Notes

[1] Freire, Paulo. "Pedagogy of the Oppressed" in Cahn, S. *Classic and Contemporary Readings in The Philosophy of Education*. McGraw Hill: New York, NY. 1997. p 461.

[2] Dewey, John. *Experience and Education*

[3] Kolb, David. *Experiential Learning: Experience as The Source of Learning and Development*. Prentice-Hall: Englewood Cliffs, NJ. 1984. P21

[4] Ibid. p20

[5] Hughes, Michael. "Constructing a Contingent Pedagogy" in Harriss, H. and Widder, L. (ed.) *Architecture Live Projects: Pedagogy into Practice.* Routledge: London. Forthcoming June, 2014.

[6] Sarnecky, William. "Building a Material Culture in Dubai." Journal of Architectural Education 65.2. Wiley Periodicals . p80-8

The Human Factor:
Materializing Relationships between Body and Architecture

Meg Jackson and Michael Gonzales

University of Houston

1_ Collage Body in Motion. *Brian Sowell*

Introduction

At once quotidian and temporal, an awareness of the dialogue between human experience and space is essential for designers of buildings, interiors, furniture, and objects. This existential human factor impacts all surfaces that directly interface with the needs of our own bodies occupying and moving through space. (1)

This paper focuses on a series of rigorous, short-duration investigations undertaken during a required Human Factors course for beginning Interior Architecture students. The seminar is a required survey course introducing anthropometrics, perception, behaviors, material-ephemeral conditions, performance, and the interface of the human body in space. Through discussions, coordinated theoretical readings and a series of design challenges which reference the body as a design generator, the students explore how the human body influences the design, construction, scale, performance, experience and occupancy of interior environments. Taught in tandem with the studios sequence, this seminar compliments and expands the study in construction, materiality, and tectonics, as well as builds upon design fundamentals.

Fundamental anthropometrics and a basic understanding of interior architectural standards are necessary for students of design; however an awareness of more subtle relationships is equally important. This course used alternative strategies to engage the students directly and actively with the complexities of spatial dynamics as related to the human condition. Directed process research included studies that engaged multimedia, fabrication methods, and material investigations. The students participated in design research as a platform for engaging with conventional interior architectural standards and design methodologies. Through iterative acts of making, the case studies presented here explore teaching strategies that embrace intuitive, yet rule-based, active approaches to learning.

The Dynamic Human Factor

Not only did we want to conceive of innovative strategies to engage the students in learning, we also challenged the way in which the human relationship to space is generally understood.

Built spaces are activated by the movement of people in, though, and around them. Historically, design has been typically taught using static organizational methods, rather than privileging the more ephemeral notions of dynamics, movement, and occupancy.

The attitude of our course was conceived under the premise that architecture is based on the organization and performance of animate bodies in space and also impacted by experience. The body affects space through its performance in space. Juhani Pallasmaa in his lecture, *Hapticity and Time*, states:

Architecture is usually understood as a visual syntax, but it can also be conceived through a sequence of human situations and encounters. Authentic architectural experiences derive from real or ideated bodily confrontations rather than visually observed entities. Authentic architectural experiences have more the essence of a verb than a noun. [1]

While engaging with the historical and conventional way of understanding a human's relationship to space, we also addressed the possibility for new types of physical space, ones that consider human interaction, perception, experience, time, behavior, and technology.

Course Content

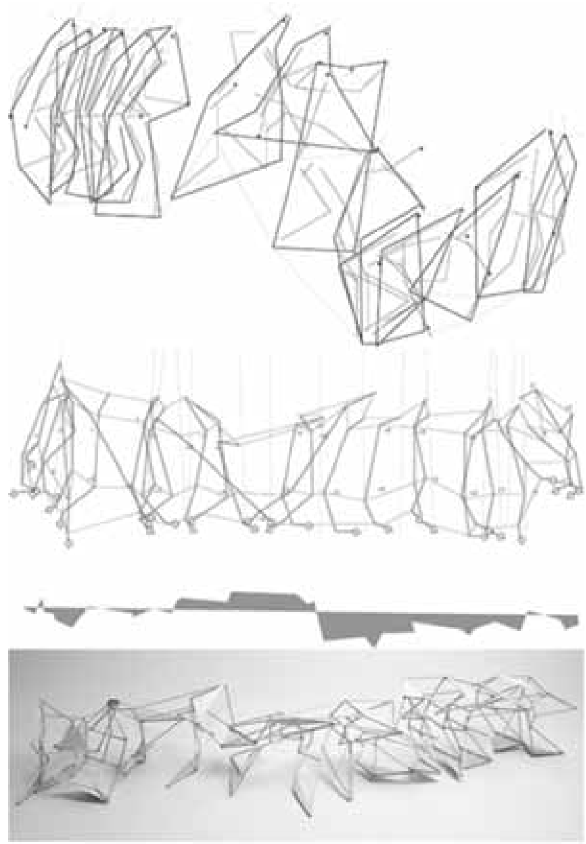
We wanted to share contemporary issues regarding ergonomics and human behavior. Some of the lecture topics included: anthropometrics, ergonomics, fashion, shelter and personal space, event, programming, workplace design, memory, perception, lighting, phenomenology, psychology, experience, color theory, the five senses, way-finding, processing, environmental control, thermal and human comfort, acoustics, identity, interactive environments, and interface design. By integrating both traditional and contemporary design considerations we were able to expose students to issues within contemporary practice while reinforcing the fundamentals of design relative to the human body and experience.

Body as Site

For this class we considered the body as site -- a complex territory for thought, expansion, innovation and exploration. (2) The human body influences the design, construction, scale, and performance of interior environments. In addition, the design of interior architecture is also shaped by human behavior, experience, and perception. Our interest in these complex "human factors" defined the theme for the course. The course addressed different layers of interiority -- from consciousness and perception to the investigation of the body itself as a factor in design.

Expanding the Discipline

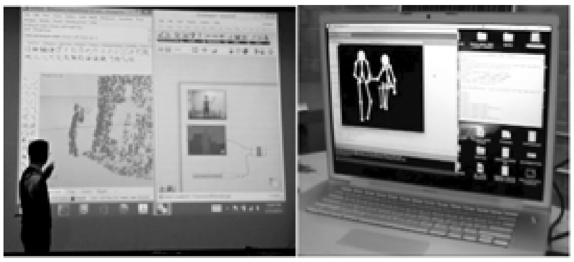
As we researched topics typically covered in human factors courses we were conscious of how often issues of technology were absent from the discussions.



2_ Topographic body diagrams. *Student work*

The complexities of technology and the body are complicated with the rise of interactive and responsive design. Several lectures in this class focused on the emerging field of sensorial spatial design in relation to how we can alternatively experience and potentially manipulate space. Technological, social and political reconfigurations require new spatial considerations. Despite operating at varying scales, layers, and proximities to the physical body, interior architecture is rooted to the basic task of enclosing space around the human form. However, technology increasingly blurs the limits of the body's territory. It is fascinating to dwell on the design implications that result from our spatial territories expanding to include both our physical body and our personal data sets. (3)

Interior architecture operates at the site of the body – which in many ways is a shifting landscape. Interventions at the site of the body, not only shelter, protect and engage us, but also ultimately define our identity and place in society. This course sought to introduce beginning design students to the complexity of therelationships between the contemporary body and the space of the interior.



3_ Responsive Media.

Body as Medium: Materiality/Essence/Scale

In *Abstracting Craft*, Malcolm McCullough writes, "that active participation is the way to retainable knowledge. In this regard skill has intrinsic, personal worth."[2]

As instructors introducing complex and often abstracted concepts, we wanted to combine the historical and contemporary precedents with actual efforts of making. It was important to us that students connected with the concepts in a concrete way.

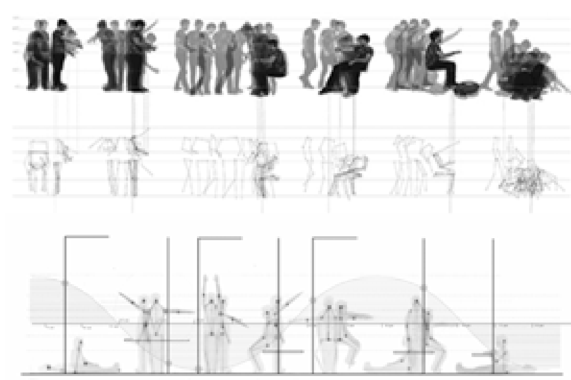
This course presents concepts in increasing scales – from the study of the body itself to the scale of the interior. The projects focus on the layers of interiority beginning with the closest layer – clothing and material manipulation -- and progresses outward. The second project focuses on the extension of one's body in space and the concept of personal shelter. The final project is a furniture construct that must contain the body. This project concentrates on the tectonics and materiality of a surface and its relationship to the body as volume.

Design curricula must teach students methods of making, techniques of critical thinking, and ways of seeing. The intellectual ability to transfer a complex, even abstract, idea into a design statement or concept is obligatory. (4) McCullough concludes by stating, "...hands are the best source of tacit personal knowledge because of all the extensions of the body, they are the most subtle, the most sensitive, the most probing, the most differentiated, and the most closely connected to the mind."[3]

These material processes are time-consuming, yet their slowness offers considerable learning to the beginning designer. Students are able to thoughtfully consider the impact of time, choice, and the human dimension when manipulating materials with their own hands. Using the human body as a generator for design offered opportunities to reimagine conventional practices.

By integrating both analog and digital methods of making, students had to confront issues of "material behavior, fabrication constraints, and assembly logics which promote an understanding of form, material, structure and behavior not as separate elements, but rather as complex interrelations."[4] In the case of Second Skin it is the design of the wrapper/skin that forms a reciprocal relationship with the body of the designer. The material manipulation (folds, creases, perforations, etc.) is only fully understood when occupied by the structure of the body. Furthermore, the body's movement is emphasized by the behavior of the fabric through time. In the third project, Container, it is the form and comfort of the body that ultimately motivates the material constraints.

In all three projects, corporeal complexities are visualized through material studies which privilege the body as a medium. The body is the site of all three exercises. Physically investigating constraints relative to human interaction, engages students with a tactile connection to research. Hopefully, this haptic relationship with data produces a deeper memory and a richer capacity for learning.



4_ Dynamic body-space timelines. *Student Work*

Project 1: Wrapper: Second Skin

The first of three cumulative projects parallels several class lectures on human factors in interior architecture. The observations and experimentations in the first project will help inform the design process for later investigations privileging the body. This project consists of two parts. For the first part, students use their individual anthropometric measurements to generate a digitally fabricated mannequin/torso that serves as the base for their investigation. (5)

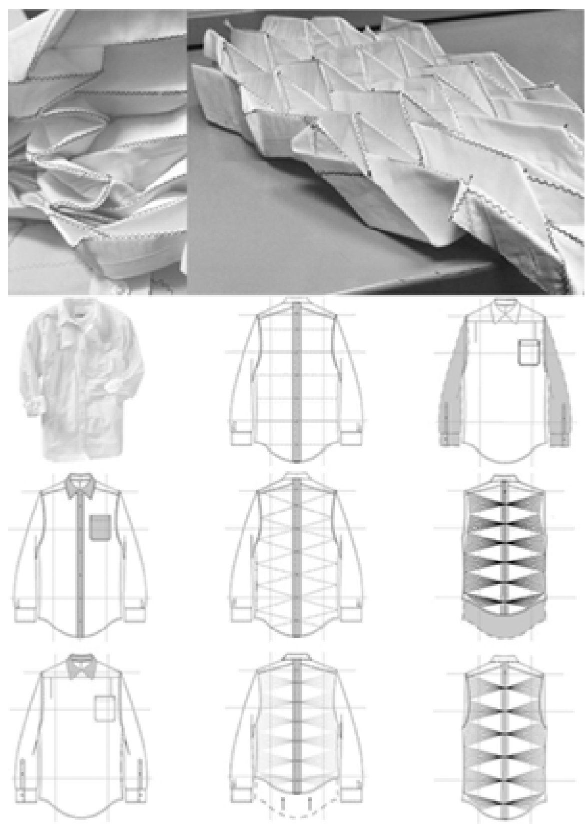
This exercise paralleled discussions on historical and contemporary proportioning methods, geometries, ergonomic considerations, anthropometrics, measurement methods, and body-mapping.

As an initial notational exercise students investigated and measured human dimensions generally, as well as their own bodies specifically. Students are often more engaged in learning when asked to reference their own body or experience. In this case, the students were excited, curious and easily persuaded to learn the techniques and tools to fabricate their projects.

5_ Fabricated mannequin. *Student work*

The second phase of the project – the wrapper- focuses on material transformation. We discussed the history of shelter, issues of personal space, fashion, performance, anatomy and geometry. Readings included writings about bodies in space and the contemporary body, memory and identity. The work of Diller and Scofidio, Lucy Orta and others served as inspiration.

The wrapper exercise tests the inherent material capabilities and anthropomorphic opportunities of a white oxford shirt relative to the human body. The idea of this project is to develop non-conventional design expressions related to the human body with emerging logics of construction. The human body, its dimensions, structure and performance should guide the transformation process. The shirt's construction and basics of enclosure should inform the deconstruction/re-construction process. Experimentation should begin at the interface between the shirt, its enclosure and the human body in space. The shirt is to be deconstructed relative to the student's concept based on the shirt as a surface relative to the human body. (6)



6_ Second Skin. *Student Work*

The students first determined a concept for research: construction, movement, texture or use. They were then asked to select operational techniques (examples: bind, fold, pleat, crease, bond, etc.)(8) that were to be fully explored through the alteration of the white oxford shirt. This project requires that the students define a methodology and a systematic approach to design process and material transformations.

While developing rules, or strategies, that guide and organize their process of alterations, the students were asked to think about the performance of the wrapper. The manipulated surface should be a commentary on the interface between body and skin. The fabric of the shirt acts as a secondary skin for the body. Students may transform the geometry of the shirt using measured, intentional, and precise operational techniques. No additions may be added to the shirt apart from thread. The project challenges the materiality and geometries of the shirt, while revealing and extending its architectonic potentialities.

The shirt, a material with definitive limitations, offered an opportunity to unexpectedly manipulate an anthropomorphic, architectural research object at the scale of the human body (7) to determine topological and functional potentialities.

7_Second Skin. *Student Work*

Though it lies beyond the physical boundaries of our body, our second skin is nevertheless critical in defining who we are and how we are perceived; thus our identities extend beyond our physical perimeter. Design is the intermediate zone between our skin and what lies beyond. As our second skin, it is an essential extension of ourselves.[5]

Project 2: Interface: The Umbrella

This second design research project, focusing on the umbrella as an extension of the body, serves as preparation for the third project – a furniture construct. This project was a critical analysis of the personal umbrella as it relates to the body. The umbrella, mediates the relationship between the body and the world. Through analytical drawings and collage techniques, the students were asked to interrogate this extension of the body for its formal, operational, conceptual, and mechanical possibilities.

8_ Second Skin. *Student Work*

This project continued the discussions about the contemporary body in space and personal shelter. Additional topics discussed were performance, temporality, movement, motion, workplace design and circulation. While the students were researching the umbrella we also looked at perception and reasoning, phenomenology, lighting, illumination and color, human behaviors and engaging our five senses. This project paralleled lectures on furniture and spatial design including assembly, ergonomics, materiality and human comfort. The final lecture in this second series was 'Processing the Interior Environment' in which we discussed color theory, processing and input, way-finding, graphic design and interfacing. For the umbrella project, some of the references were Merce Cunningham, Archigram, Neri Oxman, Lucy Orta, Oskar Schlemmer, chronophotography, and prosthetic design.

9_ Interface. *Student Work*

The students were encouraged to collect research and then analyze their research as a series of narrative notational drawings using multimedia collage techniques and calibrated vector diagrams. Rather than confining the body solely to pattern, measurement and representation, the body was a force that affected the space. (9)

This layered technique was simultaneously an experimentation of graphic communication – media, hierarchy, technique, line weight and type, color, layering, notation—as well as an analytical, rigorously calibrated, precise drawing of the relationships between body, space, and time. The act and craft of making the drawing allowed for a deeper self-investigation resulting in a generative diagram and an ability to focus critical thinking.

This type of analytic drawings offers a flexible, self-directed exploration based on solving a particular problem: *How to represent the complexity of the body in relationship to an object in space and in action over time?* Students develop a personal connectedness to the importance of human proportion, scale, *and* event.

This process promoted innovation—allowing each student to create an architectural language to notate anthropomorphic measurements simultaneously communicating a complex spatial idea. Accurate measurements and situational analysis within a single drawing allowed for a more complex introduction to the conceptual base of the project.[6] Ultimately, this approach operated on the premise that space is dynamic in four dimensions. Consequently, spaces are not understood merely as containers for the body or patterned by bodily proportions. Rather, they were engaged in performance *with* the body itself. The result was a dimensionally rich, spatial-relationship diagram that reinforced interior architectural space as an extension of human performance.

Project 3: Container: Body in Space

A building is immovable space, by contrast, the outcomes of design, such as furniture, are direct extensions of human form and are-or should be-moveable or adaptable by us and for us in space.[7]

This final project builds upon previous research into the extension of the body and its proportions to develop a performative furniture construct that contains the body in two ways.

While designing and researching their constructs, the students participated in a series of lectures: ‘Man as a System Component’. We reviewed building systems and looked at issues of environmental control, climate, thermal comfort, air quality, illumination, health and safety, egress and energy. We also looked at further issues of identity and interface and introduced several interactive and responsive design architectural projects.

Understanding the dynamic relationship between the body, space, comfort and behavior, the aim of the final project is to gain an understanding of tectonics, surface and materiality as it relates to the body in space. Students investigated advanced fabrication techniques and assembly strategies to design a construct that is portable, graspable, and can contain the body. The project began by researching assembly methods and tectonic strategies evident in flat-pack furniture to inform the design and construction of the project.

10_ Container. *Student Work*

The project gave the students the opportunity to build full-scale and to build at a scale in relationship to the human body. In addition, these projects let the students practice and investigate joinery. Once mastered, joinery may be exploited as an interior space-making generator scaled to the human body.

The final wood construct addresses ideas of portability, comfort, and assembly. Students analyzed these themes relative to their design and presented their proposal through drawings, diagrams and a series of scale models in addition to the full-scale build. (11) Evaluation criteria were based on the efficiency of material, portability and relationship to the human body.

11_ Container. *Student Work*

Conclusion

Through the act of making, students are asked to investigate, elaborate and implement complex attitudes toward materials and objects in space, especially as they relate to the human scale.

Learning through making allows for the investigation of the complexity of spatial human relationships beyond standard anthropometric tables and ergonomic requirements. Engaging directly with their own bodies moving through space and time and focusing on 'self', encourages a diversity of solutions.

A critical approach to making causes students to be aware of their bodies as a valuable reference point for understanding the complexity of spatial relationships. The process of creation leads to the discovery of the vital role that proportion, scale, and ergonomics play in design. As the projects increase in scale relative to the body, the students also understand how the body is a measurement in relation to itself, other people, objects and surfaces affecting the interior.

We behold, touch, listen and measure the world with our entire bodily existence, and the experiential world becomes organized and articulated around the center of the body.[8]

The teaching and learning of architecture is a dynamic and on-going process appropriate to its time; however it is continually grounded with a timeless connection to the human condition. We are charged with teaching beginning designers the complexity of human relationships to the built environment. We believe that making is inextricably linked to architectural thinking. The process of each project produces analytic inquiry and learning is made more effective because it is fueled by the promise of curiosity and discovery. Through projects that privilege the critical perspective of the body, applied design research and the act of making, the essential relationships between body and architecture are revealed.

Notes

[1]Pallasmaa, Juhani , "Hapticity and Time", 1999 RIBA Discourse Lecture

[2]McCullough,Malcolm,"Abstracting Craft: The Practiced Digtial Hand", MIT Press: Cambridge, MA, 1998. p 7.

[3]Ibid, 7.

[4]Menges, Achim. "Integral Formation and Materialisation" in *Computational Design Thinking,* John Wiley & Sons: Chichester, UK. 2011. p 202.

[5]Caan, Sashi. *Rethinking Design and Interiors,* Laurence King Publishing Ltd.: London, 2011. p 40.

[6]Angelil, Marc. *Deviations: Designing Architecture-A Manual*, Basel: Birkhauser Architecture, 2008.

[7]Caan, Sashi. *Rethinking Design and Interiors,* Laurence King Publishing Ltd.: London, 2011. p 51.

[8]Pallasmaa, Juhani. *The Eyes of the Skin,* Wiley-Academy: Great Britain. 2005. p 64.

A Machine for Learning:
Materials and Construction in the Beginning Design Studio

James Leach, James Spiller

Iowa State University

Introduction

An ongoing effort, begun nearly a decade ago by the building technology faculty, seeks to increase integration of the concepts and content taught within the technical courses into design studio work. This has primarily been implemented through lab assignments in the technical courses devised to apply developing technical knowledge to current, or recently-completed design studio projects. This approach has met with considerable success in the later years of the architectural education, after students have acquired a strong foundation of technical knowledge. There is greater difficulty, however, in fluently integrating building technology content in early studios, particularly given a greater fluidity in early design studio content, and a lack of technical knowledge among beginning students.

This paper details one attempt to incorporate the exploration of materials and construction within the early architecture design studio. More specifically, the work of the first year, second semester, undergraduate architecture design studio, Arch 202, will be presented. The theme of materials and construction is approached in the studio via the *Machine Project*, a six-week-long “warm up” exercise taught at the beginning of the semester. This project takes a direct approach to technical issues, with a focus on imparting first-hand experience to novice students.

Position of the Studio

Arch 202, taught in the Spring semester of the first year of architectural study, is the third design studio in the educational sequence. It is preceded by Arch 201 in the Fall, and, before that CORE, a basic design studio taken during the freshman year, prior to acceptance into the Department of Architecture. Arch 202 is taught concurrently with the introductory building technology seminar course, conducted as a series of lectures and labs encompassing fundamental issues of materials and assemblies.

A major goal of the Machine Project within the design studio is to compliment this technical content with hands-on exploratory design work utilizing real materials and tools. Another focus of the project is to continue the emphasis on previously-introduced techniques of sketching and technical drawing as integral tools in the investigative and communicative process of design.

The Machine Project

The semester begins with students working in pairs on the six-week-long Machine Project. The work is approached through a structured iterative process with several distinct phases of activity. The process begins with *Discovery* and *Tinkering,* progressing through development of a *Proposal, Prototyping, Testing,* and *Re-construction*.

Fig. 1. Students tinkering.

Discovery and Tinkering

To begin the project, each student pair is assigned one of the following vocations to investigate: physician, astronomer, cartographer, or spy. They examine the particular tools, processes, and methods by which each vocation gathers, organizes, and presents empirical information. These findings are presented and discussed in class.

Concurrent with the Discovery phase, students engage in Tinkering (Fig. 1). Each team acquires a minimum of three mechanical objects having one or more moving part. They disassemble the objects, creating exploded axonometric drawings, attempting to understand, document, and communicate construction and mechanical operation. Using only elements from their disassembled objects, the students must assemble a new hybrid capable of mechanical operation. The Discovery and Tinkering phase of the project concludes at the end of the first week of the semester.

Next, the students receive the Machine Project brief in which they are challenged to:

design, prototype and construct a full-scale instrument to mediate a relationship between the user and the physical environment, while interpreting, heightening, or re-presenting a particular observable phenomenon such as gravity, light, sound or wind. [1]

These instruments are to be "interactive with, or activated by the human body (and to employ) mechanical movement as an essential element."[1]

Proposal

In the second week of the project, each team begins an iterative ideation process. Exploring emerging concepts through sketches, diagrams, and working models (Fig. 2), they test and develop initial ideas. This process culminates in the creation of a design proposal, in which the students prepare a written statement outlining the intended relationship of their Machine to physical phenomena, human experience, and the nature of the mechanical movement employed.

Prototyping and Testing

Following instructor critique and refinement of the proposal, students develop a working prototype, exploring issues of material and connection performance, mechanical movement, structural stability, interactivity, ergonomics, and experiential effect. After two weeks of development, the prototypes undergo testing. Through a "gallery-style" review, students are able to demonstrate and observe performance while receiving feedback from instructors and peers inhabiting, operating, and interacting with their prototypes.

Re-construction

Based on prototype performance, students spend the final two weeks of the project refining and rebuilding the Machine. The final full-scale and functional machine is accompanied by a measured, exploded axonometric drawing communicating the details and choreography of construction.

Machine Project Intent

The sequencing of tasks is orchestrated to avoid overwhelming the students with the complexity of the entire project at once. The delivery structure divides the project into discrete phases, each with a clearly-defined set of goals and deliverables. Through these activities, students gradually build competence and confidence in new ways of working and thinking, with each phase building toward the next.

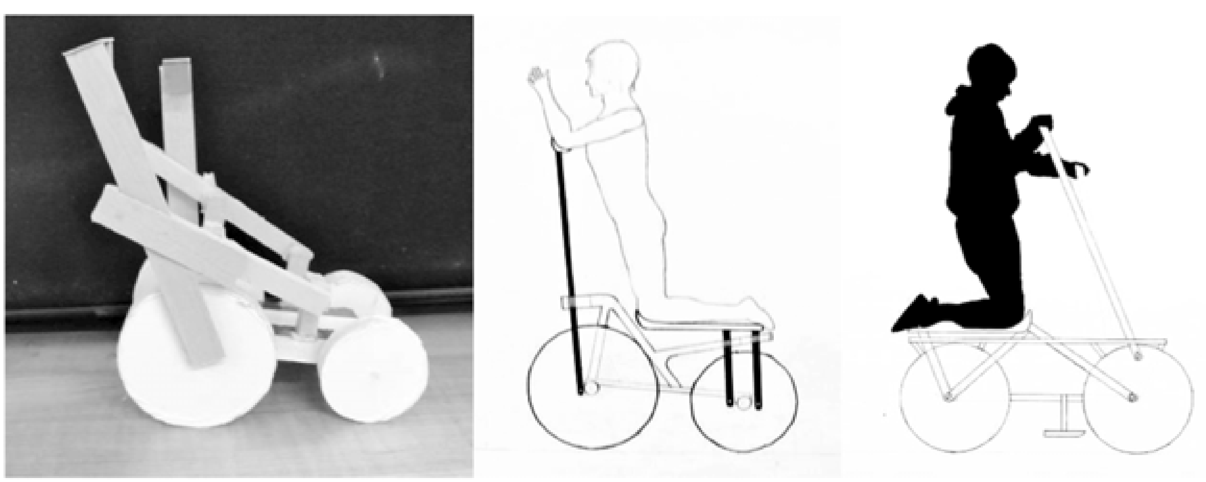


Fig. 2. Developmental drawings and model.

This approach also creates multiple avenues for conceptual engagement. One student group may develop an interest in exploring the techniques and methods used by the vocation assigned to them in the Discovery phase. Another may pursue implementation of a particular mechanical operation discovered while tinkering, while others become interested in creating a particular kind of user experience or interaction with phenomena.

The research, presentation, and discussion of the initial Discovery phase serves to expand students' awareness of the multiplicity of experiential phenomena, and the means by which they are observed, measured, and recorded. These activities also help to create a foundation of shared vocabulary and experience among all students.

The process of deconstruction, documentation, and reconstruction in the Tinkering phase not only introduces students to, but immerses them in issues of materials, connections, and assembly in an immediate and intuitive way. They are challenged to inventory, examine, assess, and inventively recombine physical constructions, but, at this stage, not to *design*. This helps to obviate any "design paralysis" that can affect novice students when confronted with new and unfamiliar concepts and processes.

The awareness and experience gained during Discovery and Tinkering, forms a conceptual foundation, enabling student to "jump in" to the development of their proposals and to continue with the primary work of the Machine Project.

Charles Eames identified one key to design as "the ability of the designer to recognize as many of the constraints as possible, his willingness and enthusiasm for working within these constraints. The constraints of price, size, strength, balance, time and so forth. Each problem has its own peculiar list."[2] Constructing a full-scale, fully functional prototype brings such constraints into sharp focus in a way not possible via the drawing and digital or physical modelling methods typically employed in design studio.

The demonstration of built prototypes in the gallery review provides a venue for students to critically assess their own work and identify critical functional failures. These failures become learning opportunities, illuminating design constraints and serve to inform further development of the design.

Fig. 3. Prototype pre-, and post-collapse.

By first-person observation of performance under real conditions, students are presented with clear and measurable success criteria: the Machines must operate, they must hold together, they must stand up, they must manifest phenomena, they must accommodate human interaction. Students learn to not only accommodate, but, as Eames says, *embrace* these requirements to achieve success. The "all-or-nothing" stakes of the project create a productive, if demanding design challenge, interweaving multiple issues of function and construction with aesthetic, conceptual, and experiential aspirations.

The Re-construction phase requires students to substantially, or completely rebuild prototypes to address not only inadequacies of operation, interaction, or stability (Fig. 3), but to refine connections and improve the craft and the quality of fabrication (Fig. 4).

Many projects proved unstable due to structural or connection shortcomings. Others could not perform their mechanical function, due to issues such as friction, inaccurate fabrication, or wear and tear on materials. Some failed to satisfactorily manifest physical phenomena. Interestingly, a great number of students were dissatisfied with the "user interface" and ergonomics of their machines. Under the lens of actual use, it became obvious that much more consideration for user experience and interaction was required.

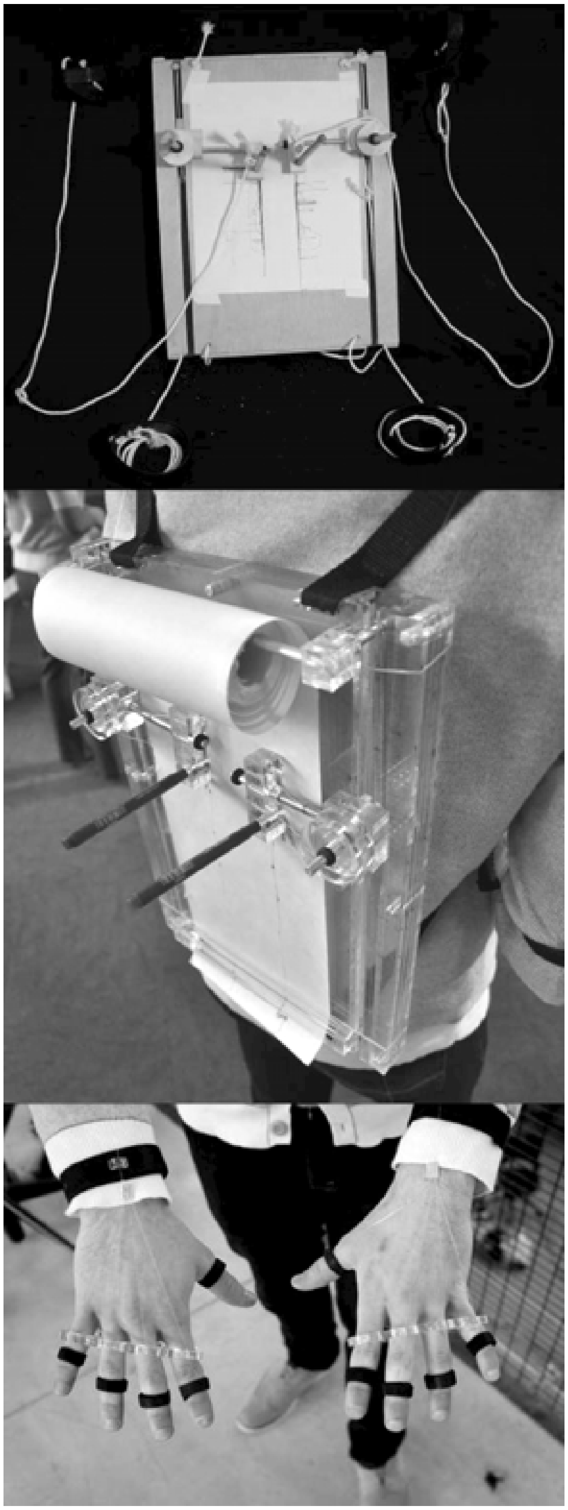


Fig. 4. Prototype (top) and Re-construction with functional and material refinements (middle and bottom).

Observations

Based on faculty observations, The Machine Project has proved wildly successful at generating student investment. Students became extremely invested in making their Machines work. The 'make it work' attitude created a heightened sense of urgency and responsibility and a greater sense of accomplishment when they achieved a successfully operating machine.

The Machine Project has also proven successful at introducing students to a multitude of issues difficult to engage through speculative "paper projects". These include technical design issues such as: material properties, tools and processes, joinery, cost analysis, structural stability, load path, and connections, as well as broader design issues of collaboration, iteration (from conception, to failure, to redevelopment, to success), and human perception/sensation.

In an effort to assess student perceptions, the faculty circulated a brief questionnaire in the following semester, soliciting input regarding the value of the Machine Project and the lessons learned therein. About one third of the class responded, and of those, no negative comments about the project were identified. This general positivity may be due to the disposition of students likely to respond to a non-required request for written work, but we were impressed by the insight and regard for the project that the students demonstrated in their responses.

Regarding the design process, Victor Valadez noted, "It forced me to think more about the entire process of how to design and build instead of just designing a form." This indicates an understanding of buildings, not as objects, but as assemblages, constructed of physical material in a physical process occurring in time and space. The identification of designing more than a form is also an indicator that students are aware of how built realities affect human experience beyond visual inputs. The awareness of the multiplicity of human sensation is one of the primary objectives of ARCH 202, whereby the Machine Project requires a sensation tested design throughout its development and refinement.

Joshua Neff stated, "Drawing can only convey so much. I think that having to construct (the machine) helped me to better understand (the role of) a construction document to explain the design." Similar comments were present throughout the responses, identifying that the students acquired real awareness of the false reality of drawn or modeled space, particularly when the students have a limited knowledge of building science, material technology, and construction practices. Student Alexandra Lunning explained that, "we are taught about materials, construction, and structures in our technology classes, but the machine project was a great introduction into the actual construction of objects and the forces at work within them." Understanding inherent disconnections between theoretical knowledge, drawing, or model, and potential built reality, is a major underpinning of thoughtful and considerate design. The Machine Project develops in students a nascent awareness of these disconnects, ideally enabling them to begin to anticipate such issues in their future work.

Admittedly, the evaluation of outcomes of the Machine Project has exposed some trade-offs as well. There was a very real struggle, later in the semester, to apply lessons learned from the Machine Project to a building design. This is partially attributable to the shift in scale, from object to building. More importantly, perhaps, was the absence of real feedback and productive constraints inherent with the limitations of a paper project. As student Zhaoyu Zhu observed, "Errors occurred throughout the process of (making) the machine. Small errors might not affect a drawing, but one small error can determine whether your machine works or not." Zhu discusses The Machine Project in terms of working or not working. This language addresses obvious physical requirements of structural, material, and mechanical performance, and ergonomics. These issues are unavoidable when dealing with a full-scale, interactive construction. However, when the students are tasked with designing a building or larger structure, the exploration of concepts and physical-spatial proposals is approached by the limited avenue of traditional design representation, conducted at reduced scale, typically in two-dimensions. Designs on the page or screen are not affected by the forces of friction or gravity, so there are no measurable, testable criteria to make manifest failures of physical performance.

Paradoxically, additional difficulties which emerged following The Machine Project typically related to a lack of fluency with these very representational strategies. Despite production of supporting technical drawings, the Machine Project is primarily a hands-on exercise. This focus does not contribute to a foundation of traditional architectural representation techniques in the beginning weeks of the studio, resulting in poorer representations of the more abstract buildings later investigated in the semester. By favoring the tactile, haptic, physical, and measurable, the Machine Project sacrifices development of the students' capabilities with abstraction and representation.

Conclusion

The end goal of Architecture is not representation, but construction, and the Machine Projects serves as a first-person introduction to issues of construction. Material performance and constructional concerns are not readily apparent to inexperienced students, and can be easily ignored when working with pencil, mouse, or model. The Machine Project begins to give students some awareness of the immensity of the gap between the drawing board and the construction site. While almost any imaginable form can be virtually modelled, construction is a physical process, with inherent limitations and potentials. Through this exercise, students gain direct experience with materials, developing an understanding of their particular expressive and performance qualities. They begin to understand that technical issues of material, form and construction can be, and often must be, integral to design concept, and that competent employment of material and form for functional effect often determines the success or failure of a project.

The Machine Project has thrust building science and material technology issues into the heart of the design studio. Moreover, through the Machine Project, practical understanding of design intent, material limitations, and human perception and experience has been set forth as a foundational element of architectural education. This approach could be considered a reverse-engineering of our typical approach to technology labs as overlays or add-ons to the design studio. The project serves to broaden student's awareness of the potential of their designs to be not just an idea or object, conceived and depicted, but physically realized construction capable of creating particular interactions and experiences. Particularly through the building, testing, and re-building of full-scale prototypes, students become aware that a host of additional performance issues, relative to user interface and experience, are critical design drivers. The typical design studio tends to be dominated by conceptual or aesthetic concerns and an often speculative approach to problem solving. The Machine project weights structural, functional, and experiential success equally with concept. As student Zhaoyu Zhu commented, "Concept is only one part of the project. If you have a sweet concept but the machine doesn't work, the concept is not that attractive."

The injection of the traditionally disparate concerns of building technology courses into the beginning design studio through the Machine Project empowers young designers with the knowledge that building performance is a substantial determinant in the success or failure of any project's development in their future architectural careers.

Notes

[1] Rhodes, Patrick. *Machine Project Brief,* ARCH 202, Iowa State University, 2013.

[2] Eames, Charles. *Design Q & A*. Dir. Charles Eames, Ray Eames. 1972. Film.

Figures/Images:

Fig. 1. Spiller, James, photographer. 2013

Fig. 2. Hamman, Michael & Hull, Donald Hull. Machine Model and Drawings, ARCH 202, Iowa State University, 2013

Fig. 3. Spiller, James, photographer. Bannik, Charlotte & Wuest, Laura. Machine Prototype, ARCH 202, Iowa State University, 2013

Fig. 3. Spiller, James, photographer. Lick, Jacob & Pigeon, Will. Machine Prototype and Re-construction, ARCH 202, Iowa State University, 2013

Working the Negative:
Defining Spatial Concepts with Plastic

Tiffany Lin

Tulane University

Introduction

Beginning design students often struggle with a fixation on shape-making, which is one of the most difficult preoccupations they must un-learn. The obsession over what a building looks like may stem from playing with Legos, watching fictional Hollywood architects design skyscrapers, or simply the desire to emulate existing building types. This leads to the misconception that buildings are primarily designed from the outside in, rather than from the inside out. Understanding the paramount role of negative space is fundamental in the education of an architecture student. This paper presents work from a beginning design studio where we introduce the manipulation of plastic as a way of exploring the tactility of space. By shaping the physical characteristics of negative space through an activated plastic mass, students are able to distill important concepts from precedent buildings and deploy these spatial systems in their own design investigations.

Seeing the Negative

In this foundations design course, students are taught to see beyond literal figures, learning to analyze the significance of the negative space within, around and in between objects. Through a series of lectures that present examples of activated negative space from related disciplines such as graphic design and film, students learn the important lessons of figure-ground reversal (Figure 1). By first seeing and understanding the important role of “space” in simpler, two-dimensional contexts, students are able to work toward unpacking complex, three-dimensional spatial systems in precedent buildings. Students learn from working with physical materials that negative space is in fact never neutral. It is something to be confronted, directed and designed.

Fig. 1. Stills from the animated film “*Up*” revealing the significance of the space in-between.[1]

Working with Plastic

At the onset of the design studio, students were taught to work with plastic as a material of exploration and a means of representing negative space. A series of instructional workshops were conducted for resin casting, laser-cutting and laminating acrylic sheets. Plastic was introduced as a design tool to reinforce an understanding of negative space and expand a student’s toolset for three-dimensional thinking. The two very different ways of creating a plastic volume allowed students to explore both the tactile process of analog fabrication (casting resin) and digitally-processed production (laser-cutting acrylic sheets). The texture of each plastic volume produced in these ways registers the process of its production, emphasizing the idea that negative space cannot be neutral. In the case of resin, the resulting spatial volume expresses the shape and texture of its mold and curing conditions, much like cast concrete (Figure 2). In the case of the acrylic sheets, the laminated edge-grain produces resonant striations in one direction and amplified transparency in the other (Figure 3). Students had to first grasp the consequence of each process and associated outcomes before deciding which method to use in their own models.


Fig. 2. Cast resin blocks from class demonstration

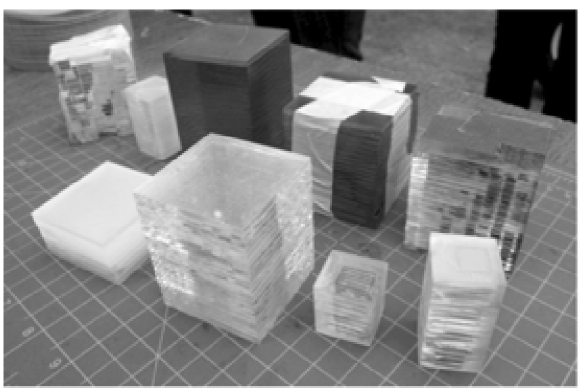


Fig. 3. Laminated acrylic blocks (laser-cut sheets)

The derivative use of plastic to represent glass was prohibited, as well as the general use of plastic as a planar material. Rather than becoming boxes or “aquariums”, the volumetric role of plastic was emphasized as a three-dimensional, generative device for spatial articulation. Using plastic volumes to communicate a design concept forces students to distill clear relationships between figure and ground. In a palette that uses stereotomic plastic forms to represent negative space, mass and void literally become equal participants and students are able to grasp the concept that architectural space can, and should, have a material resistance. No longer is negative space the left over stuff between walls and columns when one thinks of a building superficially from the outside in. It is the design element that must be confronted first, as casting resin and laminating acrylic requires a clear intention, a strategy for assembly, and precise execution.

Precedent Analysis

Architects, painters, and sculptors must recognize anew and learn to grasp the composite character of a building both as an entity and in its separate parts. Only then will their work be imbued with the architectonic spirit which it has lost as salon art.
-Walter Gropius [2]

The first design assignment asked students to analyze a precedent work of architecture through a series of physical models, then produce a set of digital diagrams that support these models. The abstract world of digital modeling was only introduced after students completed several assignments focused on the craft of hand-drawing and physical model-making. This important pedagogical decision has proven to be instrumental in the education of the beginning designer, particularly in regards to the topic of materiality and representation. As the realm of digital representation proliferates, a fundamental sensibility to scale, tactility and gravity are often missing in the beginning design project. Curricula that delve directly into digital drawing and computer-modeling often suffer from students who feel the need to create every detail in anti-gravitational space, without the resistance of scale or a physical reality. Our goal was of course not to deny the necessity of computer prowess in the contemporary architectural practice, but rather to build a sensibility to the tactile and the digital simultaneously. By asking students to first produce physical models that grappled with material textures, connections, scale and gravity, they could not easily “un-do” and were forced edit their own work as the process evolved, much like the making of a building. The challenge of extracting a conceptual diagram and only representing the essence of a building is necessary when faced with the physical limitations of a real, non-digital, model.

Physical Models

Following in the Bauhaus tradition of teaching students how to see through the craft of making, students learned to experiment with various material techniques, exploring the intrinsic characteristics of each medium.[3] The use of plastic was a required element of these analytical models, combined with more familiar materials such as wood and plaster. Students were given two weeks to generate five analytical models that

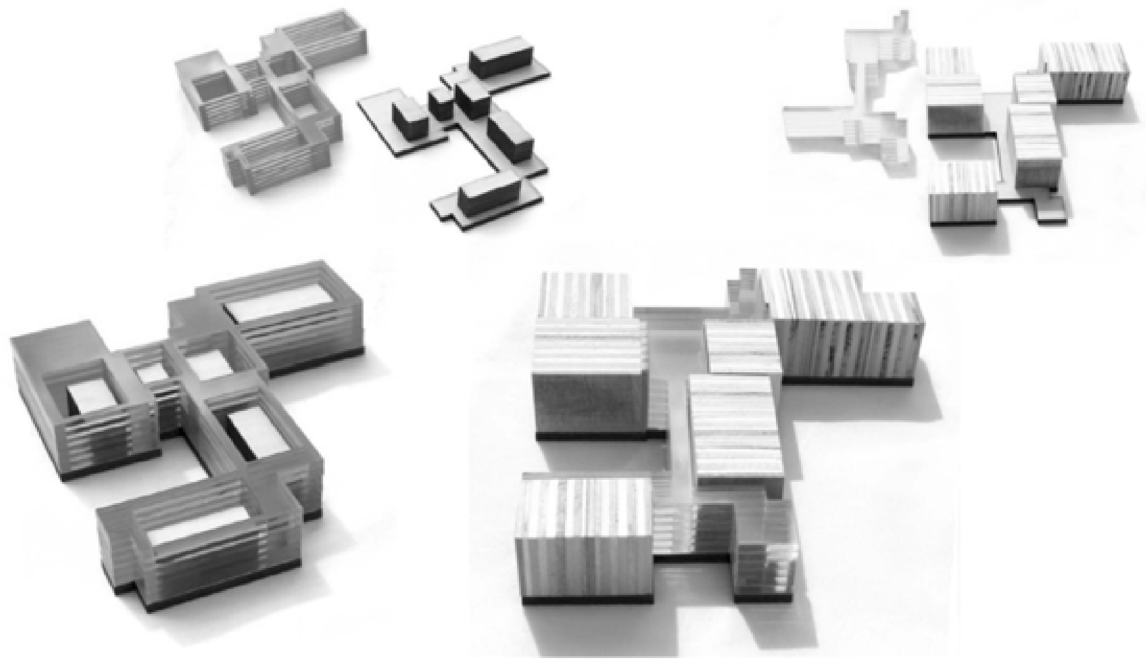


Fig. 4. Shindler House Analysis models: Spatial Extension and Circulation Core *(student D. Dodge)*

addressed the conceptual, formal, organizational and tectonic qualities of a canonical work of architecture.

Some rules that guided this work include: 1) a consistent scale of representation, 2) a clear conceptual intention for each model, 3) a coherent strategy for material deployment, and 4) models that work individually and as a part of the series. In addition, students were encouraged to engage the scale of the hand and consider the didactic value of these models as mini-explicators of their precedent building. The natural colors, textures and grains of materials used were to be carefully considered. This project was evaluated based on the clarity of analysis and the effective re-interpretation of the precedent building. Through this exercise, students learned to distill and communicate core ideas of a masterwork of architecture and internalize the complex formal compositions these projects embody.

This assignment yielded many insightful readings of precedent projects, each using the resistance of plastic differently to reveal a specific spatial characteristic. In the case of the Shindler House analysis, acrylic forms in the first model describe spatial extensions of rooms into the landscape. The second model uses a distinct plastic volume to depict the circulation core that connects individual studio spaces. Laminated sheets of acrylic used for these models generate a strong horizontal grain, emphasizing the horizontality of Shindler's sequence, further amplified by the contrasting vertical grain of the plywood frame (Figure 4).

The series of models analyzing the Muller House skillfully deploys plastic in different roles to explicate the sectional richness of Loos' architecture. The first example describes the function of vertical circulation as both the physical structure and the spatial armature within an introverted mass (Figure 5).

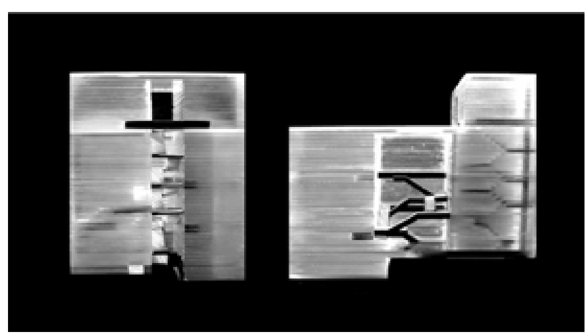


Fig. 5. Muller House Analysis (*student E. Himmel*)

The second model uses a plastic volume inserted into a plaster cast to illustrate the visual connection between occupants within a dense spatial sequence. Translucencies of the plastic volume are manipulated to highlight a visual connection that works diagonally in both plan and section (Figure 6).

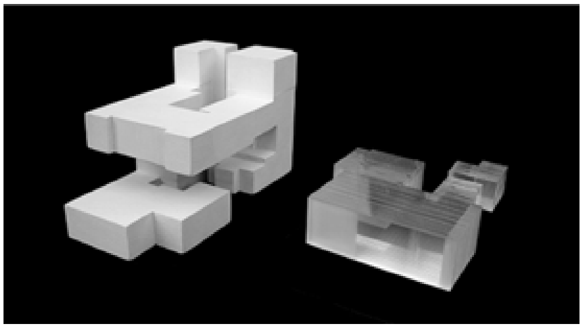


Fig. 6. Muller House Analysis (*student E. Himmel*)

The complexity of Muller House is further unpacked in the third model which uses a series of frames fabricated from inscribed acrylic sheets and laser-cut basswood inlays. Each composite frame describes a vertical cross-section through the house. The profiles of spatial compartments work together to illustrate the choreographed cinematic experience of the architectural sequence. Basswood inlays outline physical boundaries of the building while plastic sheets are sanded and layered to create a distinction between solitary spaces and transient spaces in each section. Profiles left empty identify rooms that connect laterally through the project. The complete reading of this analysis is only evident when the intricate frames are superimposed on top of one another, creating the proportional volume of the building (Figure 7, 8).

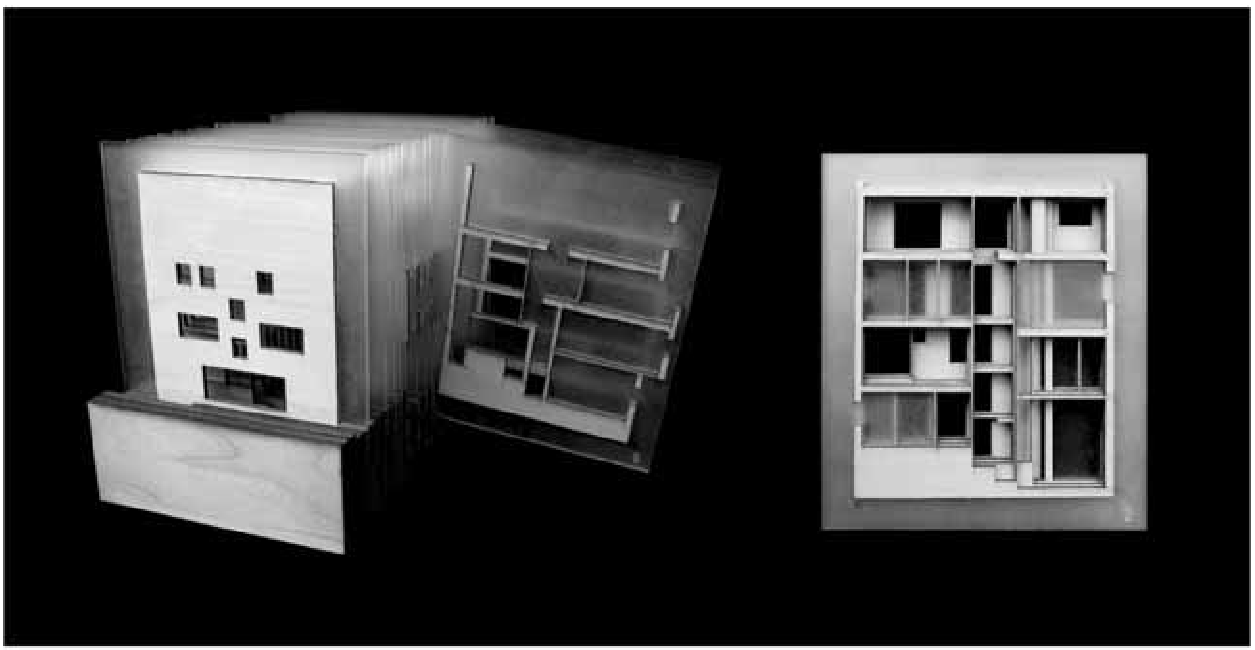


Fig. 7. Muller House Analysis (*student E. Himmel*)

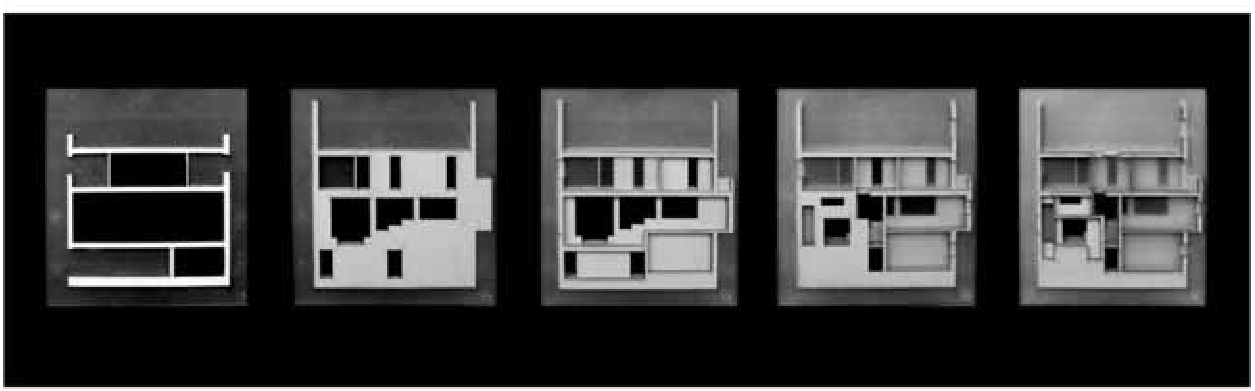


Fig. 8. Muller House Analysis: Cinematic Sectional Frames (*student E. Himmel*)

Digital Diagrams

After the iterative process of physical model-making, students were able to better focus the intentions of their precedent analyses when working in the computer. The important role of digital diagrams was introduced through a series of lectures. These diagrams have become ubiquitous in contemporary architectural practice as powerful tools that allow designers explain the big idea through one image. The ability to communicate an overarching architectural concept through an all-encompassing, transparent view requires facility not only with computer software, but more importantly, clarity and restraint in execution. Having extracted the spatial systems latent within precedent buildings, students were able to engage computer-modeling with a stated goal, without mindlessly reproducing every element of an existing building.

The first digital assignment asked students to couple each physical model with a digital diagram that would reinforce its analytical intention. In order to produce a three-dimensional digital diagram, the beginning design student has to first gain facility with multiple computer programs such as Rhino, Photoshop, and Illustrator. We did not want to compounded this challenge with the added burden of creating their own designs. By encouraging students to draw from the focused intentions of their analysis models, this digital assignment strived to generate diagrams that were as clear and spatially tactile as their physical counterparts (Figure 9-10).

Conclusion

By studying the conceptual, formal and spatial systems latent within canonical works of architecture, students are able to distill valuable design strategies that inform their own process. The use of plastic as a stereotomic material for spatial thinking forced students to confront negative space as an active participant in a three- dimensional composition, with an essential physical resistance. The analytical models and digital diagrams presented here are exemplary of

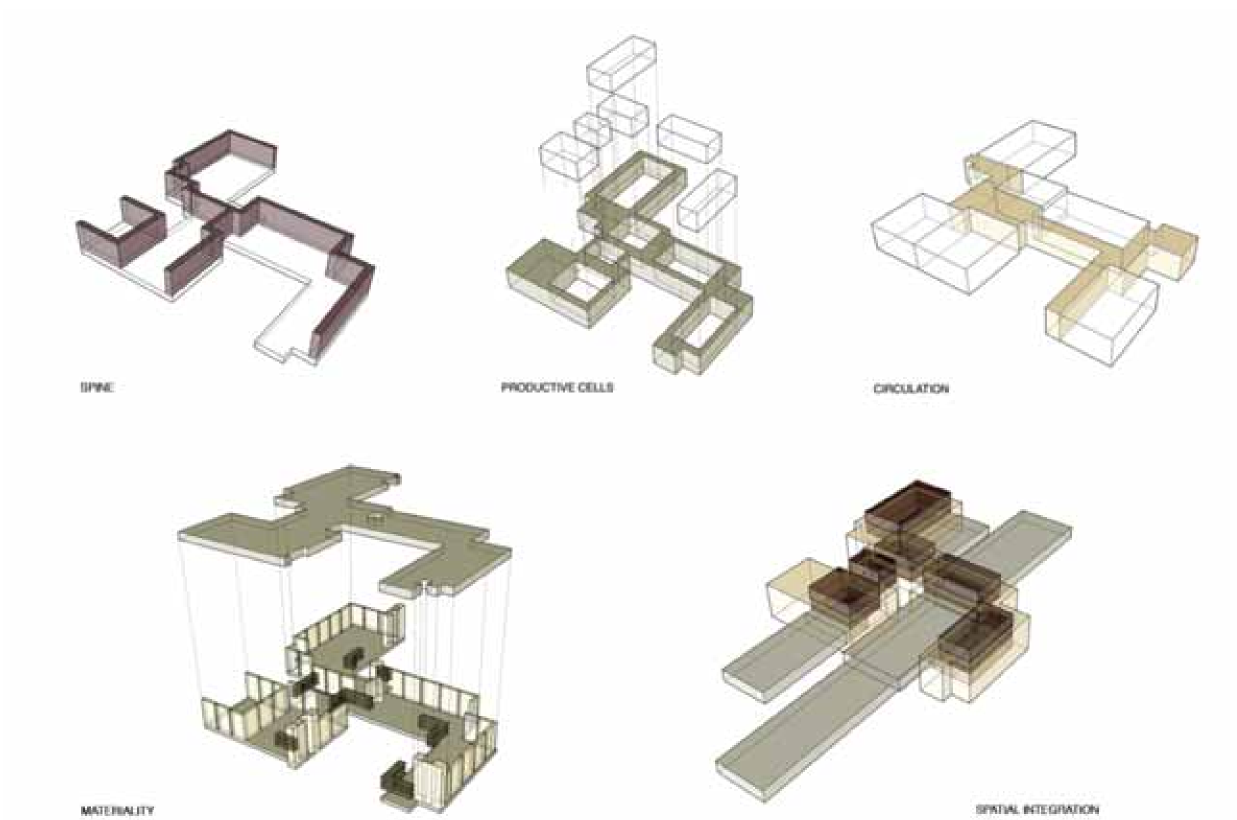


Fig. 9. Shindler House Analysis: Digital diagrams produced after analytical model exercise *(student D. Dodge)*

students who benefitted from the restraint of working with plastic as a generative tool. This sequence of precedent analysis projects represents a beginning design curriculum that strives to equip students with the tactile sensibilities necessary to navigate both digital and analog realms of spatial design.

Notes

1 *Up*. Dir. Pete Docter. Pixar Animation Studios, Walt Disney Pictures, 2009.

2 Bayer, Gropius, Gropius. Bauhaus 1919-1928. New York: The Museum of Modern Art, 1938.

3 Frampton, Kenneth. "The Bauhaus: Evolution of an Idea 1919–32". New York, NY: Thames and Hudson, 1992.

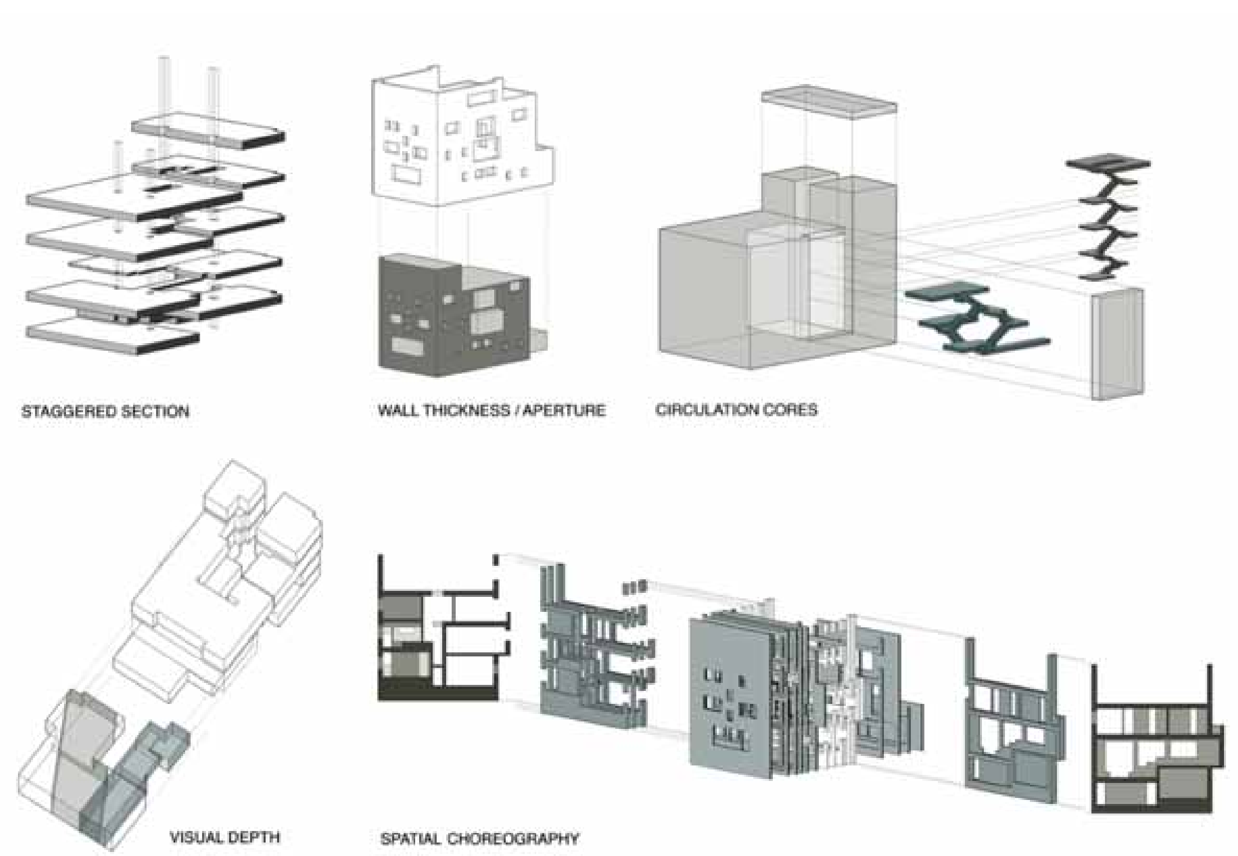


Fig. 10. Muller House Analysis Digital diagrams *(student E. Himmel)*

Creative Inquiry into Concrete Masonry Units

Andreas Luescher

Bowling Green State University, Ohio

Introduction

One of the most common or recognized building material in the industry is the concrete masonry unit (CMU), traditionally an 8x8x16 inch block used in worldwide application. While the CMU is the cheapest (and ugliest) thing in the built environment, it is also the most versatile building material. Architects and contractors alike rely heavily on concrete blocks, mass-produced and automated since 1882, for their compressive strength. Today's production equipment uses the same concepts as these early machines but with much more energy and directional compaction for denser units, faster and more accurate mixing and material movement, accurate dimensional control and automated production control. Approximately 8 billion CMUs are produced annually in North America alone. Although the simplistic manufacturing process creates a very understandable and interchangeable product, the poverty of this material does not limit the wealth of its expression.

The physical and aesthetic properties of concrete masonry units provide fertile ground for imaginative exploration and discovery. Many factors contribute to its versatility, including block size and color, face texture, aggregate color, block bond pattern, and mortar color and joint type. While blocks lend themselves to linear structures, they can also be configured differently using variable stacking methods. Blocks can be used horizontally or vertically, they can be constructed to interlock, or they can be staggered in placement. Their expressive qualities can build lines, shadows, or other elements which build upon the surrounding context.

Because of the universality and design versatility of the CMU, it is important for university students to become familiar with their many properties. This paper describes a design/build competition in an Architectural Materials and Methods class. The competition was crafted to focus attention on the physical properties of concrete masonry units and the logic of construction techniques. First-hand knowledge of CMU's – not only what they look like but also their texture, heft, pliability and particular joining requirements – expands a designer's conceptual range and design intelligence. Actual experience handling concrete blocks and meeting the demands of construction techniques gives an understanding that cannot be duplicated in any other format. The unique and particular physical qualities of concrete masonry serve as the *source* of subsequent design thinking and construction decisions. CMUs as a material are often hidden behind brick veneers, ceramic tiles, modular planes, or exterior finishing, yet their applications are fundamental to design and not merely 'functional' or 'technical' concerns to be worked out later. Concrete blocks and their construction techniques can be appreciated as aesthetic contributions, not just for their physics. The project explores these ideas by focusing on five inter-related objectives: (1) to investigate, (2) to sculpt, (3) to construct, (4) to assess and (5) to reflect.

To investigate

BGSU architecture students explored the theme of "Intricate Walls" using CMUs as a building block. In architecture, intricate walls allow for the exploration of considerations and concepts that govern architecture within a tectonic tradition of craft, construction, detail and assembly. To help acquaint students with the theme of Intricate Walls, we began studying the work of Sol LeWitt (1928-2007), an artist who began his career as a draftsman in the architecture office of I. M. Pei.

LeWitt, mainly a conceptual artist, in the latter part of his career explored the manifold ways one can organize units, such as cinder and eventually concrete blocks, through repetition, variation, and arrangement. He began to design models for outdoor public sculptures in the early 1980s based on simple grid-like geometric forms and open modular structures designed in infinite combinations. His first cement *Cube* was built in Merian-Park in Basel, Switzerland where it stayed from 1984-1986. (Fig. 1).[1] Today we can see his interpretations of these concrete block structures in various locations around the world. In the end, he shifted away from his well-known geometric vocabulary of forms to somewhat random curvilinear shapes and highly saturated colors.

Fig. 1. "Cube" is built with 20 courses, each course consists of 10, respectively 11, full-size blocks and visible from all four sides (Image by Zellweger Park)

LeWitt had the insight to see the possibilities for expression inherent in the concrete block. He was able to exploit the aesthetic and structural potential of this material. LeWitt also saw the compatibility of concrete block with a design ethos only now realizing widespread awareness. Because of that, we used his work as a precedent. Students were ask to study the interrelationship of geometry, form, tectonics, and materiality as it relates to overarching organizational systems, structural logic and physical setting.

To sculpt

After reading about LeWitt's work, students became familiar with Kant's statement "the hand is the window on to the mind." Another way to see how hands work with concrete was a visit to a CMU fabricator to learn about the concrete block's straightforward production processes: mixing, weighing, feeding, molding, curing and cubing. After the visit, students were given the design challenge for the competition. Based on the design brief that outlined the program, students used a ground plot approximately 8' x 8' in a grassy field adjacent to a small open manmade hill to construct a free-standing Intricate Wall. Whether monolithic or airy, the composition had to be constructed of concrete blocks with rebar and gravel for stability. The design instructions were deliberately short in order to allow for maximum interpretive variation (Fig. 2).

The importance of scale and materiality in the process of architectural invention seems as intui-

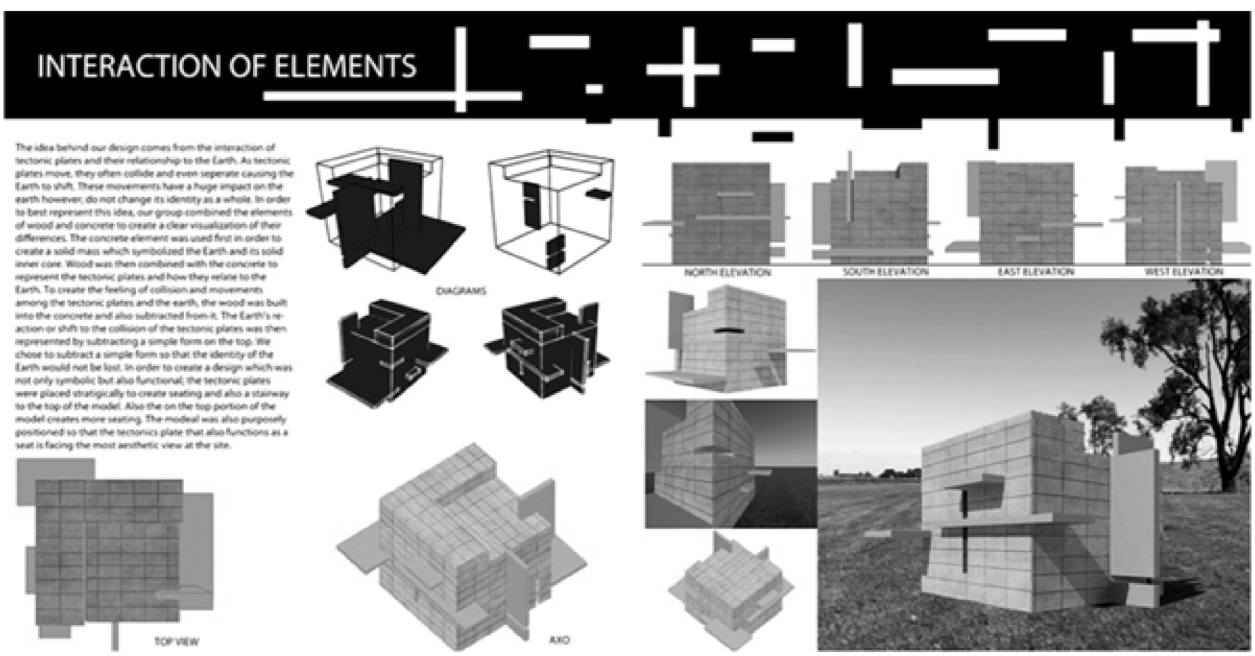


Fig. 2. Architecture Student Design Submission shows historical lineage to LeWitt's work and appreciation of the visual appeal of concrete masonry units and its overall appearance; use of color, shape, and texture; and integration with the surrounding landscape.

tive as an understanding that the mind and body work in tandem. This is supported by recent knowledge of the anatomical and functional links between brain and body, pointing away from the generally accepted compartmentalized view. But the idea that learning engages the entire physiology and conversely that the body teaches the mind is neglected by the status of physical labor in architecture culture and culture-at-large where it is stigmatized by a presumed absence of thought. In this country every aspect of a building is a product of intellect. This attitude of course is not new. Architects, like everyone else, struggle to shrug off any association of their mission with manual labor.

The ancient Greeks spoke in derogatory terms about men whose work was delivered through their hands instead of their heads, launching a mind/body dualism that positioned mechanical work completely independent of imaginative work, if not in direct opposition to it.[2] In Modern English, the term *mechanic* has connotations as varied as the person using it, but in general the word is understood as a depreciative term related to the automatic, the impersonal. [3] In a parallel contraction of meaning, the term *design* has taken on limited connotations, focusing more on the aesthetic and theoretical dimensions of design than on the integrative nature of the process itself (Boyer, Mitgang 1999). [4]

"Trials, discussion and resolution" was the unofficial class mantra. Each team created up to three design concepts, which were scrutinized bythe entire class with the ideas of "seduction" and "ambiguity" brought to the fore as driving concepts. Using break-out sessions as a new starting point, students worked together to re-conceptualize and expand the ideas and develop a single preliminary schematic design. The chosen project capitalized on the design-build protocol to bridge the design concepts and CMU as a material and method of construction. Technical CMU standards informed the design at a very early stage, allowing students to see details as design generators and to experience construction as a creative act. Students learned to see design as an act of sculpting which evolved through the back-and-forth 'dialogue' central to the design/build process. Invoking precedents of the past century, the class would approach the final product as a sculptural drawing using a 1:1 scale. This evolved into two areas of exploration (attention/ envelopment), which we worked to bring together as the design progressed - one visual, the other CMU as a material.

To construct

Working out steps by hand gives the mind that a feel of the materials which is essential to mastery in any art or trade. (Barzun, 1991, 92)

Current thinking in design/build studios signals a profound redefinition of terms and ideas which helps to overcome the separation of design and construction professionals. What is being acknowledged is the fact that *construction or building, too, requires a way of thinking*: that embodied experience is qualitatively different from abstraction and is a critical component in the evolution of ideas (Fig. 3). Furthermore, a knowledge base of architecture based solely on paper and lines can be seen as irresponsible and arbitrary. The unity of head and hand has a long list of defenders going back to the eighteenth-century Enlightenment. One prominent defender, John Ruskin, once left his professorship of fine art at Oxford in opposition to this division at the university in defense of manual labor. [6]

Fig. 3. Architecture students are engaged and challenged to use their hands in ways they don't naturally.

During the build process, design decisions continued and the design for Intricate Walls fostered unexpected angles of approach; intriguing perspectives were modified up to the last minute before the final judging. Specifically, focusing on the visual and tactile qualities of CMU's, and exploring how they might be installed differently to gain desired effects. This was simulated through the process of arranging and repositioning concrete blocks in as many different ways as they could imagine to achieve the sought out design.

In addition to the difficulties of production (e.g., tools such as concrete saw, tamper, trowel, bricklayer's hammer, etc.), student were encouraged to collaborate and try methods of construction which shaped the evolution of the final design.

Based on environmental and structural issues (height and wind resistance), major design changes were made *in situ*: detailing was conducted entirely in the field and through improvisation that was not dictated by standard reference because we had very few working drawings on hand. In the end, every aspect of the design, including the final placement of each Intricate Wall, was altered based on site trials.

Fig. 4. Architecture students analyze their process and reconsider options to gain desired effects for the final design/build implementation.

To assess

The purpose of this exercise with sophomores and juniors was cultivation of awareness of the *entire* architectural process in terms of dreams, limitations, compromises, realizations and afterthoughts (Fig. 4.).[7] As such, students, instructor and the department perceived the project as successful. Critical appraisal of the project has led to a re-casting of the exercise as a semester-length course in which design and fabrication detailing are conducted in a time frame allowing more students participation in multiple phases of the process, something impossible within the prior constraints of a five-week exercise.

Most beneficial to students was the experimental and collaborative learning process unique to the design/build methodology. In design studio students are normally left alone with their work except for desk and class critiques, whereas in this five week project student interactions became physically *alive*: a corrective to the solitary nature of the balance of the semester's work. The process naturally demanded from students an unusually intensive and exacting collaboration, a willingness to reach a consensus with minimal compromise. This communication with teammates advanced a primary lesson that "architecture is a collaborative effort and not an exercise in isolation." (Carpenter, 1997).[8] The exercise also offered students opportunities for cross-disciplinary approaches and reaching out to fabricators. Hands on benefits such as learning what it's like to use a concrete saw were matched by deeper meanings such as the freedom to connect with something students need

Fig. 5. View of radical angle structure emerging from the ground draw upon from initial cube concept.

and want. Building is one of those things you have to *do* in order to *know.*

For the professor the exercise illuminated intricacies of group dynamics and provided valuable feedback about integrating practical lessons with theory without sacrifice to either. The instructor's position was not so much enumeration of the steps; how to do things, but questioning and pushing. For students the experience of the instructor's authority was reduced--the instructor's presence merely as a facilitator or referee, intervening only when a safety issue arose, was new and exciting. In other words, the leveling of the student/instructor relationship was in itself stimulating.

To reflect

The observations implicit in the design/build competition can be stated as two points: 1) Any design course is energized by democratic experimentation, one in which association (of scope, method, character) is not merely a means to predefined goals, but rather the process for the ongoing revision of these goals, as well as of the methods for attaining them. 2) A good design studio must invite recombination of roles and personalities of people. Two practical imperatives complement these major aims. The first is the promotion or endorsement of design/build methodology by the organizations which govern architecture and construction education. The second is to work for space in education for the recombination of groups of people and their specialized jobs.

For the students, the attraction to this competition was the opportunity to think about CMU's at an intimate scale, along with the challenges of production (tools, concrete saw, drilling machine, etc.). This fostered student interaction and collaboration in the methods of construction. In addition, a few students volunteered to produce an iMovie documentary of the design/build competition composed of digital renderings, compilations of drawings and sketches, group discussions and construction footage used in designing and building of the CMU's structures. The iMovie not only documented the experience of the students, it also helped observers to fully conceptualize the design build experience, by providing a means through which they could observe the work from inception to conclusion. Observing their work from this perspective allowed the design/build teams to interpret and reassess decisions about the whole experience that ultimately affected the final outcome.

At the end of the project, students didn't leave with only plans, models and digital renderings, but also with a built structure as his or her record of action (Fig 5.). These structures remain in place in the environment where they were constructed, serving as a reflecting surface in which students can see the traces of their action, something that enables them to talk about how they are learning. Students gain an awareness of design, materials, and the collaborative process. They are exposed to the surprising notion that there are multiple ways to conceptualize, represent, and test ideas. They become participants, not merely spectators, and (in theory, at any rate) understand design and construction as an integrated process that begins with the consideration of materials. In this spirit, using methodology already in place in the professional world, we must work together to foster changes in curriculum formats that merge construction technologies and materials into their design thinking.

Notes

1 After temporary exhibition in "Sculpture in the 20th Century" in Basel and various other locations, the "Cube" can be visited at the Zellweger Park in Uster, Switzerland, http://www.zellweger-park.ch/de/kunst/sol-lewitt.html and Dreher, T., Sol LeWitt in *Kritik Zeitgenössische Kunst München*, 3, 1993, p. 26-32.

2 *Banausos* (Ancient Greek) is an epithet of the class manual laborers or artisans in Ancient Greece.

3 Webster's New Collegiate Dictionary gives: "workman, hand, laborer, workingman, artisan, roustabout" as definitions for *mechanic*. The Dictionary of Synonyms gives: automatic, instinctive, impulsive for *mechanical*, with analogies: stereotyped, hackneyed, dull, stupid, dense, and contrasts: vital, essential, fundamental, spirited.

4 Boyer, E. and Mitgang, L. *Building Community: A new Future for Architecture Education and Practice*, The Carnegie Foundation for the Advancement of Teaching: Princeton, 1996.

5 Barzun, J. *Begin Here: the Forgotten Conditions of Teaching and Learning*, University of Chicago Press: Chicago, 1991.

6 Kellogg, D. O. "John Ruskin" in *New American Supplement to the Latest Edition of the Encyclopaedia Britannica*, vol. 4, The Werner Company: Chicago, 1898. p. 2589.

7 Luescher, A. "Concrete Geometry: Playing with Blocks" in *International Journal of Art and Design Education*, 29 (2010) 1, p 17-25.

8 Carpenter, W. *Learning by Building: Design and Construction in Architectural Education,* Van Nostrand Reinhold: New York, 1997.

Brick by Brick:
Improved Outcomes through Linked Learning Objectives in Beginning Technology Labs

Kris Nelson, AIA, Lecturer & Rob Whitehead, AIA, LEED AP, Assistant Professor

Iowa State University, Department of Architecture

Intentional integration

We must work to connect the sometimes absurd effects of multiple design responsibilities...by (the) integration of all different elements.
-Ove Arup, "Aims and Means," 1970.

The practice of designing high-performing, technically proficient buildings in an integrated manner has increased in importance (and frequency) in step with elevated expectations for measurable building performance standards. However, traditional pedagogical models for building technology education have done little to adjust in response relying instead upon outdated modes for the classroom structure, content, and teaching methods.

Unique to an architectural education, building technology courses need to impart a more specific, and often divergent set of technical acumen that students need to understand in order to critically incorporate it into their overall design work. Unfortunately these technology courses are rarely taught in an integrated manner so students are left to their own devices to find, and make, critical associations between the different topics being taught. If this information is conveyed ineffectively, a critical opportunity is missed to help students develop an intuitive understanding about the relationship between building technology and potentially responsive architectural forms.

These deficiencies hit beginning design students particularly hard because when initial classes aren't effective, it adversely impacts enthusiasm for learning for the remainder of their education and their retention of information. This problem is more profound in a multi-semester sequence of courses with graduating levels of difficulty, in which there is a necessary expectation of accumulated knowledge and skills from previous courses.

In order to better prepare architecture students for evolving challenges of a highly integrated contemporary practice environment in which building technologies are expected to be understood and integrated into high-performance, sustainable building designs, the traditional means of educating architectural students about these building technologies must also evolve.

This paper will present a case-study lab that is assigned during the first semester of undergraduate architectural study at Iowa State University as a representative example of the unique pedagogy offered in the newly re-formatted and integrated building technology course. For this assignment, students are required to engage a simple design problem using a common load bearing masonry wall from two distinct, yet interconnected perspectives of design education—specifically the materials/assembly and structural design modules. This lab challenges the traditional presentation of course content and learning environment standards based on the hypothesis that experiential exercises, haptic learning methodologies and project-based design exercises in a laboratory setting can provide a more effective way forward in educating architects about integrating building technologies. The results of multiple student submissions will be presented, analyzed, and assessed in comparison to the different learning specific learning objectives and the larger macro educational goals.

Reformed sequence

Today's buildings are not good enough...(because) professionals are operating within a fatally flawed system.
–Patrick MacLeamy, CEO, HOK Architects, *"BIM, BAM, BOOM! How to Build Greener, High-Performance Buildings,"* 2008.[1]

Helping students learn to navigate through the staggeringly complex array of aesthetic and technical choices in building design is a primary educational responsibility. Because it is so complex, a large portion of architectural design education in studio deals with teaching strategies and priorities for creative problem solving and evaluation. In technology classes, this is frequently different. Although the importance of collaborative design efforts and critical cross-disciplinary integration of building technologies into the design process are frequent topics of discussion, these courses are rarely taught in a manner that supports these lessons. The means and methods by which this information is presented to students should aspire to model the desired priorities and processes taught.

Unfortunately are three common short-comings in traditional building technology education that exacerbate these problems: First, the three distinct areas of emphasis (materials/assembly, structural design, and environmental forces/systems) aren't taught in an integrated manner—the courses are split apart from each-other (and from design studio) throughout the curriculum and they develop different (often divergent) learning objectives based on their various content. Second, because of the technical nature of the information presented, many courses use an engineering-based pedagogy in which "design" is confined to the analysis and sizing of elements/systems, and the corresponding assessment is based primarily on the accuracy of calculations and not other qualitative standards. Finally, by presenting information primarily in passive learning environments, like lectures, the lessons are disassociated from the active-learning environments found in design studio and practice. The consequences are profound—a combination of these factors can adversely affect the effectiveness of the learning.[2]

In order to address these deficiencies, major revisions were made to the building technology courses offered to undergraduate architectural students at Iowa State University. All three building technology topics were combined together into one larger/longer course sequence. These classes begin during their first semester within the professional program and end during their comprehensive design studio, five semesters later. Each semester includes three different "modules" of information focused on the different technology topics, while still giving opportunities to present integrated exercises between the modules. A large portion of the work takes place in an active-learning lab environment, more akin to a design studio, in which students are taught to develop different strategies for creating assessing their work—including many haptic learning opportunities.

These labs occur during nearly every class period, most frequently following immediately after a lecture. In labs, students are frequently assigned a simple design task that requires demonstrated knowledge of the technology topic. Through rapid iterations and development, students consider order of operations during construction and opportunities for integration. Frequently students build and test mock-ups in order to evaluate performance (Figure 1).

Lab work is performed in a public forum, and students are encouraged to view, share and discuss results of their experiments. Since nearly every assignment is based on individual design work, results and processes can be openly shared without the typical concern of "shared work."

Figure 1: Testing various thin shell model prototypes

Although the means and scope vary by module topic, students are consistently required to document their work through lab reports. These reports describe their design decisions alongside technical diagrams and calculations (when required) and require self-assessment and evaluation of their work. Writing lab reports helps broaden the options for learning styles and promotes multimodal means of representations—both demonstrated strategies for increasing the learning capacity, retention and enthusiasm.[3]

Studio work is occasionally directly tied into the lab's coursework, but most of the time, the different module instructors purposefully craft particular exercises in order to directly illustrate ways to applying these through design. Primarily these labs remain somewhat isolated within their own module's topic/perspective, which is beneficial at times to help focus the learning objectives, but it shouldn't serve as the rule. Lab lessons presented and addressed in isolation from other considerations can yield simplistic results.

The faculty decided that further integration between the modules could yield appropriately complex problems that would more closely mimic real world design problems without placing unrealistic expectations on the design studio sequence. Correspondingly, a series of cross-module integrated lab projects were created and introduced into the sequence.

Building lessons

We purposely tried to push the limits of what could be built with bricks.
-Student lab report introduction.

For their first integrated lab, students were asked to design, construct, and analyze of a load-bearing masonry wall. Intentionally this exercise is introduced immediately in their technology course sequence. This first lab has certain technological information it needs to convey, but it supports larger pedagogical priorities as well. By design, the lab format emphasizes the importance of making connections between the different technology topics in order to develop more integrated conceptual design thinking skills. To help them achieve this, we introduce a range of various problem-solving techniques for students to try, including full scale construction. In other words we try to instill a sustained enthusiasm for the topic by presenting the relevance of the information taught in an engaging classroom setting.

Throughout the entire undergraduate technology sequence, the use of haptic learning techniques is a matter of central pedagogical importance in both theory and practice.[4] Across all three building technology modules, students have built and tested their work in an attempt to better understand the inherent physical behaviors of how their designs work.

Figure 2: Testing a Bridge Prototype in Lab

This two-part lab was designed to explicitly promote convergent technological and design considerations for masonry structures between the materials/assemblies and structural design modules. The first portion of the lab was based on a long-standing relationship with the Masonry Institute of Iowa.

For nearly thirty years, students in the materials/assemblies course have visited a local brick manufacturing plant for a tour and to construct a basic loadbearing masonry structure with the assistance of local masons. This year, for the first time, the structural design module was included in the development of the lab, albeit in a manner unbeknownst to the students at the time. From the perspective of the students, the lab breadth is ostensibly limited to exploring issues related to the materials/assembly particularities of load-bearing masonry construction (a rich experience in and of itself). However, the specific performance criteria for the wall were all intentionally selected in conjunction with the structural design learning objectives for the upcoming module—at this point they hadn't had any structural design coursework.

Students were introduced to the principles of loadbearing masonry in a materials/assembly lecture, which covered basic terminology, limitations, and established techniques in brick. Brick courses, bonds, wythes and geometric strategies to increase wall strength were briefly covered, in addition to several examples of traditional arches and contemporary folded or sculpturally morphed brick construction. Teams of students are given a relatively simple problem for an ensuing lab: design and construct a partially perforated, full-scale masonry wall using only 300 bricks. This methodology is based on the idea that students will learn more through extensive hands-on experience, than with lectures or textbooks alone.[5]

In spite of the openings in the wall required for perforation, each wall needed to be stable enough to provide an element of repose upon the wall (sitting or leaning) and students were required to accurately build the structure in under two hours. The students are asked to investigate a minimum of ten concepts that meet the requirements in sketch form, before selecting one concept to develop into their design proposal.

As in previous years, local masons donate their time to assist the students. Each five or six student group is assisted by one mason, and the students must use a small design document set, consisting of at least one plan drawing and one section drawing scaled to ½" = 1'-0", and at least one axonometric rendering to communicate their design intent to the mason. The masons are generally fully or partially retired, with many years of experience, and many have volunteered numerous times. The masons demonstrate basic bricklaying techniques, including breaking bricks in half with a trowel, applying mortar to the bed and head joints of the brick and basic wall layout. Mortar is pre-mixed and brought to each worksite, where 300 bricks are pre-stacked. The bricks are all modular-sized, three-hole bricks, and this parameter was communicated to students during the design phase of the project. Several groups elect to use the brick holes to satisfy the perforation requirement.

Concept, Craft and Construction

We would change the design by figuring out our foundation better and...we would spend more time on the process before we go out and lay bricks.
-Student Lab Report

A majority of the student groups quickly discovered the difference between the rough, conceptual planning performed in design studio, and the exacting, descriptive planning required for design-build (Figure 3). The improvements suggested by students ranged from construction methods to detailing to the ambition and scope of the actual designs. The students' tendency to view material as wallpaper or pattern, as opposed to an assemblage of many small, discrete pieces created many of the onsite challenges. The groups that were able to incorporate assemblage into their planning process were able to work more efficiently onsite to realize their designs.

If we were to change anything, we would have started with an assembly line type of system.
–Student Lab Report

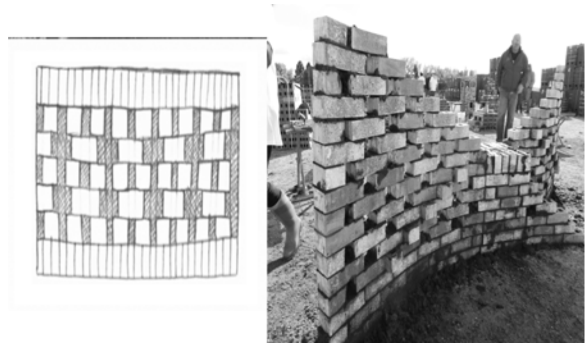


Figure 3: Example of planning with actual brick modules and the resulting project

We should have planned out exactly how many bricks were necessary for each component of our design in order to work more efficiently and effectively on the build site.
-Student Lab Report

The real-world scenario and challenge of many hands working together to craft a single object confounded many groups. On the other hand, many concepts from the lecture were adapted successfully; as an example many students utilized simple folds or serpentine plan geometry to create strong, single wythe walls, allowing the 300 brick allowance to create much larger forms (Figure 4). Several groups used small shoring elements, often in the form of temporary brick placement, to create the perforations in the final structures.

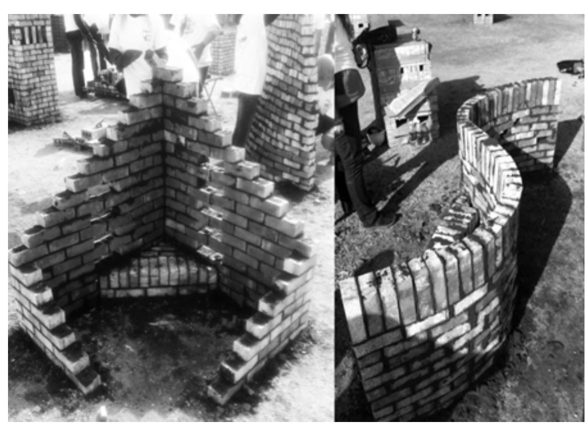


Figure 4: Examples of Folded and Curved Single Wythe Masonry Walls

Varied coursing and the use of gradual or punctuated protrusions were utilized to create dynamic forms and dramatic highlight and shadow, (Figure 5). Many groups found frustration as their lack of skill, specifically with mortar placement, affected the craft and overall appearance of the structures. The ability to consistently break bricks to create half bricks with clean edges delayed many groups. These comments were echoed in numerous lab reports.

Another surprising comment noted in the lab reports dealt with the perception that the groups felt they had potentially under-realized potential of masonry in most designs; many groups reflected on their design and concluded that additional courses or more complex pattern would have strengthened their concept and created greater visual interest in the finished project.

Figure 5: Examples of Folded and Curved Single Wythe Masonry Walls

Students completed a full lab report outlining their design and construction efforts, including a justification for their final formal arrangement of the wall and a self- assessment of the entire process. The lab reports were required to include careful documentation of all relevant pieces of information, including accurate heights/courses, radii and lengths. Much of this work was preparatory work performed before construction so these documents either assisted or hindered the groups in direct relationship to their pre-build preparation. Some groups miscalculated the number of bricks required for their design, or selected a complicated and time-consuming custom bond which reduced the number of bricks that could be laid within the time limit. Despite an allowance for jigs or other forms to help with difficult or repetitive placements, most groups elected to rely on simple, repetitive measurements performed onsite.

Stacking and spanning

This lab really had us think about the structure of our wall. We had to consider different ways to alter the design without changing the curve in the wall.
-Student Lab report

Two weeks later, after the transition between modules has occurred, these same students revisit these masonry constructs as part of their structural module in the same course. After an introductory lecture on the structural concepts of strength, stability, shape and force transfer, they are asked to assess their wall design and construction from a structural perspective. They are given an opportunity to modify the walls accordingly in order to incorporate them into a design of a bus stop shelter—an exercise that asks them to incorporate structural elements as either "bricks, sticks, & planes." The walls weren't required to serve any specific structural purpose within the shelter—a decision that was intentionally left to the students.

The first important lesson the students learned was that there was a clear connection between challenges they faced in assembly (e.g., achieving lateral stability, creating perforations and grounding the element of repose) and the structural lessons of force transfer and equilibrium. In other words, the design challenges need to be considered from multiple perspectives (Figure 6).

The second lesson, that processing abstract information while physically manipulating objects is a proven method for enhancing comprehension, may not be as explicitly evident to the students at the time, but it provides long-term benefits to structural knowledge. Specifically, when the means of presenting and processing information is too abstract, as it often is in traditional structural design courses, students are unable to visualize the concepts being presented and the relevance of what is being taught becomes unintentionally obscured. [6]Although it is a relatively simple structural assembly, trying to understand the behavior of physical phenomena, like a load-bearing masonry wall, without offering students a chance to physically experience it reduces the efficacy of student learning opportunities by forgoing opportunities to enhance their visualization skills of abstract behaviors.[7]

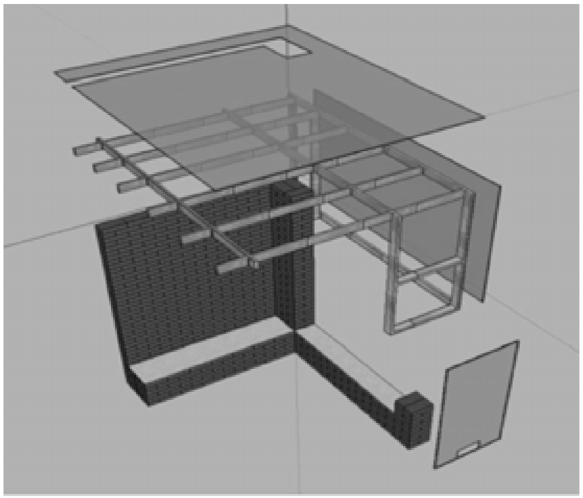


Figure 6: Although structurally conservative, the masonry wall was designed to provide support and shelter.

Bricks, Sticks, and Planes

Generally the structural content in the work was at a level to be expected of beginning design students—overly simplified remedial force diagrams and misrepresentations of structural behavior, but there was a more widespread level of elevated competency demonstrated between the masonry material and beneficial structural forms, which was quite interesting.

Transitioning from one module topic that they understood somewhat well, to another topic for which they had received little formal instruction produced three general responses in the design work for the bus shelter.

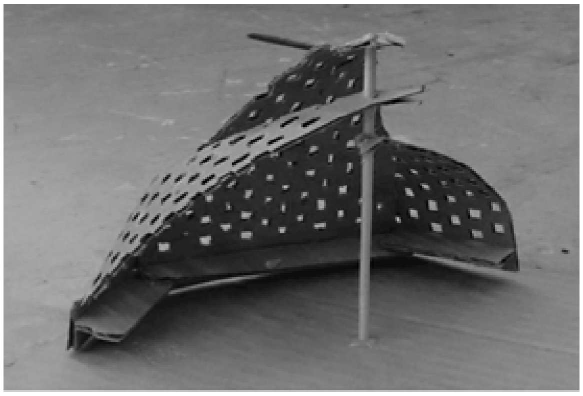
First, some teams left the wall as previously designed and built, relieving it from any additional structural or functional constraints—these students generally received the least benefit from the lab integration. It was suggested to these groups to apply more proactive experimentation to their lab work in an effort to expand their knowledge. Thankfully, this approach was used in the fewest number of labs.

Second, certain teams altered their wall design to make it much more formally conservative than what they had built—mostly as a result of the wall now being used as a load-bearing element for the bus shelter roof. This was the most predominant approach to the lab. This is understandable to a certain extent as many beginning students lack confidence in their structural work and are concerned about "failing" if the structure wasn't appropriately designed. Through feedback, these student groups were encouraged to continue to experiment and expand upon their previous knowledge as a foundation for developing structural aptitude (Figure 7).

Figure 7: The curved sloping wall that was built was reduced to a very conservative flat surface.

The third type of proposal generally involved an elevated level of formal and structural experimentation, frequently using the curved wall planes they had built as the basis for the shelter's enclosure and support. Many correctly noted that the wall's curvature helped provide a certain degree of lateral stability for the structure as well as a sense of spatial enclosure—this is a fundamental learning outcome for the beginning module that they had already intuitively learned! One group extended their curved wall upward to form a thin shell, while another group used the idea of a twisting plane as inspiration for their roof structure and wall (Figure 8). Both groups rightly understood that the twisting nature of the plane would stabilize the structure and demonstrated a critical advanced structural design consideration.

Because of the diversity of submissions, it was somewhat unclear what role the wall construction played in enhancing their direct understanding of structural behavior, but it clearly affected their responses. One hypothesis for the more conservative responses is that the students understood first-hand that more complicated geometries and structural expectations for the wall would require more advanced technical revisions to the design and/or more complicated construction difficulties—a scenario they would be more inclined to empathize with as a result of the lab.



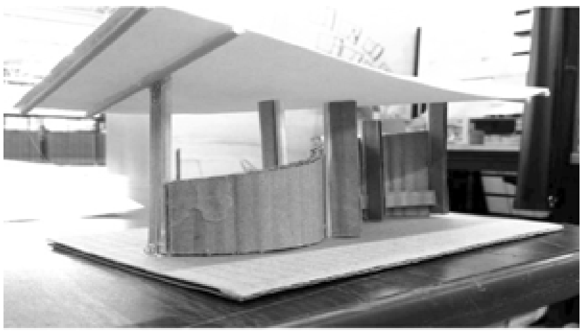


Figure 8: Curved surfaces extend throughout the design to provide enclosure.

Integrated Assessment

As a result of this combined assignment the students (and teachers) learn that they don't need to have explicit instructions or knowledge about other building technology topics before engaging these considerations into their designs. Additionally, because the assignment doesn't explicitly spell out the integrated nature of the exercise from the start, it suggests to students that integrative opportunities between design and technology topics may instead be implicit and simply awaiting their capacity to make the connection between topics (a good match for the intuitive/global learners).

The combination of drawings, diagrams, and constructed assemblies were effective in the transfer of knowledge from the abstract into more tangible realm of intuitive knowledge and design expression. The methodology provided a cognitive grounding in basic structural and material behavior and provided a methodology for self-taught examination and analysis for more advance topics covered in subsequent labs and semesters. These activities immediately improve student motivation, not only by the interactive nature of the classroom environment, but because an advanced capacity for visualization allows for a more diverse means for representing the lessons—models, images, sketches, and written descriptions of experienced physical phenomena.

Importantly, the primary student outcome desired by the assignment isn't the comprehension of difficult technical information (as these are basic topics), instead it is intended to introduce and develop a new way of working—an integrated design process through which collaborative teams integrate technological constraints with a larger set of design ideas. These lessons are repeatedly reinforced throughout the remainder of the five-course sequence with an escalating progression of difficulty.

Now that two full sequences have been completed, there are positive long-term effects as well that are noticeable. Labs completed in subsequent semesters of the structural sequence showed an advanced level of comprehension of basic structure concepts and behaviors—albeit not directly translated to load-bearing masonry walls. The lab reports have helped the students develop more advanced abilities to create multimodal representations of these assemblies and behaviors which is a skill set that is applied to their larger professional development. Further, in recent years, the comprehensive design studios frequently now feature more highly integrated technological ideas within their designs—to a degree that wasn't as pervasive before the changes in the technology sequence.

Ultimately, through the research, design, and evaluation stages of the process, students realize that relative success of their design interventions are inextricably linked with their realistic engagement with a broad range of technical encumbrances not normally required of them in design studio.

Notes

[1] MacLeamy, Patrick. Quoted at http://hokrenew.com/2010/02/09/bim-bam-boom-how-to-guarantee-greener-high-performance-buildings/

[2] Richard Felder & Linda Silverman, *Learning and Teaching Styles in Engineering Education*, Engineering Education, Volume 78, pp. 674-681,1988.

[3] Lisa Tolentino, David Birchfield, Colleen Megowan-Romanowicz, Mina Johnson-Glenberg, Aisling Kelliher and Christopher Martinez, *Teaching and Learning in the Mixed-Reality Science Classroom*, Journal of Science Education and Technology, Volume 18, Number 6, pp. 501-517, 2009.

[4] Williams II, R.L., He, X., Franklin, T., Wang, S., (2003), “Haptics-augmented engineering mechanics education tools”, *Journal of Science Education and Technology*, Volume 12 Number 1, pp. 1-12.

[5] Sun, R.; Mathews, R.C.; Lane, S.M. Implicit and Explicit Processes in the Development of Cognitive Skills: A Theoretical Interpretation with Some Practical Implications for Science Education. *Proceedings of the Twenty-Third Annual Conference of the Cognitive Science Society;* Moore: Edinburgh, 1-4 August 2001, pp. 6

[6] Insook Han, John B. Black. *Incorporating haptic feedback in simulation for learning physics*, Computers & Education, Volume 57, Issue 4, December 2011, pp. 2281-2290.

[7] diSessa, A., (1993), “Towards an epistemology of physics”, *Cognition and Instruction*, Volume 10 (2), pp. 105-225

Inducing Ingenuity:
The Cardboard Catwalk

Kate O'Connor + Maggie McManus

Marywood University

The Millenials

Since the industrial revolution, building skill has become increasingly fragmented. With regard to designing - in general and architecture in specific - hand and head are often divided into a distinction of the design of the building and the actual production and assembly of its parts. The idea of making a design conception complete before it gets constructed is frequently the rule rather than the exception.[1] To further the differentiation of practice, the current student of architecture has changed. The Millenials (also known as Generation Y) were born between the years 1981 to 1999. When it comes to more specific Millennial characteristics, such as whether this generation learns differently from their older peers, the research is just trickling in. [2]

In spite of the fact that they have come of age in the era of YouTube and reality TV; generations, like people, have personalities. Millennials have begun to forge theirs: confident, self-expressive, liberal, upbeat and open to change. They are more ethnically and racially diverse than older adults. They are less religious, less likely to have served in the military, and are on track to become the most educated generation in American history.

They are history's first "always connected" generation. Steeped in digital technology and social media, they treat their multi-tasking hand-held gadgets almost like a body part – for better or worse. More than eight-in-ten say they sleep with a cell phone glowing by the bed, poised to disgorge texts, phone calls, emails, songs, news, videos, games and wake-up jingles (see Fig. 1).[3]

When asked to name some ways in which their generation is unique and distinct, responses differ widely across age groups. Millennials source technology use as the single most popular response. Technological change and generational change often go hand in hand. That's certainly the story of the Millennials and their embrace of all things digital. The internet and mobile phones have been broadly adopted in America in the past 15 years, and Millennials have been the leading technology enthusiasts. For them, these innovations provide more than a bottomless source of information and entertainment, and more than a new ecosystem for their social lives. They are also a badge of generational identity.

Fig. 1. The Smart Phone, a Lifeline for the Generation Y.

Millennials outpace older Americans in virtually all types of internet and cell use. They are more likely to have their own social networking profiles, to connect to the internet wirelessly when away from home or work, and to post videos of themselves online. Educational attainment still matters as a factor in internet adoption, even among Millennials. Nearly all (96%) young people who are currently in college or have attended college use the internet at least occasionally, compared with 83% of those who have not attended college. [4]

Millenial -The Contemporary Architecture Student

With head-skills being separated from the hands, the cerebral and the physical part of the architectural process are regularly isolated in practice. In most extreme contemporary situations, the architect works out the form-making in the first stages of the process. In subsequent stages, the contractor or developer makes the form buildable, prioritizing economic feasibility over form conception. In most cases, the two disciplines do not interact during design studio or design exercise.

In non-traditional and often advanced architectural practices, a different paradigm of thinking is active. The character of this collaboration between architecture and engineering is called "Structural Turn". The traditionally separate areas of concern work within a pure disciplinary manner. Within the Structural Turn, a multidisciplinary approach is favored. In this integrated form of design practice, hybrid information is used to bring about new forms of collaboration and new modes of operation. [5]

When considering the Millenial architecture student, the platform of oft-required Structures Curriculum provides opportunities to exploit such a multi-disciplinary approach. It is in such a platform that we were able to experiment with new modes of addressing the ever-distracted Generation Y, as discussed later in this paper.

A study by Dalton State College psychology professor Christy Price, EdD, suggests that Millennials want more variety in class and prefer a variety of active learning methods. (August/September 2009- The Teaching Professor). "This is a culture that has been inundated with multimedia and they're all huge multitaskers, so to just sit and listen to a talking head is often not engaging enough for them," Price says. When they are not interested in something, their attention quickly shifts elsewhere. Interestingly, many of the components of their ideal learning environment – less lecture, use of multimedia, collaborating with peers – are some of the same techniques

Interdisciplinary Education

Departing from the disciplinary design situation, two modes of building education can be distinguished. The first mode is viewing building as science. In this case, obtaining knowledge *explicitly* is emphasized. The second mode is viewing building and architecture as art. By emphasizing the development of skill and intuition, knowledge is obtained *implicitly.*[6] Millennials are extremely relational. They respond to assignments that are more creative than the typical 10-page final paper, says Miami Dade College psychology professor Sheryl Hartman, PhD. She adds that professors also need to explain clearly why course content is important, as well as how students will be evaluated in their knowledge of the course. "Millennials seem to be more experiential and exploratory learners, so they really seem to benefit from the personalization and customization of assignments".[7]

To be able to reinforce an interdisciplinary understanding, an overlap of knowledge in the fields of both design and engineering should be obtained. According to Cross, the outline of both areas is delineated by types of design approach. In this dichotomy, the designer distinguishes itself from the engineer by trust in intuition. In the *implicit area*, design knowledge of the designer or architect is often tacit, founded on a reflective process. In the *explicit area*, the engineer is uncomfortable using intuition in design decisions. Using explicit knowledge, the engineer wants to be able to test and measure design choices.[8]

For architecture students to work and think more interdisciplinary, design intuition should expand technically. When training a student in acquiring knowledge implicitly in practice, this research *framing* is used to expedite *sensemaking* in architectural making.[9] In this context, framing is used to provide understanding within a "world" or "reality". By selective attention, experiences are organized, events are rendered, and actions are guided.[10] To engage the contemporary architecture student in an often dense and boring Structures class, both types of learners must be engaged. By becoming more skilled in technical knowledge acquirement, the architecture student is able to increase the development of knowledge, critical to successfully create a building. As a result, the student can advance from a passive technical-end user into a more active knowledge producer (see Fig. 2).

Fig 2. Team Egg Crate

The Assignment and Learning Outcome

By assigning "The Cardboard Catwalk" as a written description of the projected outcome and not including images, the student has no preconceived idea of what this final project should look like. Students are free to deduce and conjure meaning from the words on the page. The students are given the freedom to think creatively, create unique and original structures, and to learn while in the process of making given specific written parameters. Words have to power to invoke original and unique thoughts. Through this method of assigning a project, the students are able to express their innovative thoughts through physical manifestation (See Fig. 3).

Fig 3. Three Original Design Solutions

Millennials have grown up being able to Google anything they want to know, therefore they do not typically value information for information's sake. As a result, the professor's role is shifting from disseminating information to helping students apply the information. One of the greatest challenges for teachers is to connect course content to the current culture and make learning outcomes and activities relevant.[11] The typical Millennial student will search for information on the computer to assist with a connection to information and images for the project. The creative title distracts a successful search, and the new curricular project does not allow the class to refer to a previous given assignment.

A stringent list of written rules induces the creativity and ingenuity of the students. For example, some of the Cardboard Catwalk project rules include the following:

Each team will be allowed to use corrugated cardboard and rope of any kind. Laminating (layering cardboard sheets with glue) is strictly prohibited. No tape or mechanical fasteners will be permitted. Pre-manufactured tubing is also prohibited.

One approved additional material and quantity may be used and MUST BE pre-approved by your Professor. The use of the material must be identified in the design in advance. (see Fig. 4).

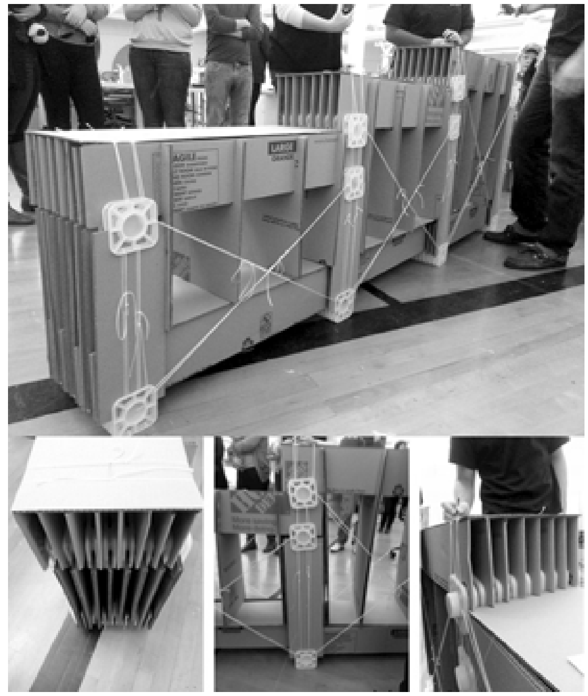


Fig. 4. Detail of Catwalk with additional material

The structure will be subjected to two LIVE loads of approximately 100-180lbs (see Fig. 5).

Fig. 5. A "live" load on a proposed Cardboard Catwalk

The catwalk must consist of three separate levels. Level One must measure 24" A.F.F. when loaded, Level Two must measure 30" A.F.F. when loaded and Level Three must measure 36" A.F.F. when loaded. There must not be more than a 2" deflection in each section when loaded.

Each section of the catwalk can be no smaller 3'-0", and the total length of the structure cannot exceed 12'-0". The frame members must be visible enough to permit observation.

The catwalk must not exceed 4 contact points on the ground. The TOTAL footprint area cannot exceed 150 in^2 to support the frame.

The task as educators when assigning this project was to amputate the students' connection with the digital realm. The means of experimenting with this notion was through the written word: very descriptive rules, though some vague in nature and open to interpretation. The title of the Assignment itself embodies both of those characteristics-- descriptive and vague: "The Cardboard Catwalk." Again, the students were encouraged to discover and gain an understanding of structural beam properties while considering and learning the structural properties of the materials themselves. The Key word here is "discover" As discussed earlier, the Millennials live in an "instant gratification" world. "Just Google it" [find the answer]. In her book *Generation Me*, Jean Twenge described Generation Y as the first generation to be fully raised in the aftermath of the technological revolution in which information has been readily available to them with the click of a mouse. This environment has driven them to be demanding educational consumers with no tolerance for delay.[12] For better or worse, this is the world we live in and as educators we must adapt. We, as educators, need to invest in our own creativity as well, and be mindful of teaching practices, methods, and assignments that can "unplug" (if just for a moment) our students from their technological devices.

Even when considering possible fabrication methods of the project this notion of being "unplugged" was considered. The scale of the project was certainly large enough to warrant woodshop access and power tool devices, yet the materials assigned called for none of that.

Instead the chosen materials of cardboard and string recalled only good, ol' fashion, hand-held devices: scissors and box cutters. The scale and choice of materials also fell out of the realm of the ever-trusted, computerized laser cutter. For this two-week assignment the kids were on their own: their brain, their hands.

The end result was a great success. Fun is always a bonus in any given assignment, and it's hard not to realize fun when in the process of making

Fig. 6. A team of three students designed the only Cardboard Catwallk able to support nine "live" loads of appx. 1500lbs

and discovering. The most successful project, in terms of weight, far exceeded the required two "live" loads. In fact, this catwalk was able to support a total of nine "live" loads – and perhaps even more weight if carefully loaded (See Fig. 6). This particular project also took a risk by negating one of only two required materials and was built solely of corrugated cardboard.

We believe these students entered into a School of Architecture because of their love of design and making. These students have grown up in an era in which they were constantly engaged. When they are not interested, their attention quickly shifts elsewhere. This project suggests Millennials prefer a variety of active learning methods, as opposed to a more traditional lecture-only format, even without utilizing technology!

In today's day and age, everyone needs an extra push; a reminder per say, that the creative and unique thoughts in the database of our own head are just that: unique thoughts. These thoughts aren't yet realized and are completely unsearchable on a web browser. Our goal was to induce these unique thoughts, to induce ingenuity from our students, and to bring them an opportunity to connect head to hand—a disintegrating concept in the practice of architecture. The experimental assignment of "The Cardboard Catwalk" succeeded in relieving students of precedent notions by severing the crutch of digital and electronic devices.

We foresee this being the first of many assignments that are prescribed in such a way, because unlike other disciplines, the evolution and history of architecture is dependent on a physical world.

Notes

1 Sennett, R. (2008). The Craftsman, Penguin Books, London.

2 Howe, N., & Strauss, W. (2007). Millennials go to college. Great Falls, VA: LifeCourse.

3 PEW Research Center. "*MILLENNIALS, A Portrait of Generation Next- Confident. Connected. Open to Change.*" www.pewresearch.org/millennials. February, 2010. p. 1

4 PEW- p. 25

5 Leach, N. Turnbull and Williams, C., (2004). *Digital Tectonics.* Wiley and Sons, West Sussex.

6 Salama, A., (2007). *A Theory for Integrating Knowledge in Architectural Design Education.* Archnet - IJAR, Volume 2 – Issue 1 – March 2008.

7 Novotney, Amy. "Engaging the Millenial Learner." The American Psychological Journal. March, 2010, Vol 41, No. 3. p. 60.

8 Cross, N., (2011). *Design Thinking*, Berg Publishers, Oxford.

9 Klein, G., Moon, B., Hoffman, R., (2006). *Making Sense of Sensemaking: Alternative Perspectives, Intelligent Systems* (IEEE) Vol. 21, No. 4.

10 Goffman, E.: 1974, Frame Analysis: An Essay on the Organization of Experiences, Harper and Row, London.

11 Novotney – p 61

12 Twenge, J. M. (2006). *Generation me: Why today's young Americans are more confident, assertive, entitled -- and more miserable than ever before*. New York: Free Press.

SLICE:
3D to 2D and Back: Understanding the Dialogue

Anne Patterson

University of Kansas School of Architecture, Design & Planning

Introduction

In his book 'Creation in Space', Jonathan Block Friedman says, "There are many ways to skin a cat. Converting two-dimensional planes into three dimensional structures is both simple and comple"[1]. The project, 'Slice' introduces the student to the languages of two and three dimensions, and the dialogue between them: the conversion back and forth from three to two dimensions through one transformation (perspective) and then back again through another (orthographic projection).

'Slice' begins with understanding the familiar, the 'seen' world then reinterpreting through projection, and imagination to create a new as yet 'unseen' world. The students begin as spectators, become observers, then makers, and end the project as the inhabitants of the places and spaces they create.

Picture vs. reality

Architecture Foundations studio at the University of Kansas used to be a series of rather loosely connected short projects, beginning with a sequence of freehand drawing exercises to loosen the hand and sharpen the eye and mind. The exercises began by observing and drawing what was visible: the known world (Fig. 1).


Fig. 1. Drawing the known world. -2012

Even in these observations there was a transformation: from three dimensional realities to two dimensional representations. Edges became lines, and depth became value as the world was flattened and trapped on a picture plane by the converging lines of perspective.

Students are very familiar with the world of images; having drawn pictures, taken photographs, and looked at screens most of their lives. For our students, pictures of reality have become synonymous with reality itself. Juhani Palalasmaa describes it thus: "In our culture of pictures, the gaze itself flattens into a picture and loses its plasticity. Instead of experiencing our being in the world, we behold it from outside as spectators of images projected on the surface of the retina"[2]. The transformation that we want students to become acutely aware of is not one that flattens the world, but one in which they see the potential for a new three-dimensional reality: a reality that does not yet exist.

'Slice' asks students to abstract what they see to create something entirely new. It requires a lot more than observation; it requires creative energy to fuel transformation. The desire is for students to become fluent in the translation between two and three dimensions and confident in their ability to use a full range of architectural tools to visualize this change of state.

Early iterations

Bas relief

Following freehand drawing exercises early in the semester there were projects where students began to work in models, in a more exploratory way, learning about three-dimensional form-making and mastering new skills. In the first of these 3D projects, entitled 'Map', a given image was mapped and extruded, generating a bas relief layer model.

The 'given image' was painting, chosen by individual instructors. I used a Cubist painting by Picasso because of the way in which it interpreted and reordered a known world. Friedman's description serves the project well:

Cubism enabled artists to concentrate on the plastic form of their world and the transition between feeling and looking as a viable subject matter in itself; the subject matter of the composition is the composition, not the pieces of the composition.

He goes on to say that

"The visual structure of the 2D field implies many 3D interpretations. And the volumetric order of the 3D field implies many renderings[3]. "

This is what we wanted students to do: to interpret and reorder an image.

Fig. 2. Excerpt from Picasso's, 'Femme au Tablier Raye Vert'

The range of values and implied layers present in the given image provided good source material for a 2D to 3D investigation. The discussion had begun.

The painting was divided amongst the class, each student receiving their own rectangular piece with instructions to map and extrude it, generating a foamcore bas relief layer model (Fig.3)

Fig. 3. Early version bas relief class model. -2009

The idea of each model belonging to a larger image and sharing a common set of rules, fostered the idea of precision, responsibility and accountability to the larger group. The downside was that without room for real creativity, the ability to make an exquisite model and to 'follow the rules' became the measures of success.

Spacemaking

As the project developed, the assigned material changed from foamcore to Strathmore Bristol and there was an increase in the height of the model to 6". First attempts at the taller models looked like mushroom forests (Fig 3) as students grappled with the idea of structural stability.

Fig. 4. Grappling with structural stability -A. Rule. -2011

Students still had to maintain the visual plan from above (Fig. 5) but now could explore the world beneath. Models began to look different.

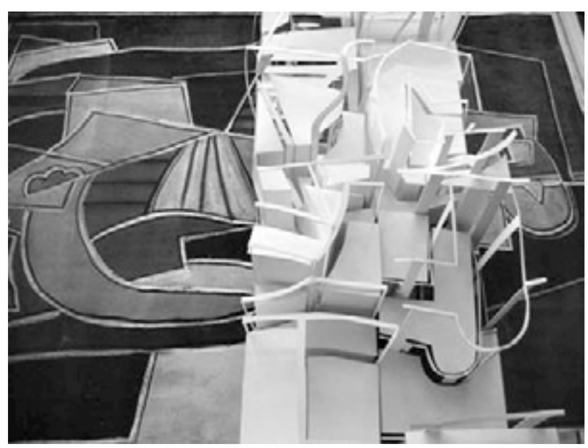


Fig. 5. Maintaining the plan from above. -2010

This increase in height gave the opportunity for the layers of the model to begin to define space: the plan was less dominant as sections and perspectival views were better descriptors of intent. Lines and planes began to describe volumes and students began to look inside what they were making, thinking about enclosure and view (Fig. 6).


Fig. 6. Increasing height, finding space. -2010

Change

This most recent version of the project came about because of two things: First, the desire to fuse the freehand and model-making explorations in the early curriculum and second, to have the students be a part of generating a source image.

Instead of an independent isolated project about layering, we tried to connect 'Slice' to the students' observational sketching exercises.

The notion of the shared, given image was abandoned in favor of students using an image of their **own** making to interpret and abstract. After all they had been using an interpretation by Picasso. What if the students became the interpreters? This way they would own the source material as well as the transformation of that material. There would be more opportunity for dialogue between two and three-dimensional worlds.

SLICE today

The images

'Slice' today begins with a sequence of observational freehand drawing exercises that use common objects as subject matter. In particular, we use freehand perspective sketches of boxes (Fig. 7) and desks (Fig. 8) done in charcoal on large newsprint pads. In these are drawings students change from spectators to observers, becoming acutely aware of the relationship between themselves, the picture plane and the scene.

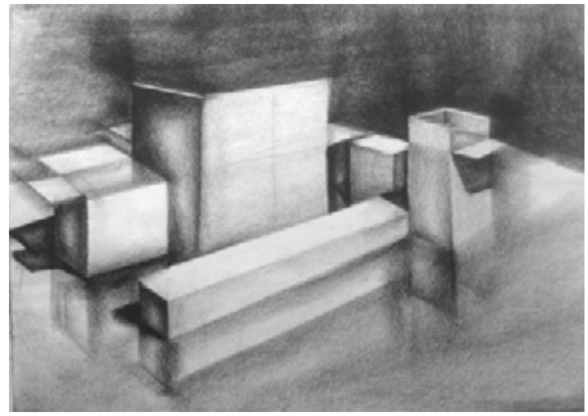


Fig. 7. Boxes with observed tone. L. Yang -2012

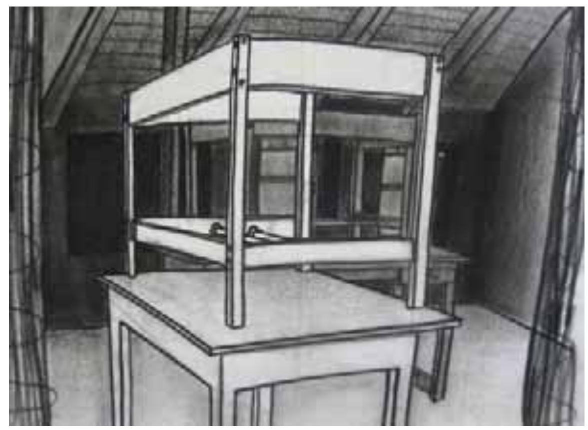


Fig. 8. Desks with formulaic tone. E. Davidson -2012

The freehand drawing exercises are orchestrated so that the subject of the drawing increases in scale relative to student. At first their eyes are above the scene as they draw boxes and then horizon shifts to within the drawing, embedding an understanding of perspective and how that changes relative to the viewer. Charcoal allows a student to make both a line and tone with one tool. In the box drawing, tone is observational: lines are used to construct the image, but then disappear as merely edges that reveal a change in light. In the desk drawings, the lines remain as tone is laid in a more formulaic way to depict depth (tone is applied as a value map of depth).

Either the box or desk tone drawings will become the source images of the transformation back into three dimensions.

The selection

The word 'slice', implies selection. In early versions of the problem, the slice was a given piece, distributed by the instructor, but in this most recent version, the students choose an image of their own making for their exploration: either their tone box drawing or their tone desk drawing. The first step is to make a 3 ½” x 10 ½” frame and use it to isolate a slice that shows a range of values and evokes depth. (Fig. 9) Imagining depth comes easily as darker values in the image recede and lighter elements leap forward. Students can ‘see’ their model emerge before it has physical presence.

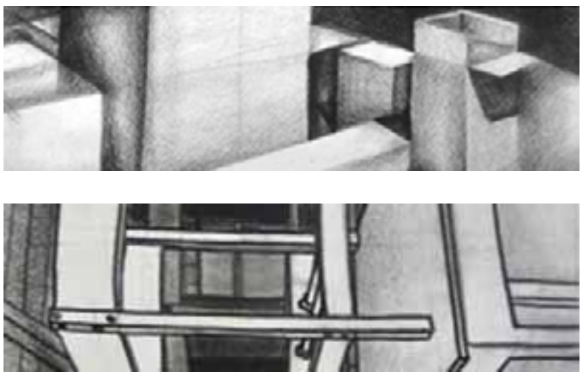


Fig. 9. Selected slices from box and desk drawings.

Students explore the slice in Photoshop in order to understand the digital tool’s capacity to make a value map with the ‘cutout’ function. This encourages an early critical dialogue between the digital and analog, comparing ‘eyes’.

Using line, the students define the boundaries between the values in the selected slice and, using drafting tools, create a hard-lined value map (Fig. 10). Mapping values requires decisive action as charcoal representation becomes drafted line: from imprecision to precision. Drawing conventions are introduced for the first time: plans, elevations, and sections must be developed in order to build the model. The value map is designated as an architectural plan that generates a Bristol model. Mapped values determine heights: white is 6” high, and black is ground, although what happens to the vertical scale between these extremes is at the discretion of the students and their ideas.

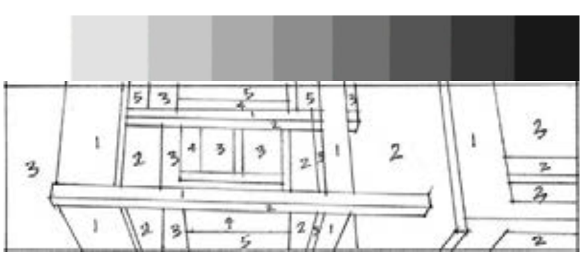


Fig. 10. Gray scale & Hand-drafted value map.

The model

In the charcoal drawing a line was a place where a choice between tones had to be made. In the model, the line still represents a place where a decision must be made: the drafted line on the value map will become a scored or cut line as the third dimension emerges: the line is transformed (Fig. 11). The assigned material for the model is still Strathmore Bristol, which comes in a variety of thicknesses and therefore material properties.

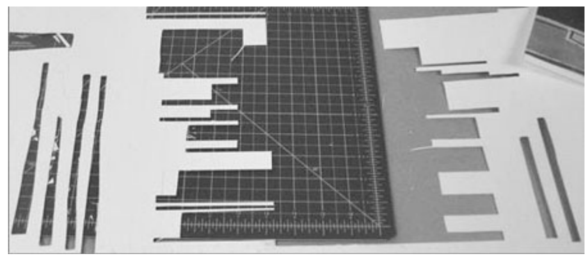


Fig. 11. The line transforms as drawing becomes model.

In observational sketching the students drew what they saw: the transformation from 3D TO 2D was direct and intuitive, made visible by one tool: charcoal. The orthographic transformation from plan to model, however, introduces new tools, and new terminologies, each with its own limits.

Spatial and structural concepts are explored with quick prototype models. As ideas solidify, the conceptual idea is developed through a series of iterative models that refine structural logic and details. (Fig. 12). The importance of establishing a set of rules for making the model becomes quickly apparent. Rules will order the system and reduce the number of incidental decisions.

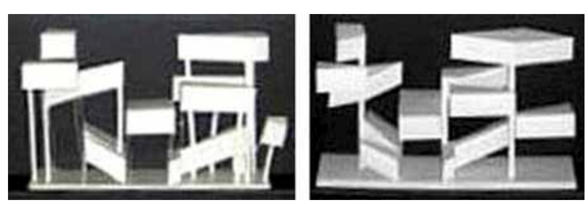


Fig. 12. ‘Floating boxes’ evolves through iteration. B. Capper -2013.

All models have the same outside dimensions but each generating plan, and generating mind is different. Some models carry some spatial property from their origin image and others leave the image behind. Each student develops their own logic for their model that is based on both a spatial and structural idea. Every solution has its own identity and therefore its own set of rules that will govern the making of the model. Together with the plan, elevations, and sections these rules become explicit instructions that might allow someone else to be the maker. Invariably, instructional, 'construction document' drawings evolve as a way to both explain and build the idea (Fig. 20). The parallels between the processes in this project and the processes in reality provide for rich dialogue with students.

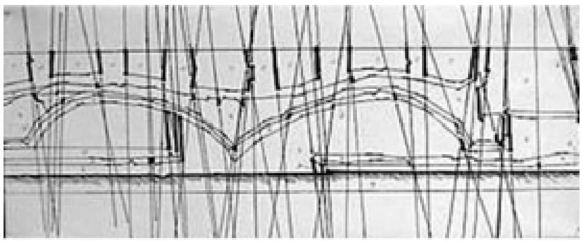


Fig. 13. Instructional drawing. A. Forney -2012

Solutions are linked to their origin image by varying degrees. The formulaic depth drawing of desks almost always creates models with horizontal layers (Fig. 14) but the observational tone drawing of boxes with its gradated tones has the potential to generate a model with inclined planes, (Fig. 15).

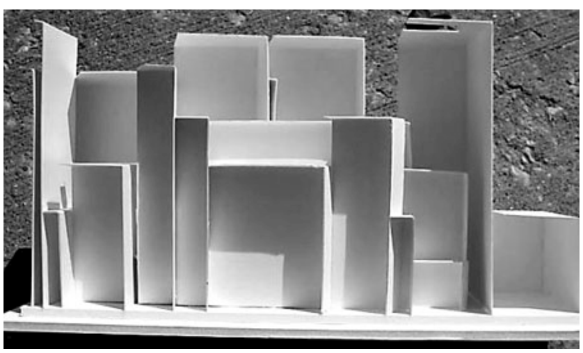


Fig. 14. Horizontal planes creating spaces that capture light.

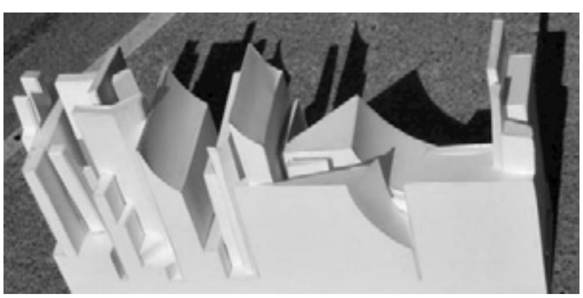


Fig. 15. Inclined planes derived from graded tone box drawing.

What was void in the original image might become a solid form in the new model or vice versa. It is quickly learned that the two dimensional plan as a generator is of limited influence in the final three dimensional form. The starting point really is only a beginning.

Structure

The quest for structural stability and clarity, and the delimiting properties of the given material emerge as major influences in the final solution. Defining a structural idea that supports a conceptual one is new ground for the student. For example, one student's desire to have vertical supports but to still be able to see through the model pointed him student toward an idea about perspectival fins (Fig. 16).

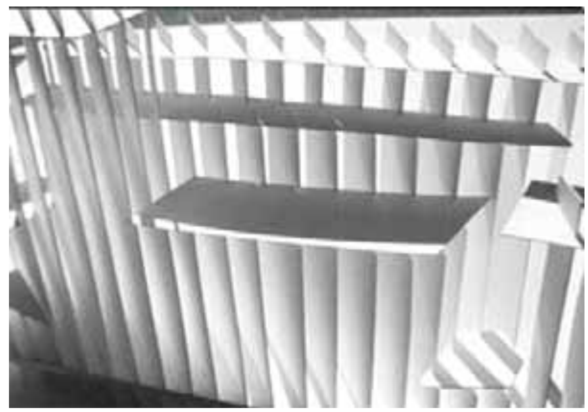


Fig. 16. Perspectival fin structure. A.Rule -2012

Testing conceptual ideas relative to the material properties is one of the most valuable explorations of the 'slice'. In fact the variety of solutions within the fixed parameters of size and material are extraordinary. A continuous ribbon concept might evoke plate structures, cumulative layers; loadbearing structure, skeletal grids; post & beam, floating boxes; cantilevers, and so on (Fig. 17).

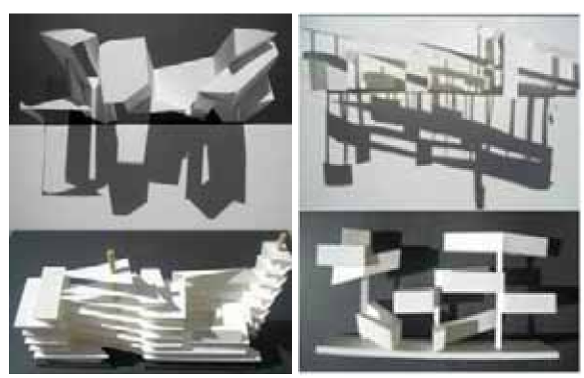


Fig. 17. Structural and spatial variety. Fall 2011-12

Beginning & Ending- comparing image

Each student takes a series of photographs of their final model, capturing its essence, bringing it to life in light, and taking it back into a two-dimensional world: a picture. Then they must choose only one image that really captures their intent and to consider whether this image shares the genetics of the source image and what choices have might have influenced the outcome. The boxes were essentially closed volumes and the desks were essentially skeletal frameworks. How did this influence final forms?

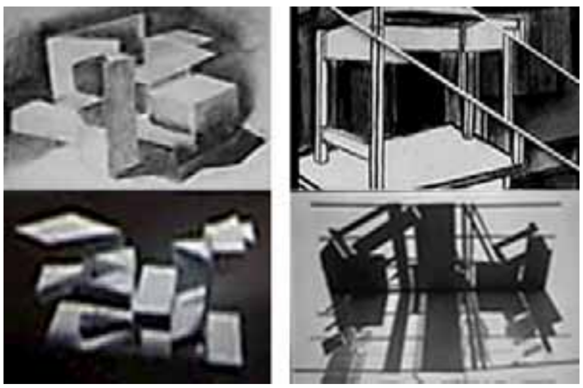


Fig. 18. Boxes and desks: Beginning and ending: Two dimensions capturing three. B.Capper, F. Pacheco –'12

Demonstrating process

The project concludes with visual and verbal presentations that describe each student's intent, thinking process, influences, and demonstrate the transformations that have taken place between the beginning and ending images. Evidence of instructional drawings, templates and idea-changing moments are evidenced in the final presentation. Students reveal what they have learned about the relationship between 2D & 3D representations and transformations how they inform each other (Fig.19).

Conclusion

In the introduction it was said that 'slice' began with understanding the familiar, the 'seen' world then reinterpreted it through projection, and imagination to create a new as yet 'unseen' world. This is what these students will do as architects. They will begin as observers (no longer spectators as architecture school has engaged them in their world), then become makers, designers, and end as the inhabitants of the places and spaces they create.

Friedman says that "Even when the steps are simple and clear, there may be no unique connection between a three dimensional figure and its two dimensional origins"[4] . What we want to students to begin to understand are the relationships between two and three dimensional worlds and how the dialogue between them influences outcomes. The designer is an agent of change, and he must understand his tools.

The physical or seen world is simply a beginning. As architects, a given condition of site, or of program, could be a trigger for the process that will lead to a real piece of architecture. Slice is a project of pictures, projections, and possibilities: an introduction to the power of process.

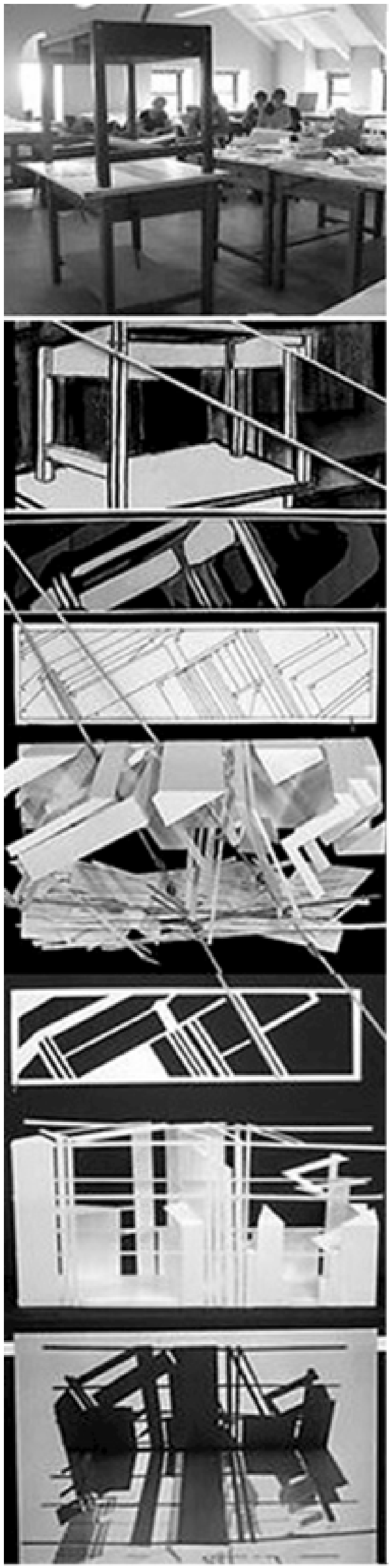


Fig. 19. Final presentation. Fatima Pacheco. -2012

Notes

[1] Jonathan Block Friedman. 'Creation in Space: a course in the fundamentals of architecture. Volume 2: Dynamics, (Kendall/Hunt Publishing Co 1999) p83

[2] Juhani Pallasmaa, '*The Eyes of the Skin: Architecture and the Senses'* (John Wiley & Sons. 2012.) p30

[3] Friedman - 'Prelude'

[4] Friedman – 'Prelude'

Synthetic Practices:

Molecular Gastronomy and (im)Materiality in the Design Studio

Jeff Ponitz

Cal Poly, San Luis Obispo

Architecture and Cuisine

Many parallels can be drawn between Architecture and Cuisine as creative material practices with immaterial effects. Each involves the skillful selection and assembly of materials in service of a multi-sensory experience to elevate the pragmatic acts of cooking and building to art forms, providing both sustenance and delight. According to Semper, the genesis of each of these arts is intertwined in the space of the hearth:

The first sign of human settlement and rest after the hunt, the battle, and wandering in the desert is today, as when the first men lost paradise, the setting up of the fireplace and the lighting of the receiving, warming, and food-preparing flame. Around the hearth the first groups assembled; around it the first alliances formed; around it the first rude religious concepts were put into the customs of a cult.[1]

The hearth is a site of material transformation where the *raw* becomes the *cooked*, but it is also a space of warmth and light, a space of community, and a space of ritual. It transcends basic needs of food and shelter to engage the body, the mind, and the soul. Anthropologist Claude Levi-Strauss described food's extension beyond the material realm into the philosophical when he famously said it must be "not only good to eat, but also good to think with."[2]

This paper examines a second-year design studio that used the study of *molecular gastronomy*—a highly experimental subset of cuisine—as a means to encourage material ingenuity, multi-sensory design, and the development of a conceptual framework. In this studio, students drew inspiration from molecular gastronomy to explore relationships between material, form, and structure, but perhaps more importantly, between the material and the immaterial. How do we teach beginning designers to create an architecture that is not only materially and formally adventurous, but also engages the senses and is "good to think with?"

Molecular gastronomy, sometimes referred to as modernist cuisine or deconstructivist cooking, celebrates the overlap between art, science, and technology. Chefs utilize syringes, blowtorches, and liquid nitrogen among other tools to create novel forms, textures, and flavor sequences that defy a gourmand's expectations; a single elaborate meal may last six hours.[3] Food critic Anthony Bourdain describes such a meal at *ElBulli*, run by famed chef Ferran Adria:

I sit and eat what is for me a delicious, shattering, wondrous, confusing, strangely comforting, frightening, and always wonderful meal.[4]

This re-occurring sense of *wonder*—an emotion of equal parts pleasure and bewilderment—can be traced to molecular gastronomy's approach to materials, at once playful and rigorous: common ingredients are broken down, reconstituted, and recombined in pursuit of a fantastic multi-sensory experience. This could be thought of as an abstraction-based approach to cuisine, wherein the essence of an ingredient is extracted, distilled, and manipulated in order to transform it into something new. Molecular gastronomy is a synthetic practice in every sense of the word, celebrating cuisine as an unnatural assemblage in which the sum is greater than the parts. This approach to abstraction made molecular gastronomy an ideal subject of study for an early design studio, where students may not fully understand the processes or the value of abstraction. But in architecture, as in cuisine, material practices are only useful insofar as they produce immaterial effects——if it doesn't taste good, what is the point?

Synthetic Pedagogy

The ten-week studio worked towards a single design project—a 10,000 square foot *Institute for Molecular Gastronomy* in San Francisco—but was delivered as a series of five two-week project modules. Each module focused on a particular aspect of the project (e.g., building envelope, atmospheric experience), and each asked students to craft specific artifacts tailored to that focus (e.g., 1/4” wall section, perspective drawing). The five project modules were described as *Experimentation, Conceptualization, Embodiment, Articulation,* and *Synthesis*.

This incremental structure was intended to act as a transition from Cal Poly’s first-year design curriculum—a fast-paced introductory sequence where students work through several design projects in a quarter—and the second-year studios, where a single project often lasts the entire quarter. This transition can lead to second-year students feeling both overwhelmed by the scope of their project, and bored by the pace. As the saying goes, “they don’t know what they don’t know,” and tend to view their project through whatever lens they are most comfortable with (typically exterior formal explorations). By breaking a ten-week project down into a series of bite-sized pieces, this structure aimed to keep students focused, engaged, and challenged.

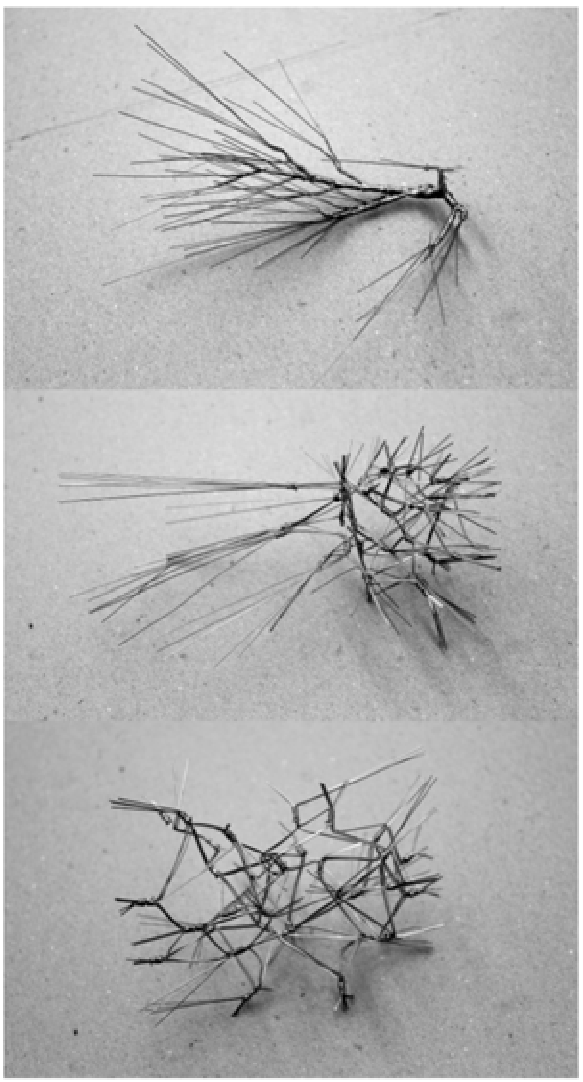


Fig. 1. Culinary Construct(ion)

This incremental structure also presented a fundamental dilemma: design is a fluid, holistic process in which a range of considerations are counter-posed, negotiated, and harmonized. Would separating these considerations result in disjointed projects that were less than the sum of their parts? To address this concern, each project module was approached as a synthetic practice in itself: students were asked at each step to reconsider how their current work called into question their assumptions from previous modules, and could transform their more comprehensive vision of their project. The goal was that by regularly shifting the criteria by which students’ design proposals may be evaluated, this approach would lead to conceptual frameworks that were rigorous and synthetic, and would expose students to multiple potential avenues for design.

1. Experimentation: Material Ingenuity

The studio began with a materials-based introduction to molecular gastronomy’s spirit of experimentation and wonder. Students were asked to design, implement, and graphically communicate a novel process of manipulating material to produce volume. All work was considered to be a self-referential, 1:1 scale study, and students were encouraged to either use unfamiliar materials, or to use familiar materials in unexpected ways. Rather than producing a single product, students were asked to design a process (or *recipe*) that could be altered to produce a range of potential effects.

Students produced two constructs that demonstrated the minimum and maximum possible results of their process (typically solid and void conditions), as well as a hybrid construct that combined a range of results. These constructs were functionless, autonomous objects, but students were asked to evaluate them on the material and immaterial effects they generated, and by what Reiser and Umemoto refer to as “fineness” in their *Atlas of Novel Tectonics*:

Fineness breaks down the gross fabric of building into finer and finer parts such that it can register small differences while maintaining an overall coherence. The fineness argument is encapsulated in the densities of a sponge:

too fine and it acts like a homogenous solid; too coarse and it becomes constrained to its members. Architecture must perform similarly, at just the right balance between material geometry and force.[5]

The pursuit of fineness was part of a larger studio goal of introducing parametric thinking in a context removed from parametric software, grounded in relationships between parameters such as material properties, geometry, force, temperature, and time. Aranda & Lasch's *Tooling*, which refers to algorithms as "recipes" for form-making, was also used to suggest the potential of procedural yet variable processes in cuisine and architecture, writing "...only when these steps are clearly stated can they really become an algorithm, a powerful packaging of logic that allows this procedural thinking to migrate inside and through multiple syntaxes, including software."[6]

To demonstrate the algorithmic nature of their process of making, students were asked to produce a graphic *recipe drawing* that communicated that process, taking inventory of materials

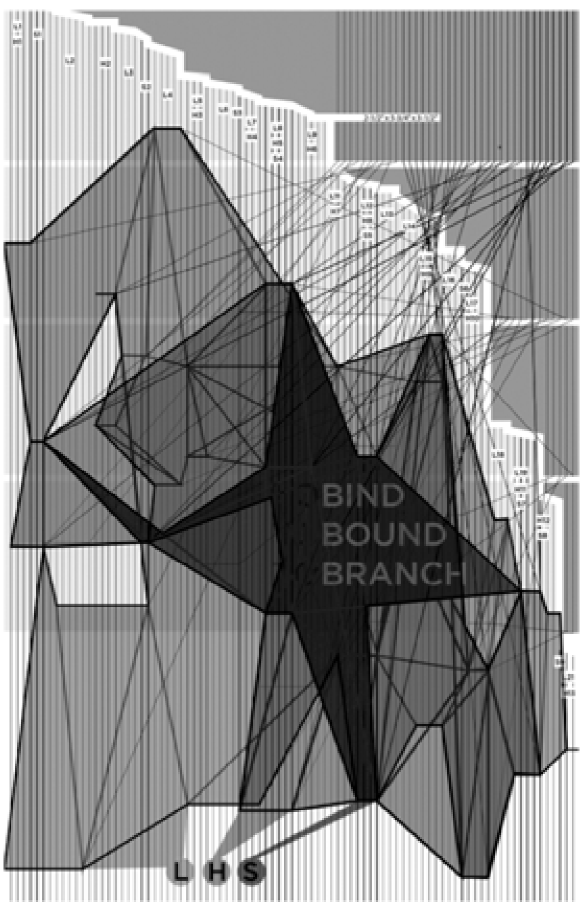


Fig. 2. Recipe Drawing

used, depicting a strategy of manipulating and combining them, and identifying the parameters that could be altered to create variable results. These drawings acted as what Richard Sennett describes as "expressive instructions [that] connect technical craft to the imagination."[7]

2. Conceptualization: Site and Program Narrative

Students knew from the beginning of the quarter that they would be designing an Institute for Molecular Gastronomy (IMG), broadly defined as a site of research and public engagement, where material experimentation comingled with atmospheric effect, and where heat, moisture, and airflow were used to construct architecture as well as cuisine. However, they were designing an institute that had not yet been institutionalized or formalized—*what is an IMG? Who is it for? How does it work? What does it need?* These were the basic questions put forth to students as they were asked to consider the IMG as an interrelated series of activities, events, and experiences rather than as a building. In this spirit, they were to work with program in the manner that molecular gastronomists work with ingredients, using novel combinations and transformations but still seeking an overall harmony.

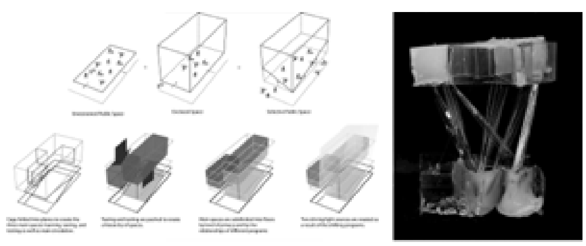


Fig. 3. Concept Diagrams and Concept Model

This process of synthesizing analysis and invention of site and program, and distilling it into a conceptual framework, could easily be described as *programming*, but to disassociate it from its more mundane associations with space-planning, students were asked to prepare a *working recipe for an IMG* that took inventory of required *ingredients* (spaces, activities, events, equipment, sources of light, desired views) and proposed a strategy for ordering and combining them (hierarchies, adjacencies, narrative structures). Diagramming was used as the primary means of proposing an IMG as a generative logic with multiple possible outcomes, rather than a single architectural product—a parametric approach to programming.

3. Embodiment: Inhabiting a Concept

After developing a conceptual framework that was firmly immaterial, the studio shifted gears to focus on spatial and experiential aspects of the IMG at the scale of the body. While students' projects were very unresolved, they were told to resist the urge to "figure their building out" before designing at a more intimate scale, and instead work from the inside, out. This required assigning a hierarchy to their projects, editing ideas down and understanding that different areas of a project can be developed at different rates.

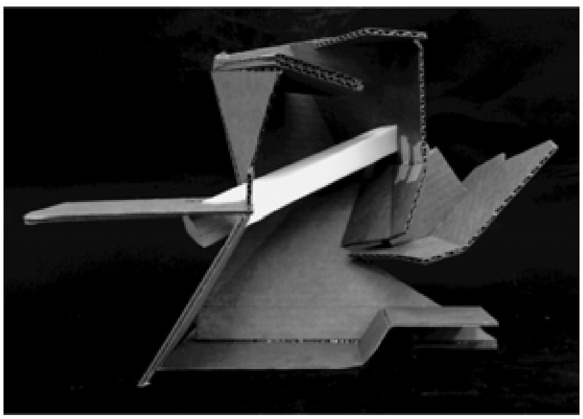


Fig. 4. Moment Model

Students were asked to select a particular spatial "moment" in their project that served as the most concentrated experience of their concept, and to draw and model it at 1/4" scale. Section drawings privileged atmosphere over material, sculpting vessels and voids in order to shape light, sound, views, and airflow while accommodating the body. Sectional "moment models" developed these spaces three-dimensionally and materially. Perspectivally collaged ideograms served as a shorthand experiential views, allowing these spaces to become events, atmospheres, and spectacles.

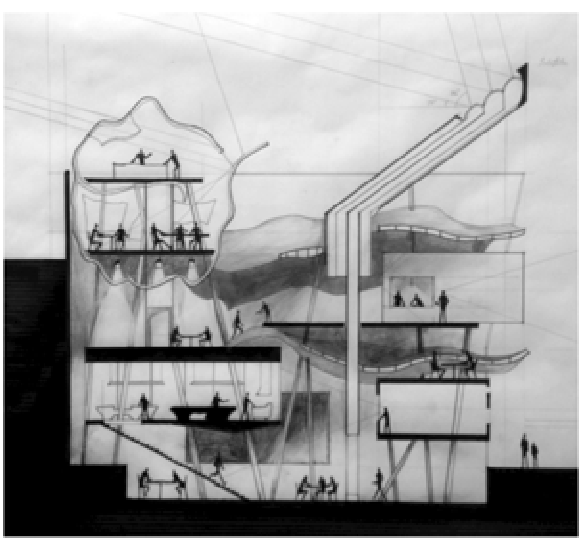


Fig. 5. Section Drawing

4. Articulation: Structure and Enclosure

The development of a particular moment in students' IMGs gave them a new way to test their conceptual framework, and inevitably changed the way they thought about their broader project. The studio again shifted gears to consider how structural and enclosure systems could be used to reconcile part-to-whole relationships in the project and augment their conceptual framework, as opposed to merely adding further detail and resolution. The initial Culinary Construct(ion)s were used as examples of a single differentiated material system that determined structure, skin, and solid/void relationships. Students built 1/8" scale sectional models, loosely based on their moment models, which encompassed a single structural bay and articulated the building envelope in terms of patterning, performance, material, and depth of surface. Exterior perspectives contextualized these systems at a larger scale. Parametric thinking was again discussed as a means of differentiating a single system to respond to varying requirements (building geometries, spans, light and view).

Fig. 6. Facade Rendering

5. Synthesis: The Alchemy of Storytelling

Approaching the end of the quarter, students had an extensive collection of ideas and artifacts at a range of scales and media; a process-oriented studio for a process-oriented client. A

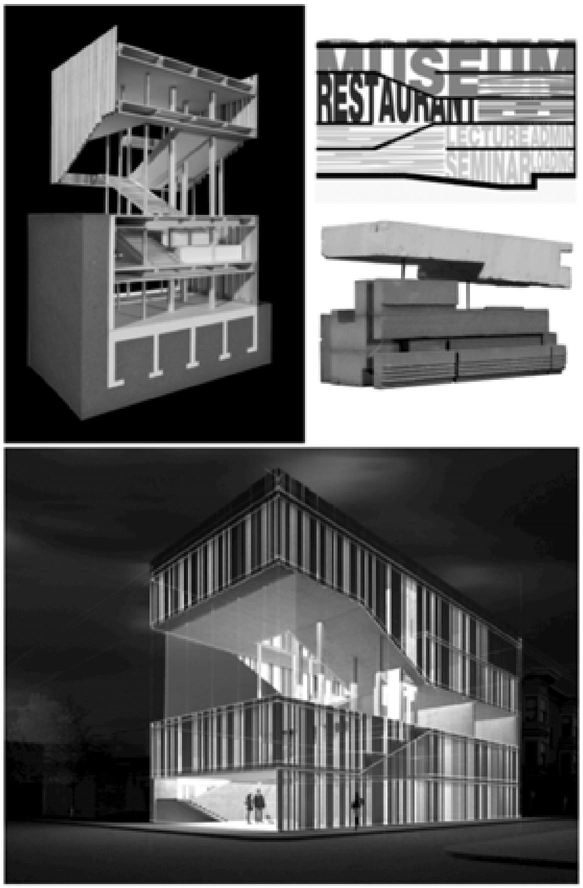


Fig. 7. Final Presentation Materials

period of synthesis was required for that process to congeal into a product suitable for public consumption. The act of presenting one's work, both verbally and graphically, was thus framed not as an act of documentation, but as an act of storytelling—a compelling narrative weaving together the material and immaterial aspects of their project, and underscoring the larger ambitions of their work. Throughout the quarter, particular modes of representation were used to communicate particular aspects of a design proposal—the idea being that representation is a biased communication tool that can be used to spark a dialogue with oneself as well as with others. In the final two weeks, students were asked to reconsider each of the artifacts they had made in the first four modules, determine what role those artifacts play in telling the story of their project, and remake them for their final presentation.

Reflection on Pedagogy

On the whole, the work produced by this studio was "not only good to eat, but also good to think with." Discussions of form, structure, and material intermingled with discussions of sensation, ephemera, and meaning. As would be expected, students struggled through some stages of the studio, and hit their stride in others. Anonymous teaching evaluations were largely supportive of the modular structure of the course; one student wrote,

The use of process stages helped to keep me on track with my work. It was very intense right from the start but I was able to accomplish much more and explore realms of design equally.

The course structure also made it a challenge for students to achieve the desired degree of depth in any single aspect of their design. When less advanced students did not meet the benchmarks of a given project module, they fell into a constant game of catch-up where the next module suffered. This method also presented a linear "one size fits all" sequence with a fixed starting point, which may have prevented other possible jumping-off points. However, that rigid sequence did open student's eyes to other design processes for the future; another student wrote,

This studio really broke me out of my shell, it really changed how I approach a project for the better. I used to have a really hard time developing a design.

Conclusion: a Matter of Taste

This studio drew many parallels between architecture and cuisine, using molecular gastronomy as a means of discussing the interrelationships between material practices and immaterial effects. These parallels could perhaps be boiled down to the notion of *taste*. When we speak of a sense of taste, we speak of a complex collection of physiological and neurological processes that ultimately boil down to a simple judgment: *I like this, I don't like that*. A sense of taste is personal and subjective, yet is often expected to align to trends and societal norms. Taste is both corporeal and cultural, innate and acquired; it is a sense, but also a sensibility.

The Latin maxim De gustibus non est disputandum—loosely translated to In matters of taste, there can be no dispute—may be disputed by beginning design instructors, who more often follow the maxim There are no wrong answers, but some are better than others. How do we teach students to develop their own sensibility without merely passing down our own? In this studio, the process of abstraction—understanding a given ingredient enough to know how to transform it into something new, different, insightful, and delightful—was a key mechanism for developing that design sensibility. Equally important was the ability to work synthetically in order to situate that ingredient within a larger framework to create a sum greater than the parts. A multi-year design curriculum is itself a transformative and synthetic process, where students must piece together a variety of voices and approaches to establish their own worldview.

Notes

[1] Gottfried Semper, *The Four Elements of Architecture and Other Writings* (New York: Cambridge University Press, 1989), p 102.

[2] Quoted in Claude Fischler, "Food Preferences, Nutritional Wisdom, and Sociocultural Evolution," in *Food, Nutrition and Evolution*, ed. Dwain Watcher and Norman Kretchmer (New York, 1981), p 58.

[3] David Ruy's essay "Lessons from Molecular Gastronomy," was a useful text in drawing an architectural ethos from molecular gastronomy, in *Log* (New York: Anyone Corporation, Fall 2009).

[4] From *Decoding Ferran Adria: Hosted by Anthony Bourdain* (DVD: Ecco, 2006).

[5] Reiser, J. and N. Umemoto, *Atlas of Novel Tectonics* (New York: Princeton Architectural Press, 2006), p 38. Reiser and Umemoto's concepts of "Difference in Kind vs. Difference in Degree" and "Intensive Systems vs. Extensive Systems" were also used to illustrate strategies for this module.

[6] Aranda, B. and Lasch, C. *Pamphlet Architecture 27: Tooling* (New York: Princeton Architectural Press, 2006), p 9. Aranda and Lasch refer to algorithms as "recipes."

[7] Sennett, Richard. "Material Consciousness," from *The Craftsman* (New Haven: Yale University Press, 2008.)

[8] Student Images Credits: Figs. 1-2. Matt Catrow; 3. Alvin Cheung; 4. Sam Strong; 5. Ben Maertens; 6. My-Linh Pham; 7. Ryan Craney

The Drawing Constructed

Steve Quevedo, Associate Professor

School of Architecture, The University of Texas at Arlington

Introduction

The role of drawing as a conceptual artifact predicting architecture dominates design education as a critical process. Drawings communicate design intentions, exploring within the two-dimensional media, spatial possibilities. As a means towards the realization of a built work, drawings are both constructed artifacts of the design process as well as architecture itself. Drawings bring forth a tactile investigation in a media that mimics the building process yet stands as a craft separated from the realities of construction. The *techne* of drawing reveals an un-concealment of an architectural truth or conceit.

The Drawing Constructed, an elective drawing course, established a series of objectives to investigate where the realms between architecture and drawing interact. Lectures, exercises and interventions within the architecture building presented drawings, which altered, enhanced or obstructed the perception and experience of space. The lectures focused on architects and their works in the execution of perspectives, *trompe-l'œil* and theater design. Lecture topics included Andrea Pozzo, Denis Diderot, Piranesi, Elizabeth Diller, Dennis Darden and George Rousse, A series of exercises explored conceptual drawings with mixed media whereby process was both reiterated and exhibited. Each exercise corresponded to specific lectures, which served as inspiration in graphic dexterity and detail but also in their didactic nature. The drawing exercises were one to two week projects and were exhibited following their completion to anticipate how the final installation would operate as an exhibition of drawing and its process.

These investigations led to the final project's development where the subject of the spatial intervention utilized the devices in the actual act of drawing and planning for the site. Anamorphic projections, trompe l'oeils, illusions, scanimations, gridding as well as digital software allowed the students to re-design the spatial perception. Resulting projects required didactics adjacent to the installations explaining the drawing's construction and research of its process. Examples of the work included: a redrawing of Borromini's forced perspective at the Palazzo Spada in Rome on a curved surface required an anamorphic grid; a mechanical apparatus known as a harmonograph employed pendulums to create complex geometric images; a rotating disc built on a chalkboard which maps the cycloid curve's construction of the Kimbell Art Museum vaults and a trompe l'oeil of a giant hole cut into the top of the stair landing.

Phase One: Constructing Drawings

As a predicator of architecture, the role of drawing is a critical process. The very first sketches suggest possibilities of proposed spaces.

The beauty of architecture is that it deals with the recessions of the mind, from which comes that which is not yet said and not yet made.[1]

Drawing is the first act. Free hand sketching is the fastest means of conveying ideas from the mind's eye and the hand. The process relies on both intuitive and creative contemplations but in architecture also involves the analytic and careful study. In other words, the sketch has the essential means for bringing forth an idea. The beauty of the free hand sketch, an improvised drawing, is that no one can truly say it is incorrect. Sketches are personal studies reflecting what the designer's intentions or observations are during the time of their creation. Thus one sees in the work of many great architects, sketches, which are quick, untidy and immediate. They represent a spontaneous decision leading to a later realization. The sketch is the first means of constructing an idea. This levity relieves the mind of the analytic or technical side of architectural drawing. In the making of a concept or *parti,* the quickness of the sketch eliminates minor details in the design process to focus on overall organization strategies.

Drawings communicate design intentions, exploring within the two-dimensional media, spatial possibilities. The role of orthographic projection allows the mind to see the three- dimensional space of a building in measurable views focusing on the relationships of length, width, and height. It allows for the inspection of spatial dimension and perfecting of proportions and order.

The drawing acts as a means for testing and exploring spatial design. Drawings represent as best possibly what the space and form of building are intending to be in their final form. Drawings, in this respect, can be hyper-realistic; a process now made even more possible with the use of highly sophisticated software programs. Where in the past, the artistic talent of the designer was crucial to be able to convey their constructions as accurately as possible by having the skills to draw and sketch quite well. Visualizing architecture meant being able to draw in both technical and artistic ways. Architects were identified by not only their buildings but their drawings as well. The two were inseparable. In addition, students strived to learn to draw well and develop distinct signatures with their drawing. They sought to create a unique identity with their drawings, one, which distinguished them as designers. The hyperrealism, predominating architectural rendering, reduces drawing to a base commodity in order to sell a design or building. So as to not become a slick promotional tool, just the opposite needs to be reiterated in design education. Design drawings need to return to their conceptual role of spatial abstractions and representatives of the quality and craft of architecture. The drawing is the architecture.

Just as drawings become an abstraction in the orthographic realm, they serve as an approximation for actual space. The construction drawing is a very technical means in this sense. They prescribe, not only form, measure, and materiality, but more importantly, the level of excellence and attention to detail. Not only do they instruct others how to build, they very carefully demonstrate how to build well.

Similar to the act of building, drawings convey several parallel processes in construction. Trace drawing establishing grids, boundaries, points, proportions and other *datums* is comparable to the marking of the ground and preparation of the site for construction. Rendering of materials, textures within the analog media of graphite or watercolors correspond to the similar investigations of material selection and how that material is finished. The choice of paper is critical to the drawing's perception; textures of rough or smooth relate to building surfaces and inform the drawing's delicacy or roughness. The quality of paper, particularly refined ones such as Mylar, Strathmore or 300 lbs. Arches, give drawings a sense of quality just as the selection of rich materials in buildings. The materials do not necessarily make for great architecture as this depends on the skill and detail towards how these materials are used. Similarly, line quality draws attention to the precision of mechanical drafting just as the attention to how joints are composed and assembled. While the digital medium has generally removed this in architectural drawings, it cannot replace the sense of wonder as to how well a drawing is crafted by hand. It is guaranteed that the plotter will always perform perfectly. But a very precise analog drawing has the ability to convey the quality of artist's craft.

It is as revealing, and not as manufacturing, that techne is a bringing-forth […]. Technology comes to presence in the realm where revealing and unconcealment take place, where aletheia, truth, happens.[2]
-Martin Heidigger

The sensibility of how one draws is conducive towards how one will build. The crafting of architecture is an act of making where even the most mundane materials such as graphite and paper reveal an essence of their nature and ability to create wonder.

The first exercise investigated a digital hybrid drawing, which alternated back and forth between a traditionally assembled collage, PhotoShop manipulations and then redrawing over a low opacity print.

This exercise served to review the accidental nature of the collage where relationships are established by alignments, overlapping fields, false attachments, inversion of occlusion and reversal of atmospheric perspective. Selected images were encouraged to have orthographic orientations and show fragments of construction elements: scaffolds, grids, and material fields.

In the digital phase, the ordering of collages could be reinforced and then viewed using various filters: embossing, grey-scale mode, and graphite pen. These views were then reassembled in subsequent images and then 'ghosted" in the low opacity print. This image was then printed on Strathmore paper as a trace on which the student could re-invent the drawing. All phases of the drawings were documented to reveal the drawing's constructions and evolution.

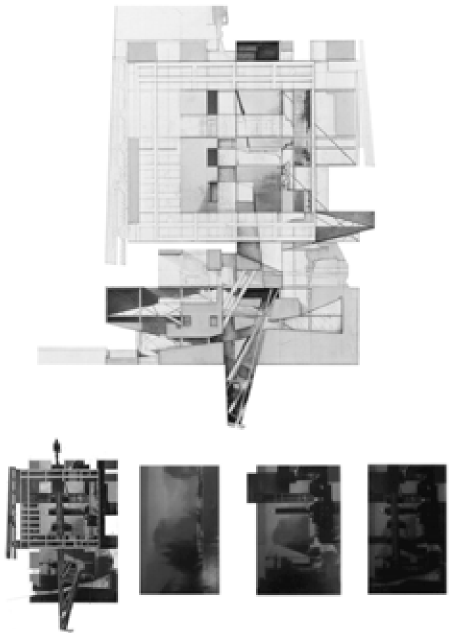


Fig. 1. Digital Hybrid Drawing, mixed media, Marco Fat Diaz, student

The use of the computer as a second eye allow for the designer to view their work in various reiterations and modes. It is a similar process to when designers would Xerox their work and make corrections or overlays, but of course much more expedient (see Fig. 1).

The second exercise, *Sgraffito* investigated the nature of drawing on a temporal surface of wall plaster (see Fig. 2). As a constructed artifact, the drawing surface is carefully built up in thin layers of plaster, sanded and finished to a smooth surface. The scratched surface from the sanding is left in place to reveal the making and development of unanticipated textures. Because the surface is so delicate, the graphite has to be applied from the inside of the drawing and worked outward to the edges. One could then scratch the surface with further sanding and create textures by removing the graphite.

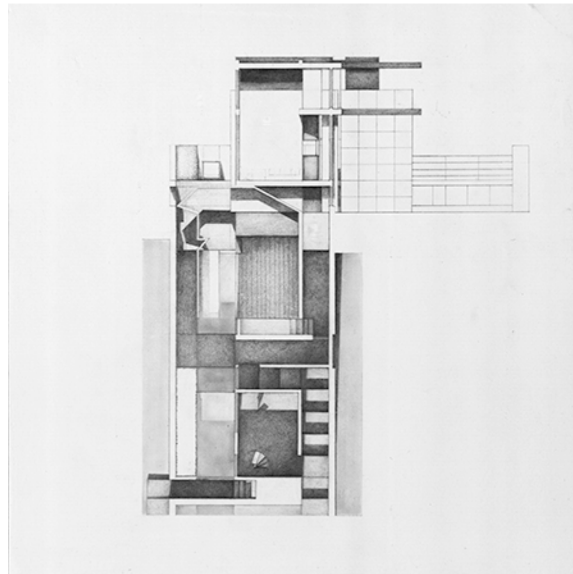


Fig. 2. Sgraffito Graphite Drawing on Wall Compound, Marco Fat Diaz, student

The next project, *the enigmatic machine*, investigated various devices, instruments and tools, which measure, survey, observe, record, photograph or scan. The observable tectonic of the devices were dismantled and re-thought with new functions in an analog drawing on Mylar.

The role of this drawing was to investigate the architectonic nature of the machine and through it's operations, how space could be viewed and observed. As such, the instrument could be incorporated or be an inspiration for the final installation. The subjects varied in range from traditional tools (clocks, cameras, sextants, telescopes) to recent detritus of discarded electronic devices (cell phones, DVD players, hard-drives). The objective of the drawing had to demonstrate the physical operations of the device by showing motion of its parts and graphically explaining what the device performed. Careful measurements of the mechanisms resembled the Diderot plates in their meticulous documentation. Rendering of the instruments emphasized the detail of intricate parts and their various roles in the machine's operations. The drawings act as archeological records in determining the subject matter; the continuing surveys of abandoned tools of forgotten technologies.

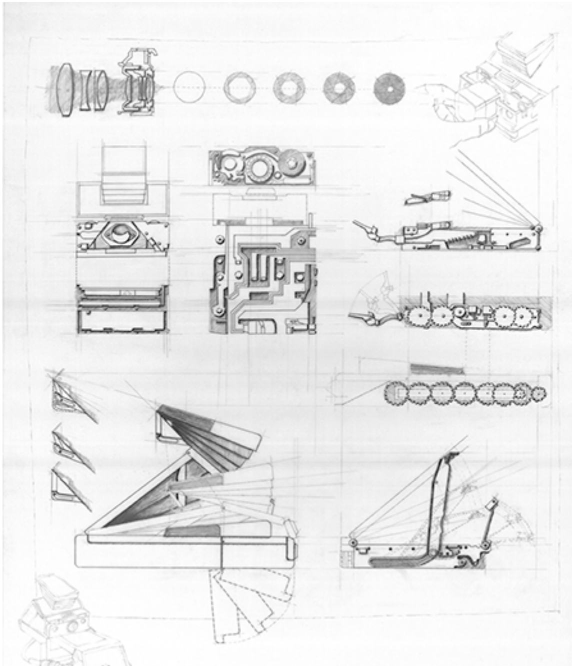


Fig. 3. *The Enigmatic Machine* - Polaroid Camera. graphite on Mylar, Chia-Yin Wu, student

Phase Two: Constructing Drawings: Drawings about Drawing

The role of construction played as an underlying theme for the lectures and exercises for the course. The first series of lectures introduced students to the incredible history of drawings. As drawings have since the publication of Alberti's *De Re Architectura*, accompanied the written text, architects have used drawings to illustrate and fantasize about the world. Denis Diderot, Andrea Pozzo and Giovanni Battista Piranesi, begin the survey in the first lecture of "The Enlightened, The Illusionist and The Imprisoned". In the work of Diderot, a philosopher and creator of *The Encyclopedie,ou Dictionnaire Raisonne des Sciences, des Arts, et des Metiers (*Paris 1751-1780), the illustrations served to accurately convey the processes of varying trades, crafts, the arts, architecture as well as construction in masonry, timber in addition to ship building, bridge construction, mining and even the military arts. Elaborate illustrations made from copper plate printing describe in minute detail by showing work under construction as a means to expose layers and process over time. The drawings are didactic in describing how to build. Likewise, Andrea Pozzo produces the book, *Rules and Examples of Perspective Proper for Painters and Architects*[3], which systematically shows in a series of steps how to create not only perspectives with great accuracy but transformative ones to be used as frescoes for domes, vaults or in some case entire rooms. Pozzo's masterpieces used perspective as a way of completely changing a space and creating an alternative reality. Spatial perception is altered and distorted creating more elaborate rooms, where painting and architecture blur the lines of distinction. At Sant' Ignacio, the vault over the nave is painted in such a manner that the true curve of the ceiling is no longer perceptible and instead converges to a new level of architecture before opening to the glory of heaven. Where the dome should exist at the transept, a painted canvas creates a *trompe-l'œil* depicting the dome, which was never built, a clever and inventive response when the pope, angry at the order, took their funding away. Pozzo 's *tour de force* however is a small room located in the Jesuit's headquarters adjacent to Il Gesu in Rome. Built as a vestibule to the rooms of the Jesuit founder St. Ignatius, walls and ceiling take a very small space and create the illusion of a grand hall, even correcting the perception of a wall, which is angled to appear square. The room is an incredible spatial experience as one is in disbelief of its ability to mask it true dimensions. As one moves away from the ideal station point, the images distort in long anamorphic, revealing the visual trick.

Lastly, the imagined prisons of Piranesi, the *Carcere,* serve to show how drawings evolve over time. The series went through two periods in which the architect engraved the images making them darker and more mysterious. Manfredi Tafuri's investigations from the Sphere and the Labyrinth analyze how the perspectives broke from the precise means of perspective construction. Not using plans and sections, but drawing strictly in a controlled free-hand manner. In reversing the drawings to determine the plans, the spaces are nonsensical and break with conventional plan symmetries. What Piranesi demonstrates however is the way drawings can create the wonder of the fantastic. They have the ability to transport the viewer to imaginary worlds. In addition, Piranesi dispenses with the tedious process of constructing the perspectives in a precise manner in favor of the joy of drawing for drawing's sake.

Subsequently lectures built on various architects and artists who utilize drawing as not only an integral part of the design process but as how the drawings can inhabit and influence the realm of architectural space.

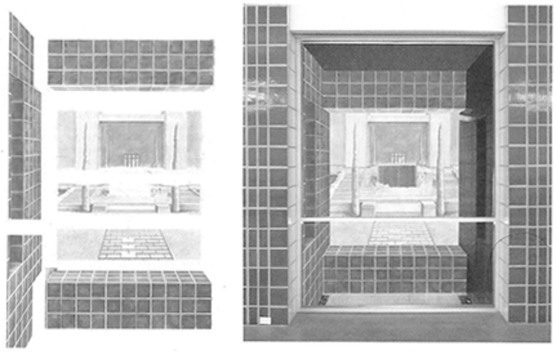


Fig. 4. Construction plates for a Window Perspective, graphite on bond paper, Samuel N. Langkop, student.

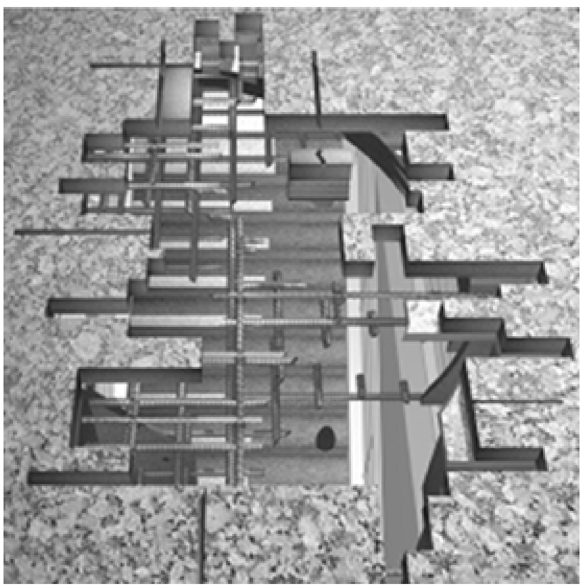


Fig. 5. *Sur-Really?* Auto-Cad rendering of a cut-out on a stair landing, Daniel Davila Montes, student.

Phase Three: The Drawing Constructed: Constructions in Space

The last project could be an individual's work or constructed in teams. Using the various media and subjects of the previous exercises, the installation had to transform the physical perception of the space by advancing perspective experiences or distorting spatial perception. The installation could also investigate an interaction between the viewer and the device or drawing. In figure 4, the student selected a window with view to the school's courtyard. Carefully measuring the interior and exterior space, he constructed a series of perspectives where the actual view would be altered. Mounted on the glass, four frames recreated the actual tile on the exterior walls. Inside the view, a completely invented

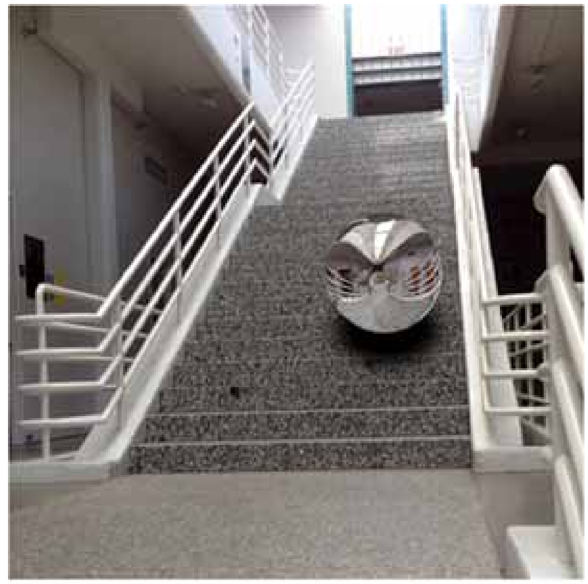


Fig. 6. *Big Ball Rolling,* Auto-Cad rendering cutout on stair landing, Stephen Jhoel Hernandez and Benjamin Hurtado Lule, students.

view replaced the existing one. A series of cutouts in the drawing revealed fragments in the background. An interesting phenomenon occurred in staging the station point for the piece. A single station point varied for individual viewers before the drawing created the illusion of being three-dimensional. The effect is similar to an autostereograms or magic eye prints. The large scale of the drawing and very specific use of shadows are necessary to create the illusion of being in the drawing.

The second installation, *Sur-Really?* (see Fig. 5), was based a very simple idea with a complex execution. The student had investigated the surrealist paintings of Salvador Dali, particularly the artist's use of overhead perspectives and visual illusions. The student, wanted to create a *trompe-l'œil* of an egg falling through the floor and creating a large hole in its wake. Selecting a prominent landing in the building, viewers would be surprised by what appeared to be a construction failure in the floor. The student researched the building's working drawings to be able to recreate the floor's actual construction and develop the view of the lower levels of the building under the stair's landing.

In the work, *"Big Ball Rolling",* (see Fig. 6) the students used panoramic photography to create the anamorphism of a large silver sphere constructed on the school's stairs. The image had to be enlarged as it went up the stair's risers. Here the students used a Sketch-Up drawing of the stairs to determine how to displace the image in the convergence of the view. The shadow of the ball became one of the more challenging problems. Students could not in anyway deface the building and each installation had to be able to be dismantled easily in case university administration disapproved of the drawing's safety. Consequently, the student carefully hand drew on trace paper the shadows and adjacent marble texture.

The most ambitious *trompe-l'œil* chose a curved wall located in one of the more obscure places in the building. Terminating a long corridor, the curve closes off a vending machine room. The students selected to reinvent Borromini's corridor at the Palazzo Spada in Rome. In the execution of the perspective, photographs of the image were projected using an old overhead projector. The effect created a mysterious image. The students experimented in a number of ways to draw the image. They first superimposed a grid over the image and then built the grid in the space using strings radiating from the station point. The grid was then drawn on the wall where the squares were distorted by the curved surface. The image was then carefully enlarged from the photograph. The overhead projector was left in place to insure correct shading and shadows, but the projected image, particularly the architectural elements, could not be traced with any accuracy because of its blurring and difficulty of seeing exactly what was being projected up close. The image would also heat up over time creating distortions in its placement.

As a result, the line drawing of the architectural elements had to be very carefully projected back to the vanishing point and mapped across the curved surface. Various options tested what would be the most efficient means of constructing a large scale drawing: an enlarged cartoon of a hand drawing, pouncing an Auto-Cad drawing with stippled holes as used in frescos were both investigated. In the end, once the students had the base lines of the perspective, the drawing on a curved surface back into a perspective became their challenge. With such a large scale, the drawing's smaller details become critical in creating in seeing the implied space as an extension to the hallway. The students employed atmospheric perspective by drawing larger in the foreground and then much smaller line strokes in the background. As a result the drawing is appealing from a distance as well as in close proximity.

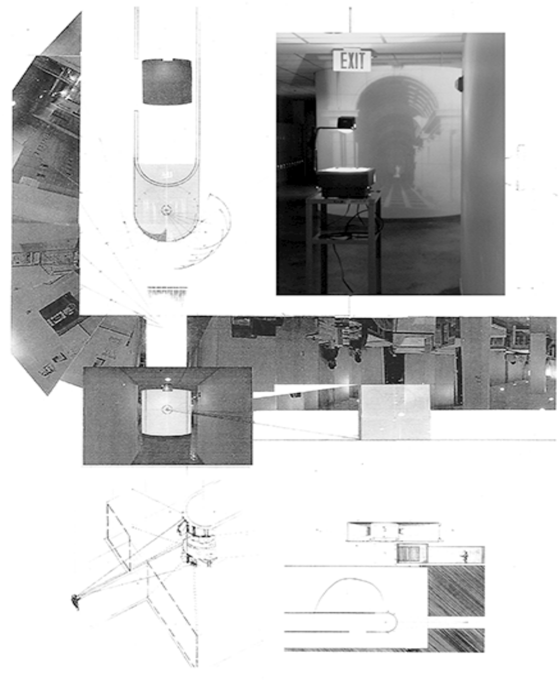


Fig. 7. *Borromini's Corridor*, study and overhead projection image, Marcus McKenzie, student.

Drawings, which engage and inhabit their space, become a realm of architecture, either in the mind's imagination or physically in space. *Venustas* is the third term of Vitruvian rule, meaning "delight or joy". It is an essential element of defining architecture. Venustas suggests that any work to be considered as a architecture must serve to create joy. Through drawing and its continuing role in architectural education, the process is a generative act in design. Drawing for students is their means of architectural expression and sometime drawings become an architectural world unto themselves.

The Drawing Constructed investigated the physical methods of drawings, the drawings' perception and impact on the space where they are exhibited and the relationship between drawings as a means of conceptualization and its implication in architectural construction. The construction of the drawings became both the source and subject within the space.

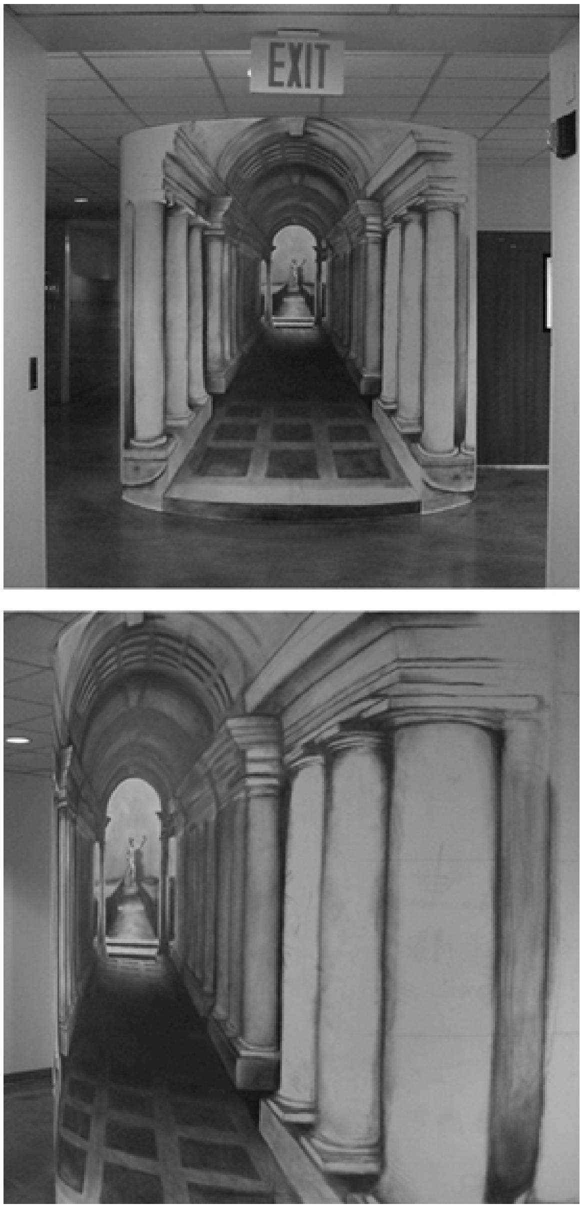


Fig. 8. *Borromini's Corridor*, overhead projection image, Marcus McKenzie, Marco Fat Diaz, Megan M. Wolf and Mario J. Guerrero, students.

Notes

[1] Kahn, Louis I. "Time Beyond Time" in *Between Silence and Light: Spirit in the Architecture of Louis I. Kahn,* edited by Lobell, John, Shambhala Publications, Inc.: Boston, MA. 1979. p. 54.

[2] Heidegger, Martin, "*The Question Concerning Technology*," *Basic Writings,* edited by Krell, David, HarperCollins Publishers: New York, 1993. p. 319.

[3] *Rules and Examples of Perspective Proper for Painters and Architects, etc. In English and Latin: containing a most easie and expeditious method to delineate in perspective all designs relating to architecture, After a New Manner, Wholly free from the Confusion of Occult Lines: by that Great Master Thereof, Andrea Pozzo, Socjes. Engraven in 105 ample folio plates, and adorn'd with 200 initial letters to the Explanatory Discourses: Printed from Copper-Plates on Ye best Paper by John Sturt. Done into English from the original printed at Rome 1693 in Lat. and Ital. By Mr. John James of Greenwich,* Pozzo, Andrea, Benj. Motte, MDCCVII. Sold by John Sturt in Golden-Lion-Court in Aldersgate-Street: London , UK,1707.

Bibliography:

Architectural Representation and the Perspective Hinge, Perez-Gomez, Alberto and Pelletier, Louise, MIT Press: Cambridge, Mass., 1997.

Drawing: the Motive Force of Architecture, Cook, Peter, Wiley: Chichester, England, Hoboken, 2008.

A Diderot Pictorial Encyclopedia of Trades and Industry; Manufacturing and the Technical Arts in Plates, selected from L'Encyclope die; ou, Dictionnaire Raisonne des Sciences, des Arts et des Metiers, of Denis Diderot. edited with introduction notes by Charles Coulston Gillispie, Dover Publications: New York,1959,

Flesh: Architectural Probes, Diller, Elizabeth and Scofidio, Ricardo, and Teyssot, Georges, New York, Princeton Architectural Press, 1994.

Perspectiva Pictorum et Architectorum, Pozzo, Andrea, B. Blom: New York, 1971.

The Sphere and the Labyrinth : Avant-gardes and Architecture from Piranesi to the 1970s , Tafuri Manfredo, translated by d'Acierno, Pellegrino and Connolly, Robert, Cambridge, MA, MIT Press,1987.

The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat, Kemp, Martin, Yale University Press: New Haven 1990.

Generative Making:

Devising New Uses for Making in the Architectural Studio

Chad Schwartz

Southern Illinois University - Carbondale

Introduction

In his essay The Tell-the-Tale Detail, Marco Frascari discusses the potential role of the detail as a generator of design. For him, within the architectural detail are both the "techne of logos" (the making of understanding) and the "logos of techne" (the understanding of making); here the construing and the construction of architecture coalesce.[1] If so, how can architectural details, building materiality, and processes of assembly inspire students as meaningful initiators of conceptual design? Detail and materiality both command prominent roles in our understanding of the essence and substance of the architecture we inhabit. Yet these elements have a tendency to escape significant investigation by architecture students due to the typical studio construct of macro-scale to micro-scale progression. In addition, although processes of making are used on a regular basis in the design studio, these processes are typically used to depict, demonstrate, develop, test, or convey design ideas. Rarely are acts of making charged with the task of generating ideas.

In a pair of recent courses, third year architecture students explored these topics by engaging with building materials through critical making. Matt Ratto, in his article "Critical Making," defines this process as a theoretical and pragmatic connection between two modes of engagement that are traditionally held apart: the conceptually based practice of critical thinking and the traditionally goal-based material work of making.[2] The exploration of materiality and detail can force students to engage a problem in ways outside of their comfort zone, sparking new ideas and habits of thinking that can be used to conceive future projects; it is a process of alternate perspectives. This paper compares two projects focused on the critical making of conceptual generators and postulates the potential this way of making holds for the training of future architects.

Critical Making

While I was studying, I developed a particular way of thinking through making. Instead of always starting with a drawing or a discussion, I used the making of test pieces in the workshop to find ideas.... Although giving myself permission to experiment, I remained open and receptive to the possibilities that the materials in my hands were offering, ready to convert them into something useful. Making them, I was wondering how each one might translate to the scale of a building or piece of furniture...[3]

This process, illustrated by designer Thomas Heatherwick, can be described as one of critical making. Within this process, there are embedded two essential thinking strategies: critical thinking and lateral thinking. Critical thinking is an act of reasoning; when an individual critically thinks, he or she "actively links thoughts together in a way that allows [him or her] to believe one thought provides support for another thought."[4] Conversely, lateral thinking is a process by which the thinker poses different approaches, concepts, or points of entry into a given problem. It is a process of exploration that is closely related to perception and asks the thinker to suspend judgment of 'correctness' or 'validity' in favor of opening up possibilities for 'what might be.' Critical thinking is a logical, step-by-step process; it is constantly attempting to move forward. Lateral thinking, on the contrary, steps sideways with the goal of revealing a series of ways to engage the problem from widely divergent perspectives. Where critical thinking is analytical in nature, lateral thinking is provocative.[5]

In critical making, these thinking skills are paired with processes of making. For making to occur, the maker must have a "systematic encounter with the material world."[6] This encounter is an embodied practice, one requiring the maker to use his or her body to generate a set of movements (known or unknown) in order to achieve the desired form or result of the made object. If the movements are known, the process likely has a logical structure; this type of making frequently strives for efficiency and a vertical step-by-step approach to making a pre-conceived product (i.e. an assembly line). Conversely, unknown movements liken the process of making to that of lateral and critical thinking. This process explores avenues for manipulating the material at hand (lateral thinking) and determines the best ways to use the material to achieve desired results (critical thinking).

Often, it is difficult for novice students to engage in making without prior knowledge of what they are going to make. There is a significant difference between making a model of a design and designing a project by making models. Tentative to make a leap without a plan in place, these students sit and ponder, frequently very unproductively. Critical making is one way of initiating a project. Utilizing the complementary tools of making and thinking, this construct has the ability to act as a generative device for sparking the design process.

In *Thinking Architecture*, Peter Zumthor positioned: "We know them all [architectural materials]. And yet we do not know them. In order to design, to invent architecture, we must learn to handle them with awareness. This is research; this is the work of remembering."[7] For Matthew Crawford, this notion centers on the need for experiential knowledge or "knowing how" instead of simply applying the universal knowledge of "knowing that."[8] Critical making not only has the potential to generate ideas, but also to deliver to students experiential knowledge of material. Juhani Pallasmaa would refer to this as learning the movements of the "architect's surrogate hands"[9] in reference to the craftsmen and laborers that execute the work that architects design. All refer to a need for architects, especially those in training, to have tangible knowledge of the elements of architecture. Critical making has the ability to provide those intimate connections.

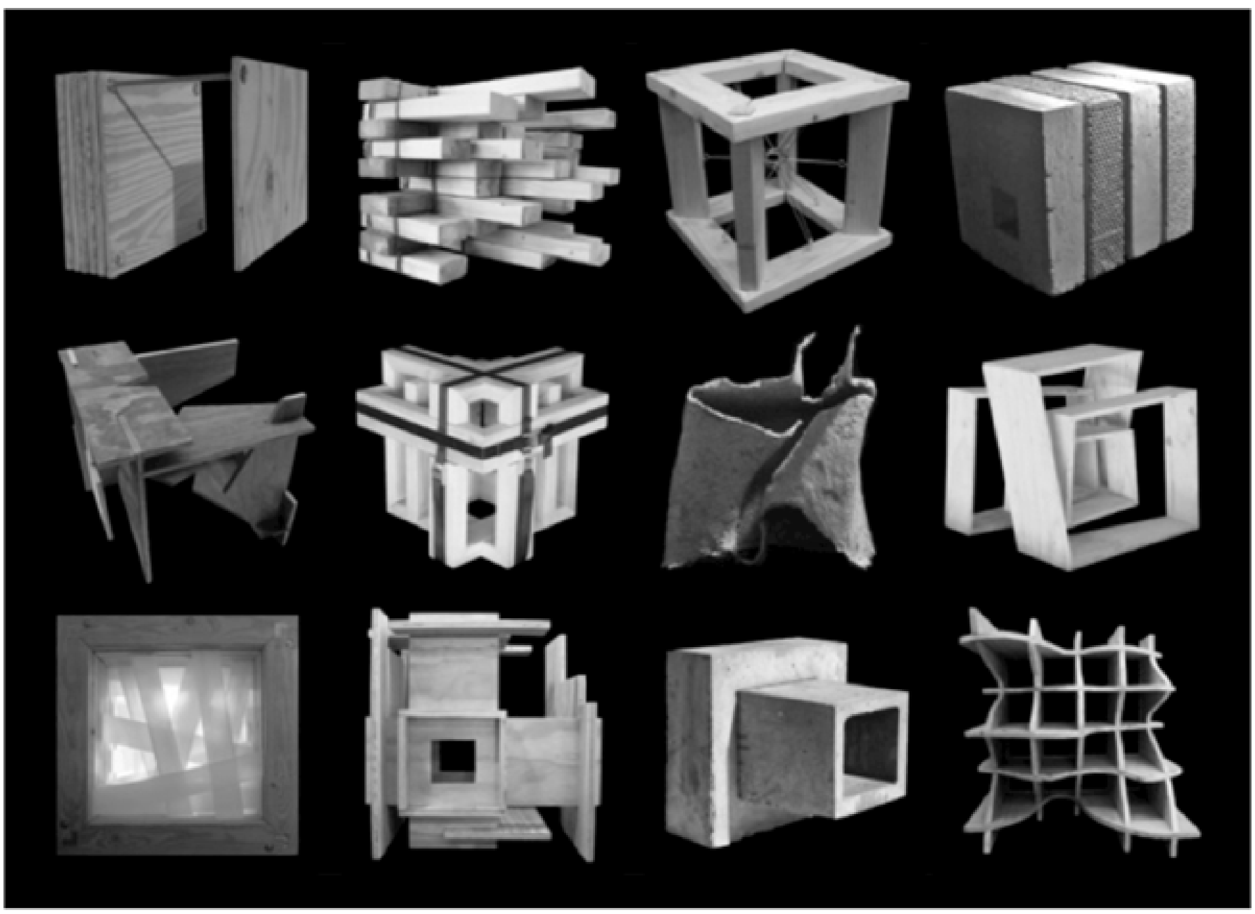


Fig. 1. Cube constructions - 2x4s, 1/2" plywood, concrete, fabric (M. Bartschi, J. Brookbank, D. Edwards, K. Griggs, P. Khatanifar, B. Lucke, R. Mays, D. Yu) (photographs by students), spring 2010

Generation I: Cubes

This first generation of critical making exercises was inspired by David Morrow Guthrie's building exercises outlined in his book *Cube*. Guthrie sought to reinvigorate architectural education through the introduction of the tangible consequences of scale and materiality as primary components of assigned exercises.[10] Like Guthrie's, these design exercises sought to directly engage the students with hands-on design; here, however, the larger goal was the establishment of conceptual ideas through the critical making process.

The studio was setup as two concurrent tracks running the full length of the semester. The first track followed a typical studio trajectory, while the second pushed the students through a series of critical making exercises involving full-scale building materials that complemented the first. The two tracks informed each other, bridging critical making with traditional research and design and vice versa. Along with the ideas of critical making, this structure fostered student engagement with the project through multiple mediums and different thought processes in an attempt to maximize the potential learning experience.

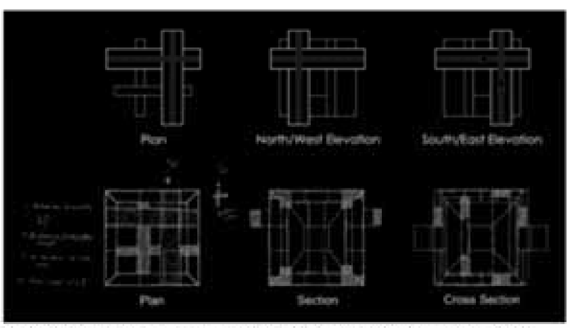


Fig. 2. As-built drawings and redlines (P. Khatanifar), spring 2010

The first phase of the critical making track asked the students to develop 16"x16"x16" full scale cube constructs out of given materials while establishing a design concept about the relationships of the individual elements, the parts to the whole, and the space created within the cube. The designs were not models, but full scale constructions; they were not representations of anything larger or more "real." Although abstraction was not completely removed from the process, this fundamental shift from creating a representation of something to creating the object itself forced the students to fully resolve each component. The design of each element was generated through sketching and making. Drawings and other digitally produced elements were used solely for documentation and analysis of the finished constructions. These limits, along with an accelerated timeframe, forced the students to jump directly into the making process; sitting and pondering could not occur. Each student had to quickly begin to engage with the materials and the process of making and learn to generate ideas through exploration and experimentation.[11]

There were four pairs of cubes built by the students in this studio, each from a different primary material (2x4s, 1/2" plywood, concrete, and fabric). The process of maintaining student engagement in each pair of constructions required alternating between sketching, fabricating (Figure 1), documenting (Figure 2), critical thinking via studio critique and drawing markups (Figure 2), and analysis (Figure 3) in an iterative cycle. Each finished construction was required to demonstrate an understanding of the medium, the detailing, and the design thesis. At the conclusion of each exercise, the students were asked to excavate ideas out of the assemblies and transfer them over to the next material construct. This analysis was crucial to the experience as it required the students to critically think beyond form (much like a case study), to the ideas or lessons generated through the process of making. This transfer of medium was also essential as the unique qualities of concrete, wood, and

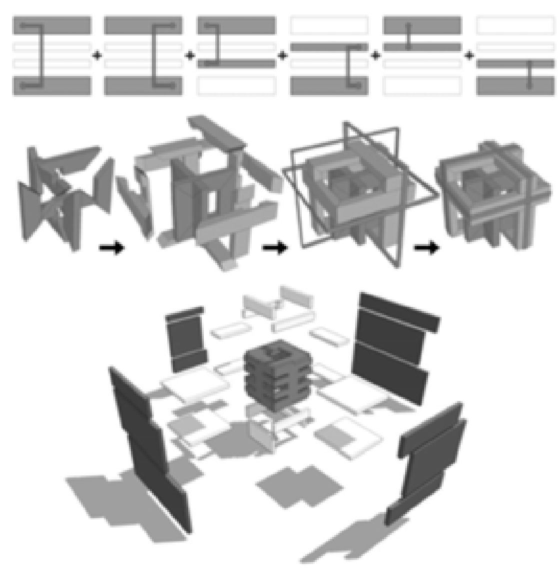


Fig. 3. Cube analysis diagrams (D. Edwards, P. Khatanifar, R. Mays), spring 2010

fabric provided the students with a wide palate for exploring their ideas. At the end of the critical making exercises, the ideas were drawn out for a final time and used to inspire the final studio project: an arts center (Figure 4).

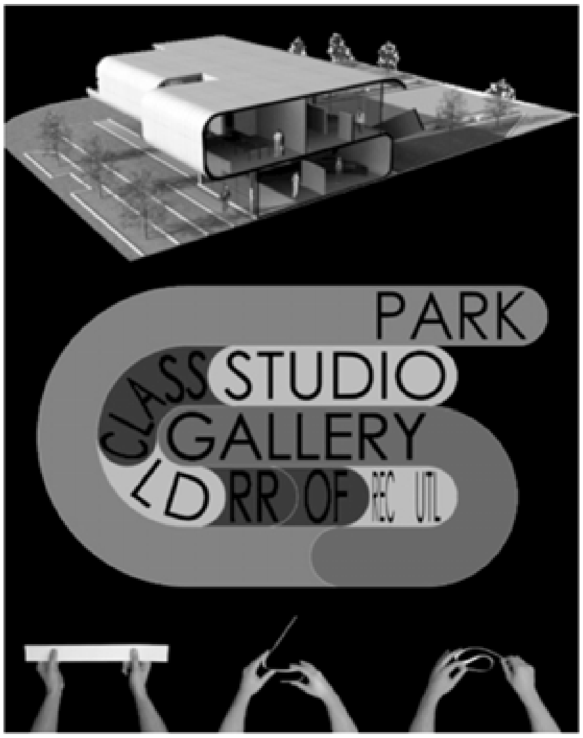


Fig. 4. Final Arts Center project (P. Khatanifar), spring 2010

There were three primary goals for the critical making exercises in this course. First, the baseline goal was to generate ideas through the making of constructions. This goal was met with distinction throughout the course. Each student in the class was able to quarry architectural ideas from their constructions. The translation of these ideas, however, proved to be more challenging. Although most of the students were able to carry their ideas from construct to construct fairly effectively, the final translation to the primary project was a significant challenge for a majority of the class.

The second goal was to use this process to broaden student perspectives regarding architectural design. The process of critical making opened up a new approach to design that most of the students had never experienced, exposing them to alternate ways of thinking and expanding their skill set.

And finally, the third goal was the creation of intimacy. The notion of critical making centers on a more intimate connection with a tangible subject. It is about touching material, feeling its form, and reshaping it into an idea. It is about developing an intimate relationship with the physical world and using that relationship to inspire design. As Martin Heidegger has stated: "the way we come to know a hammer is not by staring at it, but by grabbing hold of it and using it."[12] The experience of critical making for an architecture student can, therefore, help him or her understand the actual processes involved in creating architecture. Students engaging in this work never find that their conceived constructions are easier to build than they originally thought; it is always the opposite. As students explore their ideas about architecture with an interaction that reaches beyond the visual, they nurture their ability to understand the ramifications of their design decisions more clearly.[13]

Generation II: Panels

The second generation of the critical making exercises sought to build on the successes of the first while also addressing its shortfalls. The general construct of the assignments stayed intact in this course. Each student built pairs of constructions out of the same types of materials and followed a similar process to that of the first generation; they iteratively alternated between sketching, fabricating (Figure 5), documenting, critical thinking via studio critique and drawing markups, and analysis. Again, each finished construction was required to demonstrate an understanding of the medium, the assembly, and the design thesis. The ideas within each construction were developed and carried from one construct to the next. At the end of the critical making exercises, the ideas were, once again, drawn out and used to inspire the final studio project: a cemetery (Figures 6 and 7).

Despite the similarity in the process, this generation of exercises included several significant modifications from the first. In this studio, the generic configuration for the constructions was a 32"x16"x4" panel instead of a cube. This transition was made to align with the program of the primary studio project, but also, more importantly, to assist in the translation of ideas. The plane-like nature of the panel offered the potential to provide a clearer transition into a variety of architectural situations than the object-like nature of the cube.

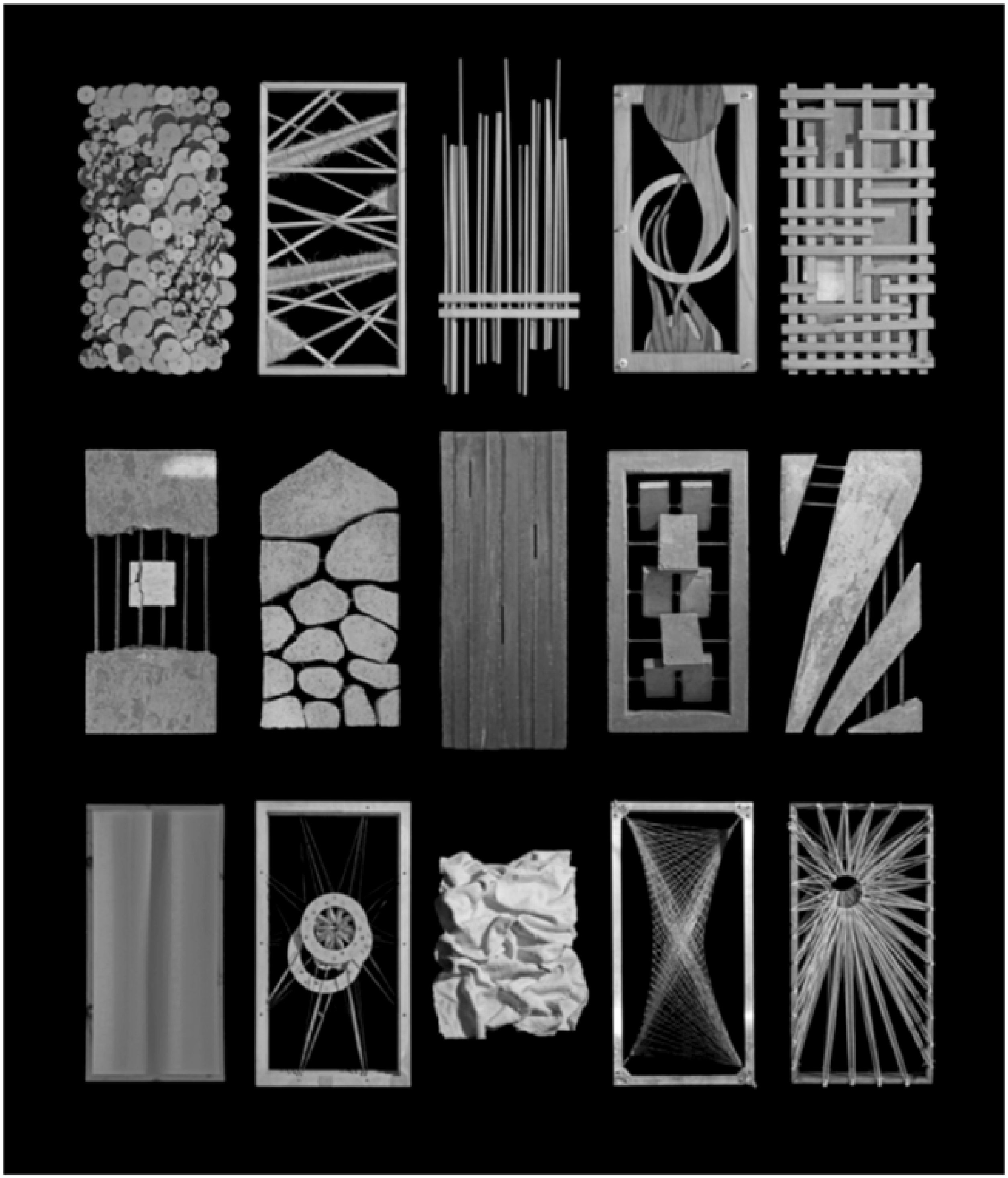


Fig. 5. Panel constructions, wood, concrete, fabric (M. Ollmann, A. Steiskal, K. Patrick, D. Thomason, S. Dale, A. Michael, R. Musial, B. Mount, R. Northcutt) (photographs by author), fall 2012

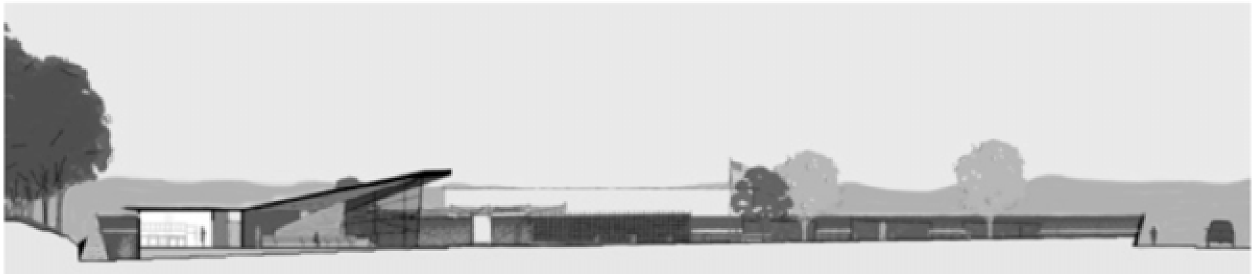


Fig. 6 (top). Cemetery Section, Fig. 7 (bottom). Cemetery Element Diagrams (R. Northcutt), fall 2012

In addition to this change, the analysis phase of the exercise integrated tasks focused on translation directly into the process. For each panel, the students were required to create simple renderings that, in an abstract way, turned photographs of their constructions into architectural environments at different scales - that of the detail, the room, the building, and the site (Figure 8). These translation exercises proved to be very useful as this class demonstrated more clarity in reinterpreting the ideas nurtured in the panel constructions during their work on the cemetery project.

The introduction to the critical making project was also modified in generation II. In this class, each student was required to select an object/scene/image to serve as an inspiration for the design of the first panel. This inspiration was found during a field trip to several local cemeteries (including our final project site) during the first week of class. The elements - the sinuous roots of an old tree, the stained glass on the door of a mausoleum, the patterning of gravestones in a remote corner of the cemetery - were photographed and the images were analyzed and mined for useful lessons. These inspirations made the initiation of the making process easier for the students as the proverbial "blank canvas" never existed; there were always existing ideas to draw from. This addition also helped root the problems in "place," even though they did not have an actual site or context.

Despite the modifications, the project goals remained the same as in the first generation: the production of ideas through the making of constructions, the broadening of student perspectives, and the opportunity for intimacy. Once again, all three goals were met relatively well. The modifications to this studio allowed for better transition into and through the series and the work produced by the students demonstrated an absorption in the process.

Conclusion

It is symptomatic of the priority given to sight that we find it necessary to remind ourselves that the tactile is an important dimension in the perception of built form. One has in mind a whole range of complementary sensory perceptions which are registered by the labile body: the intensity of light, darkness, heat and cold; the feeling of humidity; the aroma of material; the almost palpable presence of masonry as the body senses its own confinement; the momentum of an induced gait and the relative inertia of the body as it traverses the floor; the echoing resonance of our own footfall.[14]

This quote by Kenneth Frampton is as true for the education of the architecture student as it is for the practicing architect. In these two courses, third year students were introduced to a new strategy of engagement. The results revealed a strong reception by both student groups (an average of 4.95 out of 5.0 from both groups on course quality and educational experience), but also revealed that there is room to grow and build on these initial attempts. Moving forward, new impetuses include the introduction of a strong literature review (a key to Ratto's construct), the increased use of recycled materials, and new strategies to transfer ideas between constructs. Nevertheless, critical making would appear to have a place in an architectural curriculum that strives for connectivity between design and construction.

Architects Stephen Kieran and James Timberlake have claimed in *Refabricating Architecture* that the next generations of architecture will not be about style, but instead will focus on substance and the methods and processes of making.[15] Projects undertaken through the lens of critical making in the context of full-scale constructions provide architectural students the opportunity to become more engaged in architectural assembly. This process driven strategy is about substance and style and has the potential to be a significant contributor in the development of the next generation of architects.

Fig. 8. Panel inhabitation, monument (K. Odle), fall 2012.

Notes

1 Marco Frascari, "The Tell-the-Tale Detail," in Theorizing a New Agenda for Architecture: An Anthology of Architectural Theory 1965-1995, ed. Kate Nesbitt (New York: Princeton Architectural Press, 1996), 500.

2 Matt Ratto, "Critical Making: Conceptual and Material Studies in Technology and Social Life," The Information Society 27 (2011): 253.

3 Thomas Heatherwick, Thomas Heatherwick: Making (New York: The Monacelli Press, 2012), 22.

4 William Hughes, Jonathan Lavery, and Katheryn Doran, Critical thinking: An Introduction to the Basic Skills, 6th ed. (New York: Broadview Press, 2010), 19.

5 Edward de Bono, Serious Creativity: Using the Power of Lateral Thinking to Create New Ideas (New York: HarperCollins, 1992); Edward de Bono, Lateral Thinking: Creativity Step by Step (New York: Harper & Row Publishers, 1970)

6 Matthew Crawford, Shop Class as Soulcraft: An Inquiry into the Value of Work (New York: Penguin Books, 2010), 21.

7 Peter Zumthor, Thinking Architecture, 2nd ed. (Boston: Birkhauser, 2006), 66.

8 Crawford, Shop Class as Soulcraft, 161.

9 Juhani Pallasmaa, The Thinking Hand: Existential and Embodied Wisdom in Architecture (West Sussex: John Wiley & Sons Ltd., 2009), 63.

10 David Morrow Guthrie, Cube (New York: Princeton Architectural Press, 2005).

11 Paragraph adapted from: Chad Schwartz, "Crafting intimacy: Sculpting the Design Process of the Architecture Student," The International Journal of Design Education, 6 (3), 68.

12 Matthew Crawford, Shop Class as Soulcraft, 163-164.

13 Paragraph adapted from: Chad Schwartz, "Crafting intimacy," 67-68.

14 Kenneth Frampton, "Towards a Critical Regionalism: Six Points for an Architecture of Resistance," in The Anti-Aesthetic: Essays on Postmodern Culture, ed. Hal Foster (Seattle: Bay Press, 1983), 28.

15 Stephen Kieran and James Timberlake, Refabricating Architecture: How Manufacturing Methodologies are Poised to Transform Building Construction (New York: McGraw-Hill, 2004).

Material Intention | Material Implication

Robert Sproull and Kasia Leousis

Auburn University

Introduction

'What is this thing to be?' This question resides at the heart of every conceptual design process. However, when moving from design to construction, this initial inquiry is incomplete. The physicality of the built environment requires a nuanced understanding of this essential question – 'What is this thing to be...*made of*?' This two word postfix highlights a disconnection between material selection and design intention often found in proposals by beginning architecture students. Despite their ability to conceive of persuasive "big idea" solutions to problems, a closer critique of student work often reveals a lack of understanding of the finer grained implications in their design choices. Concerns and objectives related to constructability and cost frequently yield entirely to those regarding aesthetic effect.

Architecture Education Now, *Architectural Record*'s Special Report on education from 2013, indicates that the profession recognizes the deficiency as well. This 11 point manifesto for moving academia into the 21st century calls for an improvement in material research education in its very first entry[1]. The profession places this responsibility on the shoulders of educators, in effect saying, schools should make more effort to teach their students how to consider current materials when designing solutions to problems.

Universities, of course, already attempt to do this, if for no other reason to meet the requirements set forth by the National Architectural Accrediting Board (NAAB). There are standard building technology courses found in all architecture programs, however the sheer volume of information related to the full contemporary material palette renders such classes inadequate for conveying information on all topics. Because of this, materials education becomes somewhat autodidactic for students. In lieu of presenting topics on each and every construction material, (an impossible task), educators' learning objectives for these classes should be to instill in their students an ability to research and select materials in thoughtful and competent ways. This means teaching them about the process of material selection – one based on design intentions (both measurable and immeasurable), in a way that allows them to comprehend the implications of their choices.

A somewhat successful method for conveying this lesson is design-build where a project's imminent physicality obligates the student to understand, (on some level), and justify the chosen materials. Incorporating design-build projects into the architecture educational curriculum is firmly rooted in contemporary practice of student-focused professional development and as an alternative approach to theoretical or conceptual digital and paper drawings. Historically, design-build education provides a direct connection with Vitruvius' practical advice on building in De Architectura; a link to the arts and craft movement of the nineteenth-century epitomized by the work of William Morris who followed the writings by John Ruskin; and is practically organized and structured on twentieth-century design-build studios like those formed at Walter Gropius' Bauhaus School and Frank Lloyd Wright's Taliesin. In contemporary scholarship, the Journal of Architectural Education and the Association of Collegiate Schools of Architecture continue to document the debate and research concerning what place design-build as a pedagogical tool holds in architectural education. Design build courses provide students the opportunity to contemplate materials and construction first hand and engage clients in real scenarios. The value they serve in educating architects lays in the reality of their situations as these types of projects come loaded with comprehensible implications.

MATERIOUS

To better understand the disconnection between material intention and material implication, 17 students at Auburn University took part in a 15 week seminar called *MATERIOUS*. Envisioned as a supplement to the typical sequence of classes provided in the curriculum for building technology education, the course was designed to expand the students' understanding of construction materials, cultivate their ability to analyze material choices, provide a setting to examine and discuss case studies on specific material selection, and present opportunities to test ideas through a small design-build project. This required a variety of teaching methods that fell under four categories: *Thinking Materials* (readings and lectures), *Predicting Materials* (material research), *Experiencing Materials* (field trips), and *Using Materials* (full size constructions). While these activities were initially distinct, they were eventually considered and discussed mutually.

Thinking Materials

Thinking Materials focused on the examination of the work of others as a way for each student to take positions on material related decisions. These readings and lectures presented different architects' projects and methodologies, and as a means of facilitating discussion required students to complete 'photographic' responses to each. In these exercises, students were asked to find one quote from the assigned reading that illustrated their opinion on the topic, and present it alongside an image separate from anything the text referred to. In doing so the students had to A) take a position on the readings, and B) engage the topic enough to seek out a specific supporting example.

Fig. 1 Typical Case Study: Folded Aluminum bookshelf by Giacomo Longoni G-Design, Milan, Italy.

These topical readings on subjects like the unique material responses that result from Herzog and de Meuron's design process, or Blaine Brownell's thoughts on disruptive innovation, provided the framework that would be referenced throughout the design and construction process of full scale constructions in the class.

Fig. 2 Typical Photographic response to assigned reading. Megan Wood

Predicting Materials

Predicting materials consisted of research into particular materials to be used in the ongoing design-build project. This was through online and print sources, as well as contact with manufacturers from the industry. After holding informational and brainstorming sessions in the library and studio, the faculty member and librarian collaborated on a materials-focused research session for the students that asked them to solve a site-specific design problem. The students, guided by the faculty member and librarian, engaged in mini-research sessions throughout the design process that focused on cost, form, properties, and applications in order to make appropriate material selections.

For this project, the in-depth materials research necessary to complete the building process required them to use the database Material ConneXion, a recent library acquisition and new resource for the students, in conjunction with print and web resources on materiality and material investigations. These guided research sessions were based upon standard and expected student learning outcomes for visual and textual research proficiencies[2] for students at every level, within specific design disciplines. The skill set that deals specifically with student competencies in understanding building materials research for architecture students includes gathering information using materials and systems handbooks, manufacturer's guides and web sites, and specialized databases. Students were asked to take into account a researched material's entire range of properties, and consider how those being investigated might help support the design intent of the project the class was designing. This research was then presented to the class as a whole and discussed in depth.

Fig. 3 Typical Materials research presentation.

Experiencing Materials

Experiencing Materials was based on the premise that many design intentions, especially those that are unquantifiable, cannot be captured in media. Because of this, experiencing them first hand became a valuable method of conveying the meaning of materials and details. This required traveling to local and regional projects that employed or assembled materials in significant ways. These trips were supplemented with project specific lectures that prepared them for what they would be seeing and experiencing at various locations.

The most fruitful trip taken was to the High Museum of Art in Atlanta by Richard Meier and Renzo Piano. It offered two noteworthy material responses from recognized master architects completing projects more than 20 years apart. Detailing on both projects was discussed, and, specifically, the process and history of the final façade material for Piano's addition was presented in detail. Additionally, work from the permanent collection that includes relevant pieces for MATERIOUS by Anish Kapoor and Gerhard Richter among others and a travelling exhibition that included several works by Alexander Calder provided stimulus for discussion on the significance of those artist's material selections.

Using Materials

Using Materials consisted of the on-going design, fabrication and installation of a display element in the Library of Architecture, Design, and Construction (LADC). It served as a testing project for the methods and ideas being presented and discussed in class. In coordination with this

Fig. 4 Students examining Untitled 2010 work by Anish Kapoor in stainless steel at the High Museum of Art in Atlanta.

project, a series of specific readings were assigned from Edward Ford's The Architectural Detail. Discussion from this reading centered on five different detail philosophies, and these readings eventually helped facilitate discussion and direction on exactly how materials might be used and assembled in the design build project.

Fig. 5 Connection detail from the Plug-in Wall

The Plug-in Wall

With the architecture librarian acting as client, students were asked to investigate diverse materials and design methods to create a dynamic and interactive exhibition wall within the School's Library of Architecture, Design and Construction. The librarian charged the students to design a multipurpose installation that would be beautiful standing alone yet functional as an exhibit space for new books, curated media collections relating to common topics or themes, and student work. Additionally, the wall needed to connect through material choice and manipulation to the School's primary gallery/exhibit space located in close proximity to the library's main entrance (but operating in isolation from it). In doing so it would provide opportunities for peripatetic exhibit experiences that draw people into the recently renovated library and serve as a space for community gatherings.

Developing Intent

The project initiated with students meeting with the Librarian to discuss the LADC'c goals and expectations of the project. This led to a series of objectives that would essentially become the basis for the students' design intention. There were three main intentions beyond the initial requests from the client. They were: 1) the project needed to be functional yet versatile enough to handle many future scenarios. 2) The project needed to create a noticeable architectural moment in the library to attract people to browse the items displayed on it, and 3) the project needed to coordinate with the library's recently completed renovation while enhancing the space as much as possible.

Initial thoughts were that the library's main sculptural staircase would be home to this new element – a location that would provide easy visibility when checking out books. However, after the student team presented initial design ideas it was decided that a back corner, (still very visible from the entry and from the main stair) would provide a better opportunity for the project. This lead to the development of a fourth design intention – if possible reinforce the definition of the space with this project.

Fig. 6. Plan diagram showing views between gallery and other significant spaces.

Fig. 7. Existing Staircase in the LADC

Material & Action

As a starting point for the design work that related to materials, the class was asked to evaluate two items; a material and an action to be performed on that material. For the material they were asked consider availability, workability, specific material properties and traits as well as cost which could not to exceed $1000. For the action they were asked to consider what was easily available on campus or inexpensively from fabricators and craftsmen in the area. This was an indirect way of monitoring cost as well. There were many interesting combinations proposed; bent/warped metal, milled Corian®, sliced plywood, stacked cardboard tubes.

Design Intent/ Design Philosophies

As part of a hands-on collaborative process, student teams developed four concepts within the specific site-based framework. The teams designated themselves according to the solution they were investigating - the Cell Team, the Stacking Team, the Layering Team, and the Metal Team. It was interesting to note that each team selected either the material or the action they were proposing as their name.

Teams explored the project through drawings and physical and digital models; however they were also required to include full scale mock-ups in their investigations. These proved invaluable to the process, as it obliged the student teams to understand exactly how their proposals worked, and informed them where any issues existed.

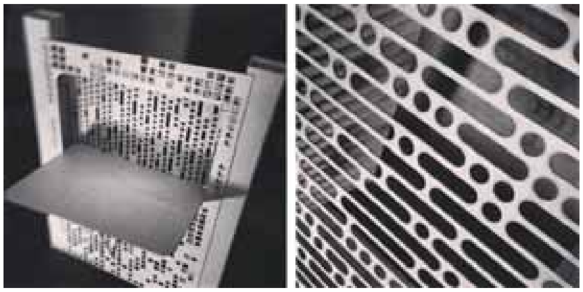


Fig. 8. Mock-ups of Layering Teams solution.

At the end of the term, each team was required to present these projects to the architecture librarian, the library's associate dean, and the Head of the School. They were required to specifically discuss the materials they were proposing with an explanation of how they met the initial intentions. The solutions were unique between each team, but often employed similar materials in different ways. Additionally each team was required to indicate how the major details of their project would work.

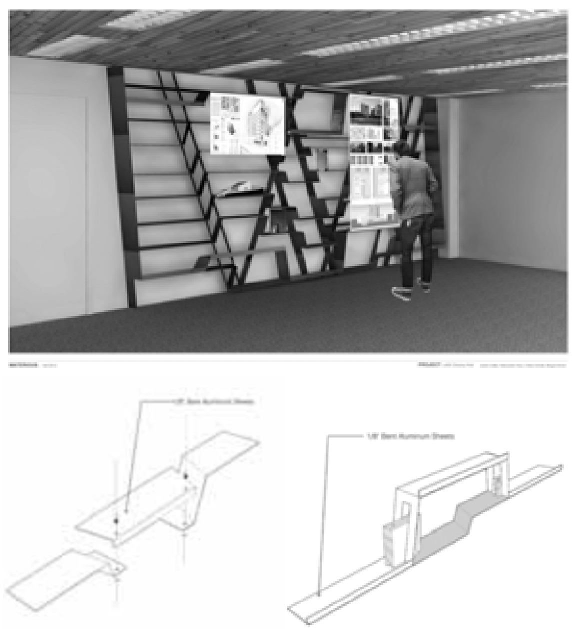


Fig. 9. Typical Presentation work. These images describe the Metal Team's project.

At the conclusion of this seminar, with input from the financial stakeholders, the librarian and faculty member chose two designs, the metal group and the layers group, that were developed further during the subsequent semester's special independent Materials and Methods of Construction course. This course focused on implementing the designs initiated by the previous group of students.

This second group of students focused on detailing vs. cost, and compared the two projects in these terms as they further developed them. As this occurred it became obvious that while the initial proposal met most of the design intentions, material cost would be a factor for both. The layers group simply used too much of its proposed plywood, while the aluminum made the cost of the metals group solution unpredictable and difficult to execute. As a remedy, each group was allowed to propose evolutions of these solutions using different materials, provided they held to the same design intentions. This resulted in the Metals group being re-envisioned in CNC milled MDF. The lines of the metal that gave the initial design solution its unique visual character were reconsidered as grooves. The result was a much more executable solution, and design, fabrication and installation moved forward with this project.

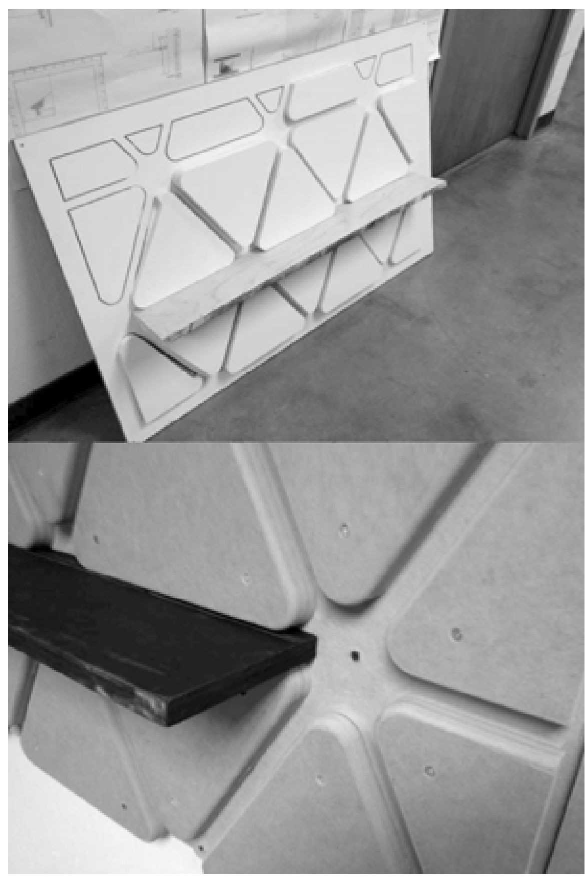


Fig. 10. Two mock-ups executed by the students in the intended final materials.

Students still continued to utilize the full scale mock up as a means of understanding the project, specifically where it related to design philosophy. Of Edward Ford's five methods, the idea that details can be hidden was adopted as an assembly approach. This resulted in an almost monolithic surface, patterned with triangular grooves, and painted to match the existing wall. Through the mock ups the group concluded that the pattern itself would be noticeable enough to gain attention and draw people over to the various displays. Additionally, the grooves' dimension, (3/4"), created an extremely versatile system that accepts a wide variety of off-the-shelf construction materials which can 'plug in' to its pattern. This means that future groups who wish to use the wall for exhibits can easily create new shelves if their materials require it. Lastly the wall manages to be noticeable, yet subtle enough to not compete with the timeless Eames furniture placed through the renovation.

Fig. 11. Final design concept presentation.

Final Result

In 2002, JAE devoted the entire issue Building Speculations to the discussion of diverse pedagogical motives for design-build projects[4]. A decade later, the comprehensive survey by Canizaro of design-build programs in 2011-2012 found that an important aspect of current design-build programs is serving their local communities and that "every program designs and builds as a public service and as such, engages in service-learning."[3] By connecting the library with the exhibition and gallery space outside, the students were able to expand opportunities for community building in both spaces, as a result of the installation wall. Through their collaborative design efforts, the students gained a sense of ownership and pride in the library. This sense of ownership has impacted students and faculty beyond the course. Tours for prospective program applicants regularly begin or end at the installation wall and the student-designed and built exhibition space have become part of the School's curricular narrative as an example of opportunities for professional practice at the undergraduate level.

Fig. 12. Before& after of library space

The students that took the classes associated with the wall dealt with its materiality in a much more focused manner than typical design oriented classes. They distinctly set out with particular design intentions and through the manipulation of materials were successful in achieving those goals.

Fig. 13. Installation of the Plug-in Wall

The most successful result of the classes occurred through the synthesis of all the various methods of teaching. Through readings, lectures and discussions, students saw examples how others decide what materials are appropriate. They reinforced these ideas by researching materials through online databases, printed media, and during field trips to various built projects. Finally, they were able to test the new in-depth ideas they encountered through the built project. Students considered design intentions as they relate to materials, predicted their own use of specific materials' effects, experienced some of those materials first hand prior to construction, and used them in their own work. These four activities that were initially not necessarily connected became part of one large unified undertaking.

Fig. 14. The Plug-in Wall

Notes

[1] Special Report: Architecture Education Now James Cramer's Gentle Manifesto to Improve Architecture Education, Cramer, James
http://archrecord.construction.com/features/Americas_Best_Architecture_Schools/2012/Arc

[2] Information Competencies for Students in Design Disciplines are compiled by the Art Libraries Society of North America
http://www.arlisna.org/resources/onlinepubs/informationcomp.pdf

[3] Lily H. Chi, "Building Speculations: Introduction," Journal of Architectural Education 55, no. 3 (February 2002): 161.

[4] Vincent B. Canizaro, "Design-Build in Architectural Education: Motivations, Practices, Challenges, Successes and Failures," ArchNet-IJAR 6, no. 3 (November 2012): 23.

Figures:

Figure1: Image by Giacomo Longoni

Figure 2: Image by Megan Wood

Figure 3: Image by Kristen Gruhn

Figure 4: Image by Robert Sproull

Figure 5: Image by Robert Sproull

Figure 6: Image by Robert Sproull

Figure 7: Image by Kasia Leousis

Figure 8: Image by Robert Sproull

Figure 9: Image by Chloe Shultz & Justin Collier

Figure 10: Image by Robert Sproull

Figure 11: Image by Tanner Avery

Figure 12: Image by Robert Sproull & Kasia Leousis

Figure 13: Image by Robert Sproull

Figure 14: Image by Robert Sproull

Light Receiving Device:
Inhabiting the Temporal

Kentaro Tsubaki

Tulane University, School of Architecture

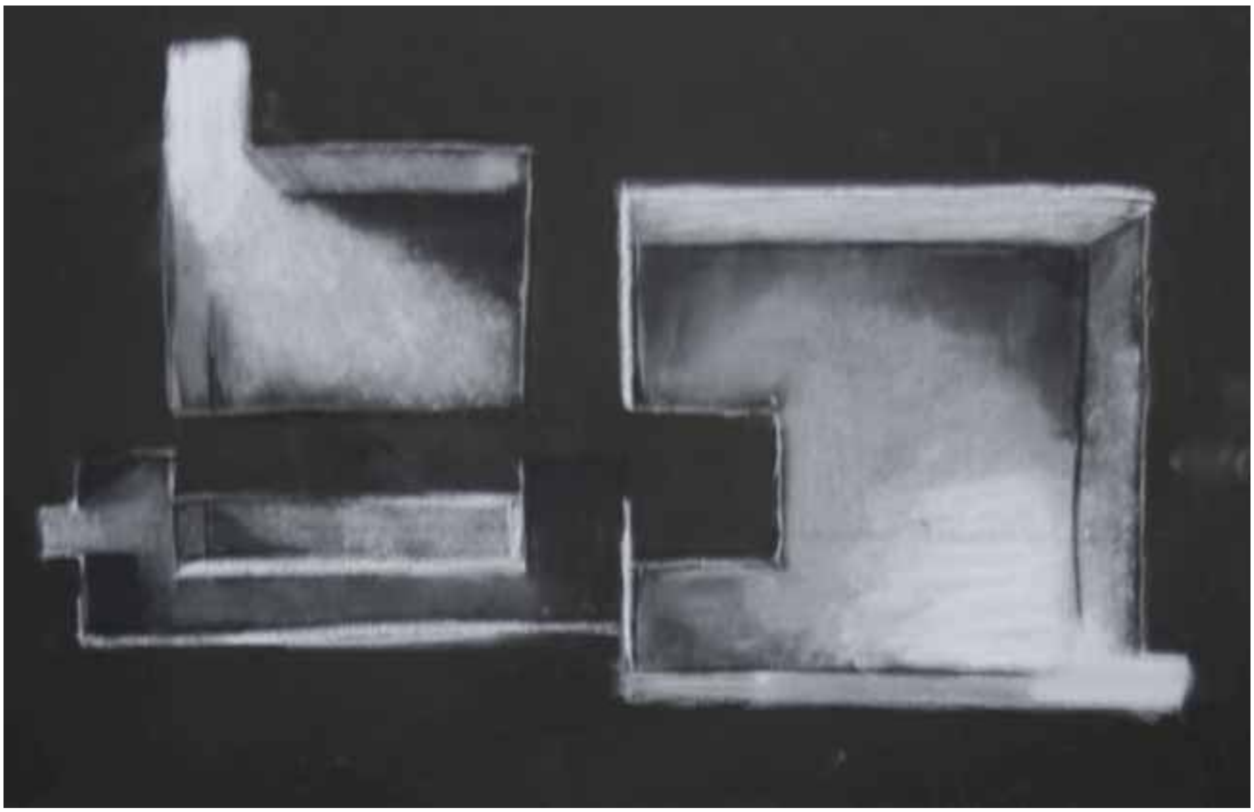


Fig. 1. Charcoal Subtractive *Light Drawing* (Student: V. Leung).

Nature in the form of water, light, and sky restores architecture from a metaphysical to an earthly plane and gives life to architecture. A concern for the relationship between architecture and nature inevitably leads to a concern for the temporal context of architecture. I want to emphasize the sense of time and to create compositions in which a feeling of transience or the passing of time is a part of the spatial experience.[1]
Tadao Ando, *From the Periphery of Architecture.*

Composition, Notation and Temporality

In his essay, *mapping the unmappable: on notation*, Stan Allen illuminates us with the nuanced relationship between a building and architectural drawings.

A representational drawing that tries to simulate those effects will always fall short, freezing, diminishing, and trivializing the complexity of the realized building. Paradoxically, the dry, unemotional form of notation, which makes no attempt to approach reality through resemblance, is better able to anticipate the complexity and unpredictability of the real. This is the realm of building that can only be addressed through notation, and which connects architecture to the most abstract arts: poetry and music. In the passage from drawing to building, the real and virtual will always be present in some unpredictable mixture.[2]

Musical score is a representational method notating the actions of musicians through their instruments. A musical performance is a time-based response of the players to the score, the audience and to the environment. Thus, the composers are inherently aware of the temporal quality, the element of surprise in a musical performance as they compose. They anticipate and accept the interpretations and improvisations by the performers of their composition.

Architecture too is a composition performed through a building - as a collection of instruments – by its occupants and the surrounding environment. It is a performance responding to various internal and external forces as they seek equilibrium through time. Architectural drawing is an equivalent to a musical score, a projective notational system for making tangible physical counterparts to perform phenomenally. Thus, it is imperative for architect-composers to recognize and embrace the indeterminate, temporal nature of the building performance as they compose.

Theory of Inquiry

How can we encourage students to be conscious of the temporal-spatial performance of the physical artifacts they construct? How do we instill in students the nature of drawing as a projective tool for making?

Logical forms accrue to subject-matter in virtue of subjection of the latter in inquiry to the conditions determined by its end - institution of warranted conclusion.[3]

Dewy scholar Larry A. Hickman clarifies this notion as "the logical form accrue to inquiry as a result of subject-matter it takes up and the conclusions it finds warranted."[4] This is the complete opposite of the traditional notion that the logical forms are imposed upon the subject matter of inquiry. Dewey believed that the tools we use in inquiry (tools of logic) are not given to us a priori. Instead, they were developed in the course of inquiry that was proven successful. Inquiry is a reflective activity in which existing tools and materials are brought together in novel and creative arrangements in order to produce something new.

Architectural design is by definition a reflective act. Thus, it poses a significant hurdle to students of beginning design since they have yet to develop the tools of inquiry simply from the lack of relevant trial and error experiences.

This paper is a case study of (6) week exercise conducted by the second semester M. Arch. I. students at Tulane School of Architecture. The studio supplements the lack of full-scale trial and error experiences of the beginning design students by creating a scalable mini temporal-spatial experience as a focused exercise. It cultivates the student awareness to the phenomenal nature of a physical construct in conjunction with the projective role of drawing in making.

Light Receiving Device

In hot humid climate of southern Louisiana, shade is synonymous for comfort, a very well sought after environmental condition. Avoiding the direct sunlight is deeply engrained in the culture. However, it is less evident that light, shade and shadow is a time dependent temporal condition integral to the perception of space. Natural light is one of a few eminently scalable architectural elements. The project encourages students to engage and develop an innate understanding of the relationships between the physical construct and the performance of light through iterative design, fabrication and observation of *Light Receiving Device*.

The beginning is prescriptive and abstract to facilitate the development of a skill set necessary for the investigation. Students are introduced to site and setback dimensions to determine maximum zoning envelope and three program volumes, major, minor and transitional. They are asked to explore ways to spatially organize rectilinear volumetric components within the site to approximate an urban infill condition through plan-section drawings and physical models @ 1/8" = 1'-0" scale (fig.2).

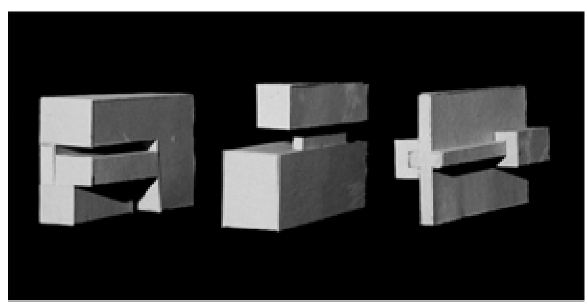


Fig. 2. Program Volume Compositions (Student: J. Morganstein).

Two mathematical concepts are introduced following the initial step; Boolean operation (union, intersection and difference) on positive volumes as a basic formal transformational strategy foreshadowing the fundamental operational mode in digital media along with the combinatory thinking. The latter is particularly important to foster the design habit to quickly and systematically generate options. Primary mode of investigation is axonometric drawings emphasizing the fact that it is an investigative tool, not a pictorial depiction of an imaginary outcome (fig.3).

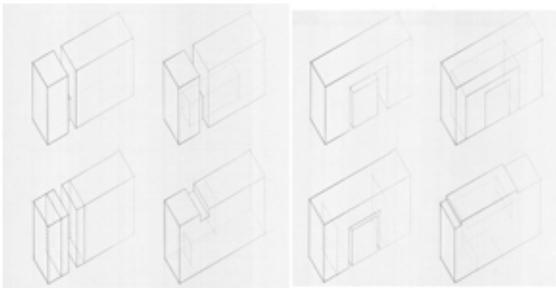


Fig. 3. Boolean Studies (Student: G. Diebold)

Then, students are asked to visually evaluate the formal complexity of the outcome. They are asked to imagine the volumetric compositions as a negative space against the overall site-volume anticipating the stereotomic *Light Receiving Device*. Each student selects a composition and subtracts it from the overall site-volume to create a cavernous void space to be realized through plaster casting and explored through light, shade and shadow. Primarily mode of investigation is restricted to the orthographic drawings @ 1/8" = 1'-0" scale. Study models @ 1/16" = 1'-0" scale are constructed based on the drawings to aid the three-dimensional comprehension prior to the design revision for the next iteration (Fig. 4 & 5)

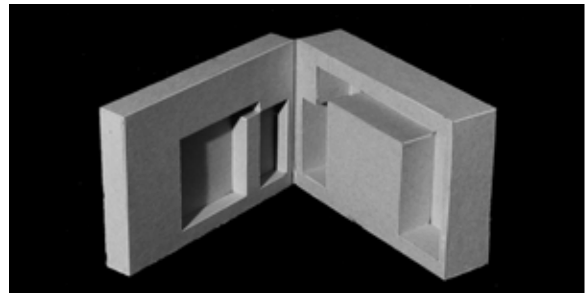


Fig. 4. Volume Composition Subtraction Studies (Student: G. Diebold)

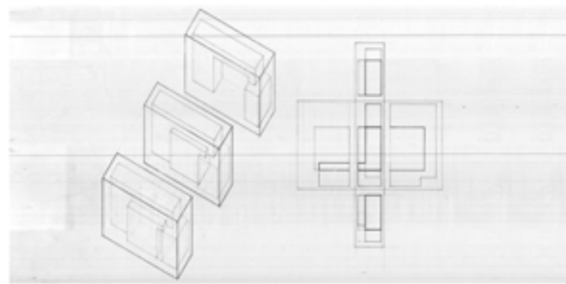


Fig. 5. Volume Composition Subtraction Study Drawings (Student: G. Diebold)

Three apertures as "inlets of light" to illuminate the surfaces of the voids are then, introduced as an architectural intervention. The intentions for each aperture to consider are; to look above, to look beyond and to look below, gestural in nature. The projected effects of the apertures are explored through shade and shadow on orthographic drawings @ 1/8" = 1'-0" (Fig.6).

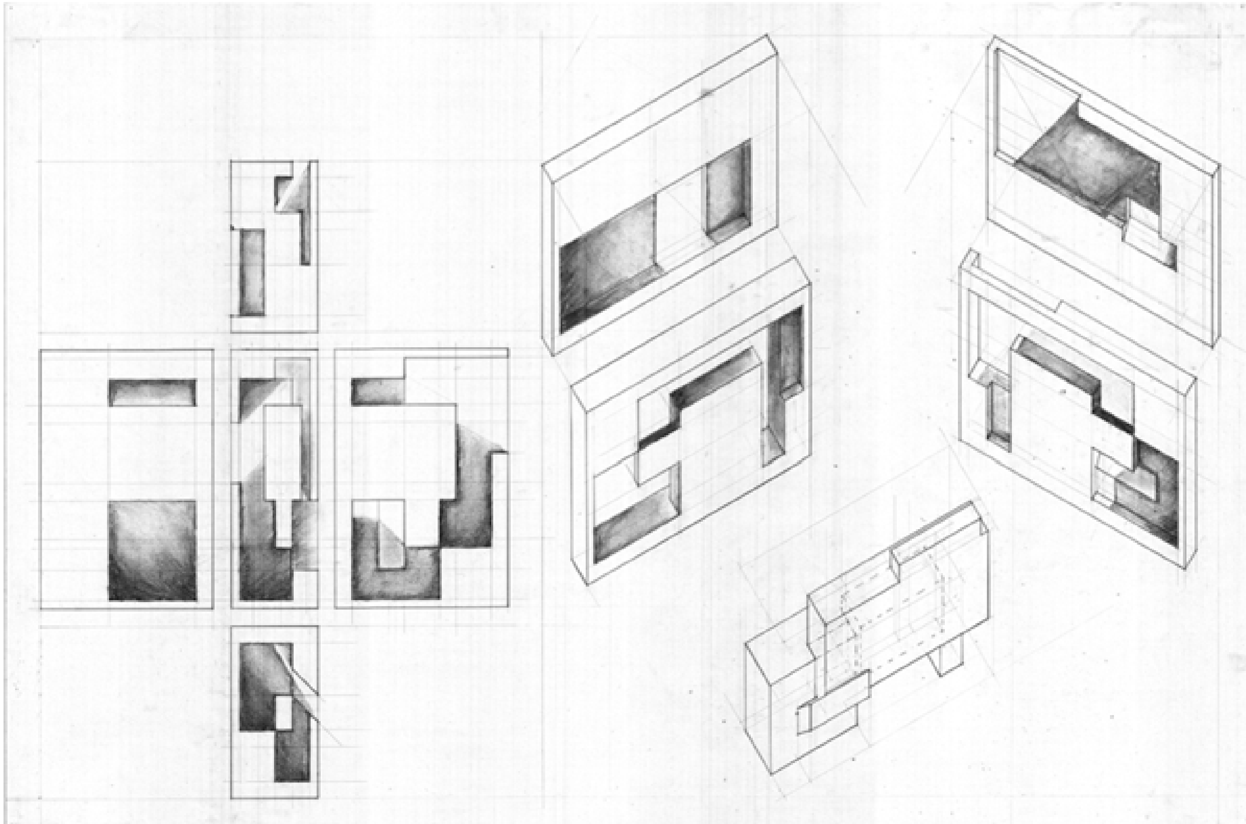


Fig. 6. Projected *Shade and Shadow* Foldout Drawing and Axonometric Studies (Student: V. Smith-Torres).

Next step is about the actual making and the role of drawing as a tool for making. Students are introduced to the idea of *Light Receiving Device* as a 1/4” = 1’-0” scale, two-part plaster cast. Their task is to construct a formwork for the cast, a concise physical problem they must confront heads on by dealing with the reality of materials. Plaster resists the traditional mode of incremental fabrication and correction. Combined with the substantial density requiring proper consideration for gravity and negative-positive relationships, the drawing becomes indispensable tool for the design and fabrication. Orthographic drawings @ 1/8” = 1’-0” scale are constructed and enlarged to be used as a full-scale construction template for fabrication (Fig.7). Each student performed three to four iterative casts as they refined the design of the device and construction of the formwork (Fig.8 & 9).

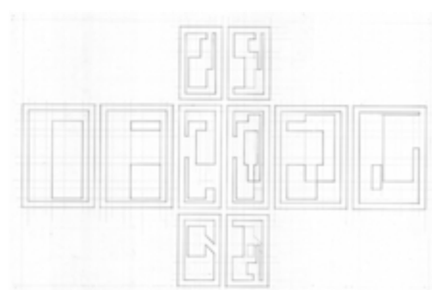


Fig. 7. Formwork Template Drawing (Student: V. Smith-Torres).

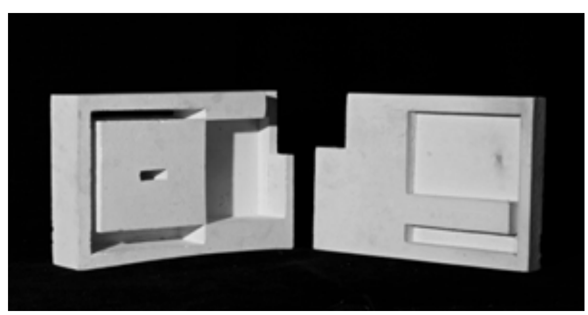


Fig. 8. *Light Receiving Device* Plaster Cast (Student: A. Ascherman).

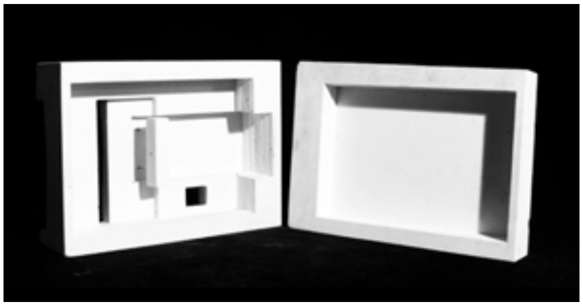


Fig. 9. *Light Receiving Device* Plaster Cast (Student: G. Whittaker).

Simultaneously, each cast are observed in various lighting conditions and its quality subjectively evaluated to refine the subsequent iteration of the *Light Filtering Devices*. The temporal-spatial nature of the space are captured in shadow box photographing and embodied through a series of charcoal subtractive drawings as Light Drawings (Fig.10 & 11).

Conclusion

Students, partial only to the representational mode of architectural investigation, were for the first time, systemically introduced to confront, experience and embody the temporal-spatial nature of a physical construct through the performance of light. This fundamental perceptual shift will no doubt positively impact the future development of the students as a counterpoint to the ever more ubiquitous virtually simulated digital environments.

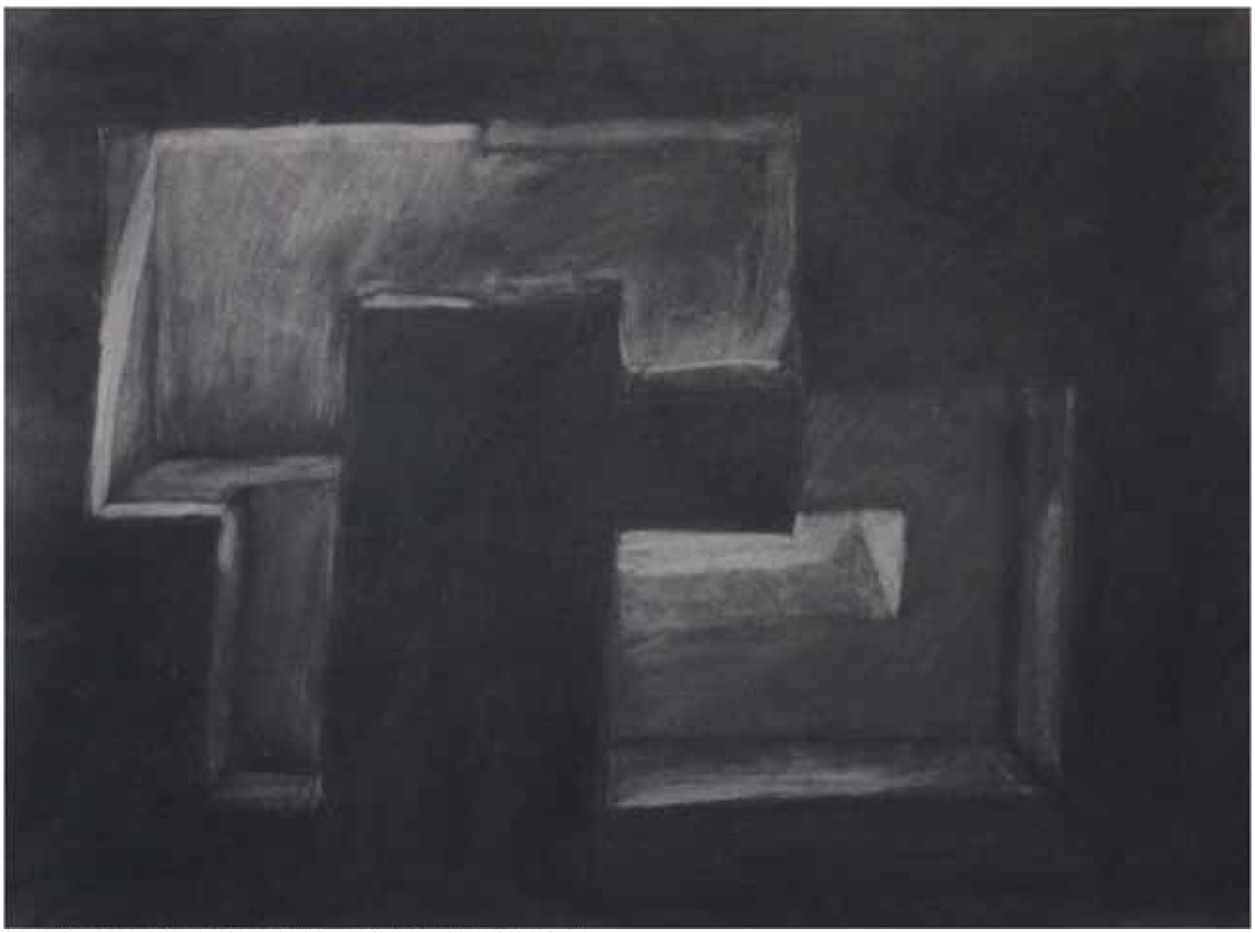


Fig. 10. Charcoal Subtractive *Light Drawing* (Student: V. Smith-Torres).

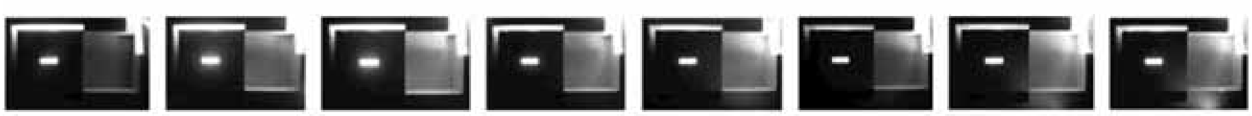


Fig. 11. Shadowbox Studies (Student: A. Ascherman).

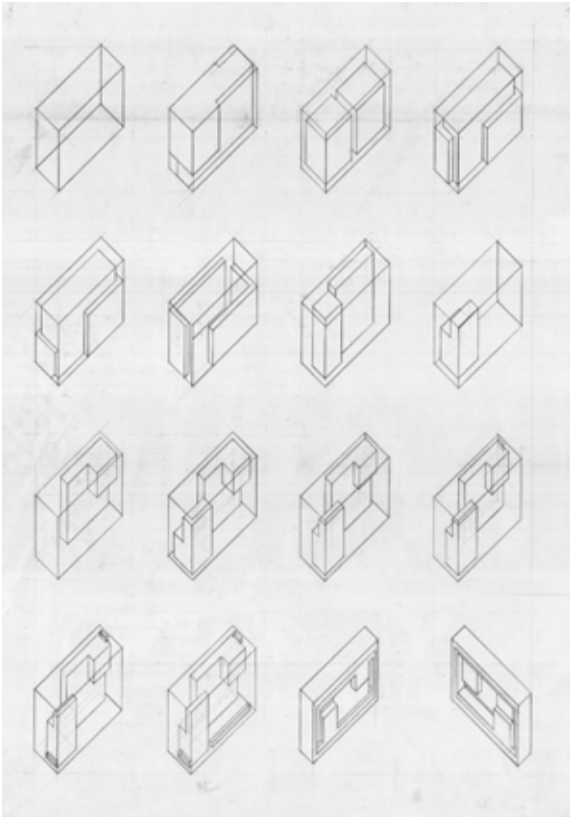


Fig.12. Process Reflection Drawings (Student: W. Zink).

Notes

[1] Ando. T. *From the Periphery of Architecture.* Dal, Co F, and Tadao Andō. Tadao Ando: Complete Works. London: Phaidon Press, 2000. P462.

[2] Allen. S, *mapping the unmappable: on notation*. Practice: Architecture, Technique and Representation: Critical voices in art, theory and culture. London: Routledge / Taylor & Francis, 2003. P32-33.

[3] *The Later Works of John Dewey, 1925 - 1953 1938 - Logic, the Theory of Inquiry.* Southern Illinois Univ Press, 2008. P 370.

[4] Hickman,L. *Reading Dewey: interpretations for a postmodern generation.* Bloomington: Indiana University Press,1998. P169.

Craft-Based Education:

A Model that Supports Play and Innovation

Joshua Vermillion, Jonathon Anderson, Dave Rowe

University of Nevada, Las Vegas

Introduction

We operate with a simple value proposition: that the processes employed by artists and designers in creative work can be an important part of any problem-solving activity. Our culture has placed more and more importance on the STEM disciplines (science, technology, engineering, and mathematics) in public education and public funding. At the same time, these fields and others (such as business, entrepreneurship, and medical industries to name a few) have begun studying and applying "design thinking" methods.[1] Companies that focus on design and the creative process to innovate, such as Apple and Google, are leaders in their markets. John Maeda, the former president of the Rhode Island School of Design has argued that STEM needs an additional letter, "A" for art and design, to truly innovate in the 21st century.[2]

How best to train beginning art and design students for STEAM? The authors propose a framework that focuses on craft as a creative ethos. Craft, it is argued, is based on an understanding and skillful application of tools and processes as they relate to designing and making. We want to examine the process of building these understandings and skills for our students in order to develop critical thinking skills for analysis and conceptualization. For us, design and art provide a platform where innovation is developed through the investigation of ideas by practicing, experimenting, and prototyping, With this idea in mind, our collective begun to ask questions like: how does the digital realm fuel innovation? Is craft the basis of making? What opportunities lie at the intersection of art, design and technology? What kind of environment encourages and catalyzes innovation? How can we instill a fearless creativity in our students to experiment, play, ask questions, and prototype, all without worry of the inevitable failures along the journey? How do we, as academic faculty, facilitate communication and the open exchange of ideas? Through our regular collaborations and discussions, we have come to the conclusion that it is vital to foster environments that allow each student or collaborator to learn from each other as well as themselves. This is particularly important as the authors teach in different disciplines (art, architecture and design).

In an effort to address our common concerns about foundation education and provide a framework from which to work, we have proposed a new cross- discipline platform. Our working title for this project is *MAKE.* This approach represents collaboration on several levels. First, it is a coming together of our respective fields: architecture, design and art. Second, it also represents a collaboration of many layers of the academic experience: students, pedagogy, and facilities. As with any project, we have parameters to guide us, but the ultimate goal is to produce a unique and challenging experience for each participant in the project, whether student or faculty member.

Defining Craft

It is important to identify what the term "craft" means to design and art. In the contemporary art field, craft has a double meaning: craft can be a genre of art that uses material (ceramics, metals, textiles, etc.) as a way to unify work or process. However, craft as a term can also be used to describe the activity of making something, traditionally by hand, but increasingly inclusive of digital technologies. It is no coincidence that these two meanings of craft can often be used together. In fact, the use of specific materials can often drive many of the decisions in relation to "play" in art. Many of the traditional "craft" materials are often represented in some of the most cutting edge material studies. Ceramics in particular finds itself bridging low and high tech pursuits. The same fundamental material used to create pottery and bricks can also be used to create artificial limbs or insulation for the space shuttle. Many of these high tech developments rely on the basic material understanding found in introductory design courses.

Craft brings process to the forefront of design, a process of careful and deliberate planning, skill, and execution in the making of an artifact. To expand this simple definition, Malcolm McCullough, who writes extensively about craft, observed:

Craft remains skilled work applied toward practical ends. It is indescribable talent with describable aims. It is habitual skilled practice with particular tools, materials, and media, for the purpose of making increasingly well-executed artifacts. Craft is the application of personal knowledge to the giving of form. It is the condition in which inherent qualities and economies of the media are encouraged to shape both process and products.[3]

Applying McCullough's rationale, craft involves working with tools, materials, and media. It is with this tacit understanding of the properties and biases of tools, materials, and media that the craftsperson can think through and plan a course of action—a process. This understanding coupled with the dexterity and ability to execute with tools, materials, and media is what constitutes skill. Additionally, we can cull from McCullough that skill is achieved by practice. The process of making is an enriching activity that produces, on one hand, an artifact, and on the other hand, a set of skills. This 'learning by doing' sets up a feedback loop, in which the skills and knowledge gained from one project is applied to the decision making and crafting of future products. The resulting artifact is important, not only as a commodity, but as the by product and evidence of all of the toil, time, skill, experimentation, and learning required to make it—the craft of making.

A crafted product is individually, specially, and carefully made. It is born from deploying well thought out and practiced techniques with the use of tools. When tools and media are used to craft they become extensions of the craftsperson's hands, eyes, and mind. As time goes on, tools, materials, and methods change, but the issues underlying making will always rely on craft. Craft isn't entirely reliant on "hand" tools, but applies to digital tools as well. With this working understanding, the authors see craft as an ethic for beginning art and design students to fold together careful thinking, decision-making, and skillful doing in the same operation.

Craft and Innovation

Our contention is that courses often provide limited time to learn and practice the many skills associated with craft, including but not limited to; materiality; drawing, digital modeling and other visualizing; fabrication tools and methods; analyzing and diagramming. We must responsibly lay the groundwork for processes and methods that foster innovation and aggressively introduce highly complex digital and analog tools to creative students in foundation level courses. To be sure, we are not advocating a purely virtual experience. Digital technologies can never replace the tactile experience of manipulating a material such as clay, but they can augment a well- rounded workshop- based experience for students. None of the participants in MAKE view the platform as taking over our existing pedagogy, but providing a unique opportunity to expand our students' experiences.

For us this foundation is built on a simple understanding that craft supplements innovation by acting with care and intention, developing curiosity, discovering and application, and developing skills and understanding of materials, tools, and methods. While pedagogical structure and scaffolding are important, they should not be so over-bearing or intrusive as to stifle open-ended experimentation, or discourage risk-taking for fear of failure. To innovate, students must be able to shape their own understandings and knowledge through engagement with tools and materials. They must have the freedom to follow this process where it leads, so they can, as Michael Speaks elegantly wrote, "discover opportunities that can be exploited and transformed for unpredictable design solutions."[4]

The Ingredients

To develop our craft-based framework, we have focused on our schools' physical environment for making and designing, as well as the introduction of skills and ideas through assignments and workshops. Central to our way of thinking about our facilities, tools, and courses are a shared set of values that inform our objectives and help shape our outcomes.

New Faculty + New Place + New Team

One of the key ingredients to this framework is the hiring of three new faculty members who bring experience from various institutions. When we arrived at UNLV we quickly realized a common pedagogical approach and eagerly went to work with a team that has the potential for exponential growth in our applied creative scholarship and student success.

It was to our benefit that UNLV did not have any framework in place and was open to experimentation and an attitude of “do now, ask for forgiveness later”.. In fact, UNLV has been very supportive of, and actively encouraged collaborative teaching and research opportunities at all levels. Our drive and the universities openness is what ultimately allow these ideas to take place inside and outside the classroom. After all, Las Vegas itself is a city built on the balance of risk and reward. In this case, we advance our vision of collaborative learning, and the reward is evident in the better educational experience for students.

Facilities

To help facilitate this idea of innovation, craft, and making we are in the process of improving UNLV’s Art and Architecture fabrication labs and shops as integral to the curriculum and research needs of our programs. Our informal organization or collective, MAKE (www.unlvmake.org), focuses on knowledge creation by providing design and prototyping resources for entrepreneurial projects, grant-sponsored applied research or creative works with partners, training, and coursework. This facility acts an interdisciplinary hub for architecture and art studios, courses, research, and creative work that couples design, art, and other creative disciplines with the values of making, modeling, and prototyping. More specifically, with the ubiquity of digital technologies, MAKE isn’t just a shop but rather an important infrastructural platform for testing ideas using advanced manufacturing, robotics, rapid prototyping (3D printing), and other novel digital technologies with faculty, students, and industry or community partners.

We envision the facility as a hub for creative activity, centralizing tools such as 3D printers, laser cutters, CNC routers, and robotics, while preserving the identity of each department involved. It is important to us that Art and Architecture learn from each other but still maintain their own pedagogy. By treating MAKE in this way, we can maintain the uniqueness of each program while allowing cross- pollination to flourish.

Skill-building and Assignments

Like most established teaching paradigms, we expect to utilize a range of educational techniques; demonstrations, lectures, workshops, and field trips. We also see MAKE as capable of utilizing the burgeoning field of online education. While we collectively view online education as deficient when it comes to creative and material expression, we see it as an opportunity to move essential digital skills to a platform easily accessed by students on their own schedules. Utilizing resources such as LYNDA for online technical training allow the students to maximize the time they have in class for important ideation and exploration. Many of these skills require only a combination of time and focus to achieve success, and little faculty involvement.

Assignments in MAKE will be more open ended than traditional Foundations classes, allowing students the opportunity for personal growth and discovery, while demonstrating the value of making as a design and idea generator. In particular, they must be contemporary. Involving students in design challenges that solve real problems rather than theoretical ones can serve to energize students and remind them that lessons learned in their first year of college are valuable and relevant to their experiences outside of the classroom. It is important to remember that students in their first will not be emerging into the workforce until 4 years later, and today’s design challenges are not the same as those of tomorrow. With continuous updates, fluid curriculum can prepare each student for their own reality upon graduation.

Values

We try to be upfront with students about what they are doing and why they are doing it. These conversations move beyond the immediate situation at hand to a larger set of values that guide our students’ inquiry—essentially we hope that by using this framework they are learning how to learn. While not a comprehensive list, the most important values are:

1) Building skills with and appreciating a variety of tools, both analog and digital. Skill building is accomplished, sometimes with demonstrations (learning from others, such as in Figure 1), and other times from experimentation and practice (learning by doing). Learning how and where to find answers. What resources are available and how to leverage these resources (web, instruc-

tors, classmates, class sponsorships). Developing knowledge of appropriate technologies as they relate to specific applications. Skill building is not limited to pure technical concerns either. Gaining advanced problem- solving skills coupled with confidence in ones own abilities will permit each student to be successful and contribute to the MAKE culture. It is also important for students to understand basic skills in order to challenge their application. Deviating from prescribed, (correct) ways of working can lead to informative discoveries, both challenging and reinforcing of existing paradigms.

Fig. 1. Students participate in tile workshop – sponsored by National Tile Contractors Association, ProSpec, and Coverings Show.

2) Practice and iteration: Practice is an important aspect of design for the simple fact that practice leads to proficiency. This has been a part of arts education from the outset. This is the accepted method of skill transfer in traditional arts educational programs. However, iteration is also important. By repeating a process, the outcome can change as proficiency is acquired. This continual refinement and practice leads to an eventual mastery of not just fundamental skills, but actual specific solutions to design challenges.

3) Play: Serious play can allow for open-ended experimentation with materials and tools. It can encourage risk-taking, as well as facilitating happy accidents. Barry Kudrowitz at the University of Minnesota has written extensively about the importance of play for design and creative production, particularly in helping individuals to connect disparate ideas into innovative combinations.[5] Many Fortune 500 companies, as pointed out by Michael Schrage, use methods that encourage serious play to innovate.[6]

4) Failures: Failures are inevitable in the learning process, and it is important to educate students to what constitutes failure. In an educational context, Failure is not a negative; rather it is often a new and unanticipated direction. (Of course failure as a result of non- participation is still abject failure) In the MAKE platform, failure is embraced as a learning mechanism. It is particularly challenging to a beginning student when their actions produce an unintended result. We must allow our students the luxury of embracing this phenomenon and help them understand the significance of potential discoveries.

5) Collaboration: As members of separate programs, we are keenly aware of the fact that we each have different vantage points in the creative process. The discussions leading up to this collaboration began as a way to unite our similar goals while each benefitting from our unique experiences. Ultimately we are interested in the possibility of working with other units either on the UNLV campus, or within the College of Fine Arts including Theatre, Dance, and Entertainment Engineering and Design. We envision the success of this project occurring in the free flow of ideas across disciplines. As faculty members, we have already been working collaboratively, and we expect this to continue both with our own work and at the student level. As part of collaboration, we also aim for a free exchange of ideas. Collaboration only works with informed participants, but it is also necessary that each individual commit to sharing discoveries. Ego, ownership, and secrecy must be kept to a minimum. In short, we advocate for an “open source” approach to discovery and pedagogy while engaged with MAKE.

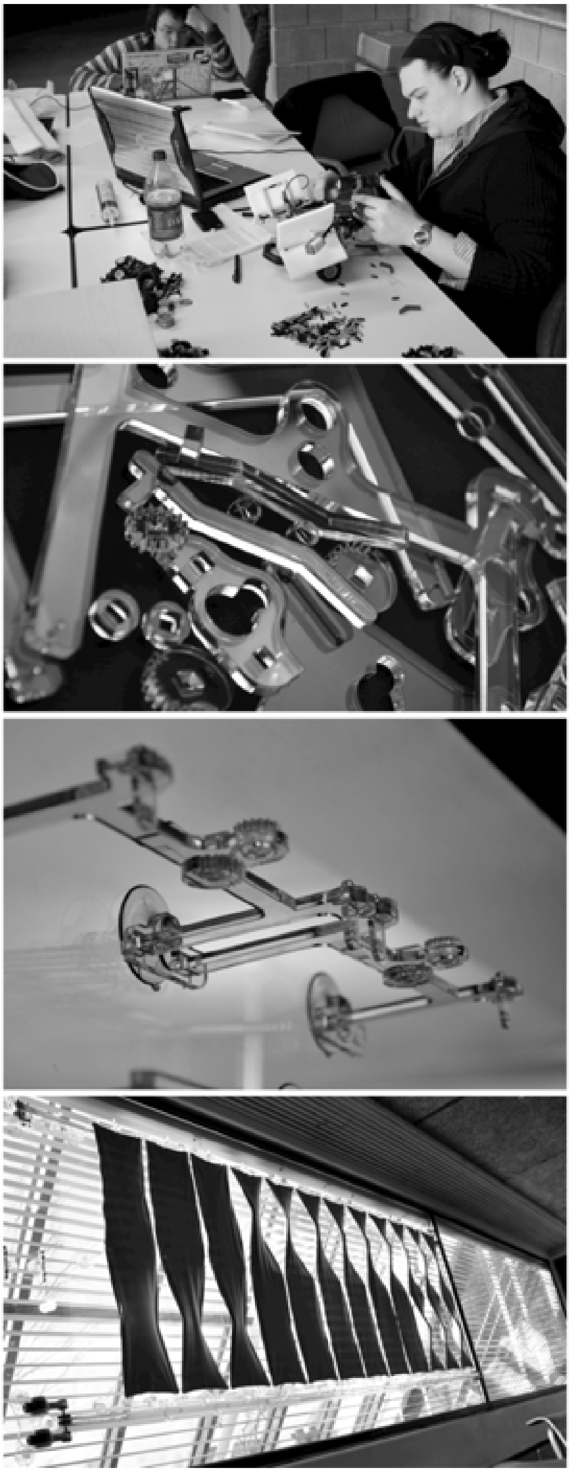


Fig. 2. Example of serious play with Lego NXT kits, followed by laser fabrication for kit customization to create spatial installations.

6) Feedback Loop: By forging this new space and approach, we can generate a feedback loop within students; ideas are generated, examples are produced, and the results are

Fig. 3. Example of collaborative, “messy”, ideation and prototyping space.

Fig. 4. Example of collaborative, “messy”, ideation and prototyping spaces.

analyzed to produce new ideas that continue the cycle. An initial idea that begins with an architecture student designing with a virtual modeling program such as Rhino may eventually morph into a sculpture executed in ceramics. A painting student may explore the expressive manipulation of pigment on canvas, providing an architecture student with colors and patterns for a building façade. We expect the lessons gained in the MAKE studio to have a life far beyond any initial class, providing the groundwork for endless learning and exploration for the students.

7) A level playing field: With regard to fostering an open and exploratory environment it is important to treat all discoveries with the same respect and interest. Every participant, from freshman design students, advanced undergrads, graduate students, up to and including faculty, have the ability to work as team mem-

bers. Through this disruption of the traditional student- teacher hierarchy, the collaborative environment can foster, and each participant can affect the final outcome of projects and discoveries. Beginning students gain the knowledge and context of the mature participants. Advanced students and grads gain from the discoveries of students just starting out in the process.

Conclusion

Ken Robinson has defined creativity as "the process of having original ideas that have value."[7] As the world we operate within grows more complex, creativity and innovation grow in value. We propose that craft is a useful pedagogical framework to nurture the creativity of our students (in fine art, architecture, and design), with respect to cultivating, testing, and communicating ideas. By combining our efforts across disciplines, (art, architecture, design) we envision a collaborative atmosphere supported by innovative teaching strategies and physical spaces.

It is important to note that this project is in it's infancy. As we move forward with development and funding, we expect the parameters to change. This is part of the point of MAKE; allowing flexibility in learning and ideation. We see the project in the same terms as the discoveries we want our students to experience. Art and design, we argue, have a large role to play in shaping

our environment. This framework is built on the idea of actively developing and disseminating a creative process that is fueled by a feedback loop of experimentation, ideation, prototyping, and critical thinking. We strive to create students that are visually literate, but also capable of advancing the current conversation on how art and design contribute to problem solving on a global scale.

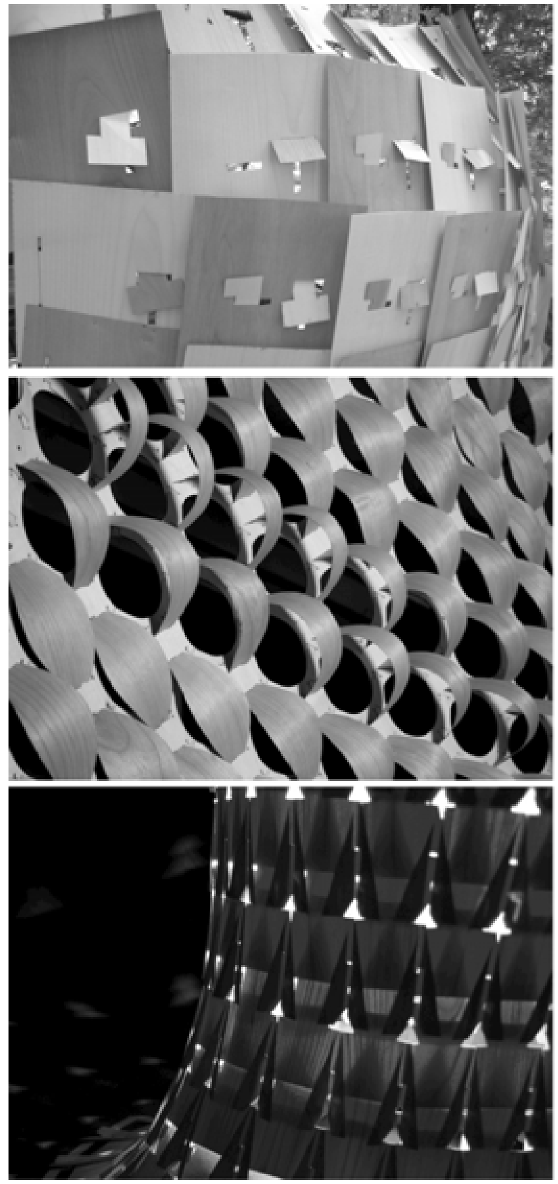


Fig. 5. Example material study feedback loop with hardwood veneer. The first results are very crude (top), but continue to be refined (middle and bottom).

Notes

1 Brown, Tim. "Design Thinking," in *Harvard Business Review*, June 2008.

2 Maeda, John. "STEM + Art = STEAM," The STEAM Journal: Vol. 1: Iss. 1, Article 34, 2013.

3 McCullough, Malcolm. *Abstracting Craft: The Practiced Digital Hand*. MIT Press: Cambridge, MA. 1996.

4 Speaks, Michael. "Intelligence After Theory" in *Perspecta 38: Architecture After All*. MIT Press: Cambridge, MA. 2006.

5 Kudrowitz, Barry and Wallace, David. "Improvisational Comedy and Product Design Ideation: Making Non-Obvious Connections between Seemingly Unrelated Things." Proceedings of the International Conference on Design and Emotion. Chicago. Oct 5-7, 2010.

6 Schrage, Michael. *Serious Play: How the World's Best Companies Simulate to Innovate*. Harvard Business Review Press: Cambridge, MA. 1999.

7 Robinson, Ken. "How Schools Kill Creativity" from TED Talks (video). June 2006. Retrieved from

http://new.ted.com/talks/ken_robinson_says_schools_kill_creativity#

150: 13: 6 (Students: Full-Scale Installations: Weeks)

Mo Zell

UWM

Introduction

Sarah Bonnemaison and Ronit Eisenbach in *Installations by Architects* explain the difference between installations and architecture: "(a)n installation…is temporary, that is, its demise is planned from the outset; its function turns away from utility in favor of criticism and reflection; and it foregrounds the content. [Installations] also offer precious freedom to experiment."[1]

Implicit in this observation is an understanding that installations require a different set of construction parameters than typical design/build projects; that they require a critical stance, one that provides opportunities to not only solve problems, but also to *create* questions. The *Urban Edge Studio: Making/Installation,* a sophomore undergraduate design/build studio, provided the framework for the students to engage this critical stance. The catalyst for this process was the *provocateur,* i.e. that person who would provoke the students into assuming this critical stance by suggesting new ways of seeing and defining architecture, necessarily pushing them into, for them, unchartered territory. The studio also, however, as this was a beginning design studio, taught and encouraged a fundamental architectural grammar, one that attempted to link space and experience together into the palpable present, one in which the artifact (installation) was itself ephemeral, thereby highlighting that condition of space/time/experience, and necessarily limiting the onerous expectations in making a building, or anything of permanence.[2] The studio, though, was still a design/build studio and the ideas were ultimately realized at full-scale with all of its attendant risks and rewards.

In the *Journal of Architectural Education's* introductory essay on the topic *1:1*, Jori Erdman and Thomas Leslie write that "the two most widespread issues in current full-scale design education are what opportunities are offered by the link between the digital and material worlds and how 1:1 can manifest itself within the socioeconomic milieu of program's communities and regions."[3] They go on to state that a design/build project's most significant value is "in how architecture can be read as one of our deepest interactions with the surrounding world—both as an act and, once built, as a set of spatial and sensible experiences."[4] Design/build, they contend, negotiates between architecture as abstraction (drawings, models, etc.) and architecture as construction, where design intent becomes physical presence. I propose that temporary installations, as a form of design/build pedagogy, add inherent value into the foundation curriculum by forcing the translation of abstraction into construction coupled with critique and reflection. And, that by placing these installations in the city, students respond, react, and provoke new ways of engaging the urban environment and its users.

For too many students of architecture, translating abstract representation into a full-scale construction does not happen until well into their professional careers.[5] When offered in a school's curriculum, the design/build project has proved to be a powerful and effective method of teaching architecture students about a broad range of issues including but not limited to tectonics, construction, social issues, and economic limitations. Certain architecture schools across the country are attempting to fill this breach with design/build experiences at a variety of scales.[6] These hands-on, full-scale investigations have not yet, however, penetrated the undergraduate beginning design studio. Indeed, Yale's First Year Building Project is one of the few examples that requires all of its first year graduate students in the M Arch I program to participate.[7] Instead, the design/build studio is typically offered in advanced studios with limited access for even upper level students.[8]

Another pedagogical tool often times used in architecture schools is the introduction of the 'provocateur', where a distinguished visiting professor is hired to teach an upper level studio.[9] The 'provocateur' teams with a full-time faculty member to teach an experimental studio.[10] Again, these types of collaborative teaching dyads are almost never found within the undergraduate beginning design studio. Two issues result from this gaping maw: one is the limited quantity of students able to access design/build studios and second is 'reduced effect' due to the location of these types of studios within the school's curriculum. That is, these studios are often the culmination of a student's education as opposed to the foundation from which their architectural education is built, thus needlessly limiting their effect on the school's culture. To address the issue of access, I positioned the design/build studio in the undergraduate foundation curriculum (making it a requirement instead of an option for 150 sophomore students) reviving Texas Ranger Werner Seligmann's notion of control and emphasis on beginning design.[11]

The Urban Edge Studio: Installation/Making (UE), supported with funding by the Urban Edge Award, addresses the following issues: access to design/build, interaction with the city, and the introduction of a reflective, critical design process. Elizabeth Diller of Diller Scofidio + Renfro was invited to serve as the studio 'provocateur' and to collaborate with faculty and students in implementing these concepts. With Diller's experiences in provocative, independent, theoretical, and built installation projects, the UE studio was well placed to achieve its mission. By emphasizing 'making' as a method of learning, the studio reframed the curriculum to include hands-on, urban context-sensitive public installations. The installation projects developed by the students were intended to explore the breadth of architecture, not as building, but as space and experience -- by creating, as Erdman and Leslie suggest, human interactions that negotiate between new spaces and the surrounding context in a manner that provokes dialogue, response, and discussion. The installations themselves became provocations.

Elizabeth Diller, in her ability to re-form preconceived ideas of space, provoking new ways of understanding both site and space, and her interest in critiquing architecture through the use of installations, was ideally suited for the role of provocateur. As her MacArthur Fellowship Award citation read, Diller's work "explores how space functions in our culture and illustrates that architecture, when understood as the physical manifestation of social relationships, is everywhere, not just in buildings."[12] Diller further intimates in her TED talk that her firm's architecture "challenges the assumptions about conventions of space".[13] During discussions with the students she defined installation to be somewhere between art and architecture and "usually subversive". As she informed the students on her final visit to the studio, "you're being asked to do something very uninstitutionalized. It's very unorthodox." She enjoined the students to consider architecture not as building but as a provocation, and that "...you're not problem solving, you're problem inventing".[14] Shedding the concept that only buildings are considered architecture provided students an avenue to experiment with the physical manifestation of their ideas against the backdrop of an urban community.

For the beginning design student, not only were the mayline and hammer new but the framework of inventing problems instead of responding to problems, established in the studio pedagogy, new. Since program considerations were minimized, students, in turn, elevated the response to the site conditions. All sites, located in the city, were empty, most doubled as parking.

The 15-week semester was divided into three acts. The first two acts consisted of a series of 'warm up' tasks designed to confront the students with the complexity of making, moving from design intention to constructed reality, preparing them for third act, the installation itself.[15] Materials and tectonics were explored more thoroughly in the first act, the ubiquitous 'cube' project, where the students were asked to register a 12" cube, considering all of the latent qualities of a material, by both containing and revealing, thus explicating *raum*.[16] The assignment attempted to structure an understanding between form and the corporeality of space.[17] The second project, a 1:1 installation charrette over a 36-hour period, required students to quickly consider an existing window in the architecture school as their site. The project was bracketed by scale (small, 2' x 4' frame), location (something familiar and close) and time (36 hours). This project instilled a nimble perspicacity that proved necessary during the full-scale urban installations.

6 weeks - full-scale installation[18]

In the early 20th century, Milwaukee's top four industries were tool & die/machining, meatpacking, leather tanning, and brewing. By 2000, like many Midwestern post-industrial cities, Milwaukee's industries either folded or were outsourced, with the resultant demolition for speculative development leaving an abundance of vacant land and surface parking in the downtown core. Milwaukee's former tag line, 'machine shop of the world', faded while a new reputation as a global freshwater leader is now slowly emerging, symbolized by its location on Lake Michigan.[19] Despite this progressive global position, Milwaukee currently lacks development pressure downtown, has a stagnant population, and possesses uninspired building/zoning codes. And though a significant impact of this newly found global agenda is expected vacant land still dominates the city.

As a way to serve as a catalyst for ‘action’ on the glut of underutilized land, 150 sophomore undergraduates produced 13 design/build installations on a school-supplied budget of $800 per project.[20] Motivating the public to first take notice and then reconsider the emptiness of the site necessitated a careful inspection of the assigned area and context. For example, one installation, the *Highway Palimpsest,* imposed a kit of plywood columns (and internal terrarium) to order the vacant site, recalling its inglorious past (a highway interchange), and thus invoking a new kind of greenspace.

Like many U.S. cities, Milwaukee's urban fabric was impacted in the latter half of the 20th century when the interstate highway system was built. In 2003, in an attempt to re-stitch downtown with the northern neighborhoods the Park East Freeway spur was torn down. In its place was left a large swath of land primed for development. *Highway Palimpsest* offered a new future on one of these empty lots by considering the past. Using 12 unskilled laborers (students) in a method of assembly line construction, a series of 10' structures crafted from plywood discs wrapped in plastic (tackling the challenge of making flat material into a volume) were placed across the site marking the location of the old highway columns. Inside each of these new columns the students planted flowers representing the potential for growth emanating from the ruins of the site's concrete past.

Complimenting the columns, a continuous spray painted grid of parking stalls, traced over the ground profile, exposed the varied nuance on the surface—noting trash, car parts, rocks, etc. What originally seemed a flat, blank site, a tabula rasa on which to work, irrevocably changed when the overlaid parking grid accentuated the variations, revealing its palpable realness. (Figure 1.) This mirrors a presumption that building materials are straight, dimensionally stable and accurate. Overcoming imperfections of the built world proved a valuable lesson for the students in that no matter how straight something was drawn in the computer or on paper it didn’t always translate on the site.21 In addition to the existing ‘real’ conditions of the site, the guerilla style implementation of the installations meant that these existing conditions (no matter how uneven, ragged, or ‘ugly’) had to remain intact while the installation was in place, despite the fact these very imperfections were to be ‘corrected’ later when prepared for future use, placing further limits on the students’ ability to mark the ground. No Michael Heizer’s possible.

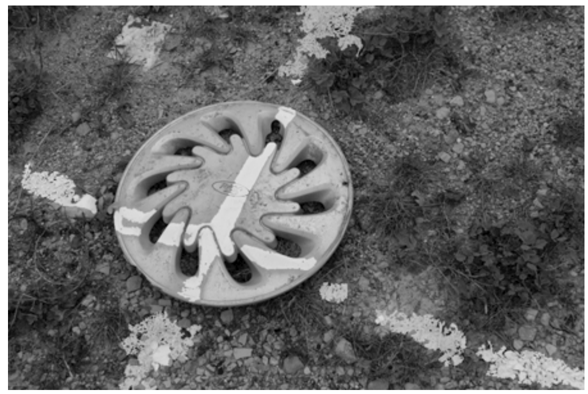


Figure 1. Sprayed parking lines enhanced variations in the ground plane.

At the juncture where three of Milwaukee's rivers flow into Lake Michigan was an active waterway with ships, boats, and land-based fisherman. A river walk, raised eight feet above the water, isolated pedestrians from touching water. In this installation, *Waves and Wings*, students reflected on the disconnect between pedestrians and the river by designing a mechanism to simultaneously stimulate the visual and aural senses of the user,

Figure 2. Waves and Wings installation wraps the existing sidewalk railing.

connecting water movement to people movement (Figure 2).

Waves created by a boat's wake triggered a 'winged' armature that flexes up and down like a weighted bobber responding to the motion of the waves. The armature, designed as a laminated spring using wire and finished 1x wood, flexes to release the two springs resulting in the wood 'clapping' together. These mechanisms lightly bob when the waters were calm. But as soon as a boat passes the wake causes the springs of the wings into a frenzy of motion and clapping. The wood armature relies on the existing steel tube railing for stability but also reflects the requirement to not alter the site. Wood is both notched around the concrete curb and fastened, sandwiching the steel between 2 wood plates, protecting the steel from modification. The wings flex into a curved shape over the river walk defining a spatial promenade on axis with a lighthouse. Students explored small, lightweight, flexible material as it revealed space.

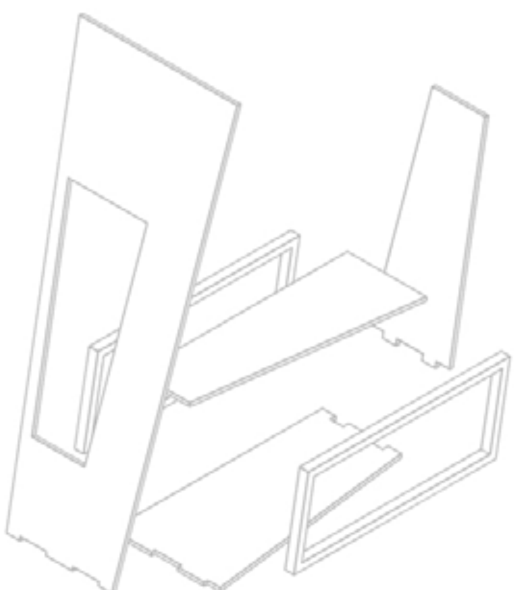


Figure 3. Chair Gradient crafted from 4'x 8' plywood.

As the river winds through the city the street grid breaks, shifts, or deflects as a response. The collision of these offset street grids results in awkward moments of intersection, leaving triangular sites in the city. Another installation, *Chair Gradient*, reconsiders one of these irregular islands, too small for development, as a place to reflect on the city; a place to observe rather than be observed. From a single sheet of 4'x 8' plywood, students designed a chair prototype that repeats 15 times with slight variations in the individual pieces, (Figure 3).

An opening cut into the chair's backrest, and repositioned as the seat, incrementally increased in size from one chair to the next.

Figure 4. Chair Gradient view portals juxtaposed against moving car.

As the seats become slimmer, the backs get taller, the number of wedges used to stabilize the chair against the ground increases. Lessons of how much material should contact the ground persisted in this installation - soft ground proving a challenging surface to rest on. Gradations in the chair's color, transforming from bright yellow to vibrant orange and finally to fire red, accentuate changes to the module. This installation activates a once neglected parcel with the slowness of 'repose' juxtaposed against the speed of the passing car.

Figure 5. Pedestrians pause before traversing the Manipulated Landscape installation.

Due to the guerilla nature of the assignment, the projects were installed in one day. On installation day, guest jurors contextualized the projects into the broader milieu of architecture education and architectural practice by discussing the benefits of risk in studio culture, analogies to paradigms of professional practice, the usefulness of collaborative work, the benefits of intellectual agility to think through the potential of a project, and how to carry forward these ideas. An agility to think and act quickly was highlighted most meaningfully when the project *Manipulated Landscape* had to move sites the morning of install (Figure 5). After supplies, including 50 rolls of sod, were delivered to the original site, a conflict with the land owner required students to move 6 miles north to the campus. What seemed like an impediment turned into an opportunity. Changing sites required the students to act quickly; be critical of their own work; reflect on it; and make necessary alterations. The reconfiguration produced a manicured but warped landscape bisecting a heavily trafficked pedestrian path. The sloped wood structure, reminiscent of skateboard ramp construction – 2x wood frame and plywood sheathing -- easily twisted from its intended orientation. The public, confused by the grass-covered sidewalk (originally intended for the street) were hesitant to walk upon it.

Conclusion:

Addressing the inherent limitations found in typical foundation studios, *UE Studio* broadened the inquiry of beginning design to include making at 1:1 and problematizing the urban condition through criticism and reflection. Combining design and drawing exercises with space making and full-scale construction in the city, students more readily grasped the relationship between concept (idea) and final resolution (making) while highlighting urban circumstances (lack of greenspace, reframing historical conditions, amplifying environmental conditions). Michael Hughes summarizes design/build pedagogy as an expanded discourse that "serves to extend the student's field of operation while positing an alternative to the fragmentary nature of beginning architectural design education in which site and building, as well as drawing and making, are too often seen as separate, codified realms of isolated expertise."[22] In the UE studio, this expanded dialogue included responding to the context of underutilized urban parking lots, using installations as a mechanism to take a critical stance on what to do with these types of important spaces in the city.

On reflection, site locations on the periphery or edge of downtown afforded opportunities for guerrilla style installation with little interference from officials or absentee landowners but also meant little forced interaction with the public. The larger, peripheral sites overwhelmed many of the installations due to their sheer size. Also, due to the inability to mark the ground more permanently, many installations relied on wedges of all shapes and sizes to balance the connection to the ground. The provocateur's strong advocacy for installation as action provided an important frame of reference for the students but, due to the limited number of visits, the effect was less than anticipated.

The design and construction of installations provided beginning students with valuable lessons in how to consider spatial experience;, how design responds to urban context, and how urban dwellers and visitors interact with the built environment. The knowledge that they themselves were agents of change, bringing vision and synthesis to bear on the city and the built environment, made a powerful impression on these students, and is now part of their educational foundation. A sense of entrepreneurship emanates from the students involved in these installations. Perhaps the most important lesson learned was how to leverage limitations - something fundamental to all architectural endeavors – design/build or not.

Figure 6. Ice Wall installation placed blocks of ice, similar to laying concrete block, on the local beach. The wall slowly eroded over the day feeding Lake Michigan with fresh drinking water. In turn, visualizing fresh water issues that effect the region and the world.

Notes

[1] Sarah Bonnemaison and Ronit Eisenbach, *Installations by Architects: Experiments in Building and Design* (New York: Princeton Architectural Press, 2009), 14.

[2] The studio consisted of 150 students, 1 faculty coordinator, 3 faculty, 4 teaching assistants and one studio provocateur.

[3] Jori Erdman and Thomas Leslie, "Introduction," *Journal of Architectural Education* 60:2 (2006): 3.

[4] Erdman and Leslie, 3.

[5] In the book *Cube*, Guthrie critiques abstract representations: "we cannot encounter the spatial and behavioral properties of the materials they [abstractions] represent or fully experience the physical consequences of our decisions through these modes of representation alone."(David Morrow Guthrie, *Cube* (NY: Princeton Architectural Press. 2005), 1.)

[6] JAE volume 59 Issue 4 *Installations by Architects* and volume 60 Issue 2 *1:1* elaborates on a number of design/build studios and practices. From the framework established by Charles Moore and Kent Bloomer at Yale the design/build studio continues to 'mature' and broaden "as educators are beginning to expand their objectives beyond the enriched student learning experiences gained from hands-on projects and community service to include explicit design research objectives." (David Hinson, *JAE 61:1* (2007): 23.) For example: Auburn University, University of Kansas, Tulane and others.

[7] In 1967 Charles Moore established one of the first permanent design/build studios in the country, the Yale First-year Building Project. "In the midst of the student unrest of the 1960s he [Moore] saw the project as a way for students to commit to positive social action by building for the poor." ("Vlock Building Project," last modified June 29, 2011, Yale website.) My First-Year Building Project included a summer internship to complete construction of a single-family house. This proved to be a formative moment when 'taking action' on improving the public realm was established.

[8] Design/build studios are offered as one among many advanced topic studios limited to about 12-15 students per studio per semester or, more likely, per academic year. Thus only a small population of students can access each year.

[9] Yale School of Architecture's Bass Fellowship serves as one example.

[10] Past provocateur collaborators at UWM include Assoc. Prof. Grace La, working with Winy Maas; Assoc. Prof. Kyle Talbott working with Frank Barkow, Assoc. Prof. Manu Sobti working the Julie Bargman, Adjunct Prof. Ryan O'Connor working with Alejandro Aravena, Assoc. Prof. Jim Wasley working with Herbert Dreiseitl, Assoc. Prof. Chris Cornelius with Diébédo Francis Kéré, and Assoc. Prof. Mo Zell working with Sou Fujimoto.

[11] While at the University of Texas (1956-1958), Seligmann stated "we felt that if we had the first and second year, and then had the fifth year again,...then we had the school basically under control".

[12] Excerpted from the MacArthur Foundation press materials.

[13] Technology, Education, Design Conference (TED)

[14] Elizabeth Diller, March 11, 2009. Meeting with students. Diller offered a methodology of working that she embraces in her office, one that slows the process of design down. She suggested that the creative act, what students wanted to impose on the site, be taken one piece at a time. "It could be anything," she said, "but you have to have an opinion about something and then you set boundaries and terms that provide limitations and then get deeper into variations to get deep into an issue. The form itself shouldn't be taken for granted. It isn't institutionalized anything."

[15] Though the studio was based on experimentation, students were always concerned about grades.

[16] Space is difficult to identify since its own physicality is, in actuality, defined or contained by other elements. See Sigfried Gideon's *Space, Time and Architecture* and Henri Lefebvre's *The Production of Space* for additional writings.

[17] One could examine the project Ghost by Rachel Whiteread to clarify this translation of space into form.

[18] Act 3 began weeks earlier when students were required to research an artist/architect who explicitly created installations as a method of public commentary. These included: Casagrande & Rintala and Decosterd & Rahm, Olafur Eliasson, Mary Miss, Richard Serra, Fred Sandback, Walter de Maria, Meejon Yoon and Eric Howeler, Donald Judd, Lewis Tsurumaki Lewis, Weiss/Manfredi, Michael Maltzan, Teddy Cruz, James Corner, among others.

[19] The Great Lakes is the largest group of freshwater lakes in the world holding over 20% of the world's surface fresh water.

[20] Managing 150 students necessitated a careful orchestration of group collaborations. Each studio, consisting of 40 students, had students initially pair off. The 2nd week, as designs were categorized, pairs were regrouped into teams of 4. The following week 4 became 8 - 12. At that point, week 3 of 6, the teams were stabilized and final preparations were made for the installation. As the size of the group changed, negotiations were made between rival ideas.

[21] If the detail were the God of Mies' religion, these students were not a pious lot. The students rarely considered the detail of how an installation touched the ground.

[22] Michael Hughes, "Constructing a Cross-Disciplinary Introduction," We Are A Discipline: 25th National Conference on the Beginning Design Student (2009): 105.

Process of Assembly:
Design, Drawing and Fabrication

Nicholas Ault

Clemson University

Introduction

The act of making is a transcendent exercise for design students. It is an activity that bridges the perceptual gap between the designed object and the designer, but also engages the students' ability to visualize the physicality of design in new and interesting ways. Previously, the act of making, through traditional means, allowed the students to directly engage material and encouraged the experience of a materials tactility, rigidity and response to tooling. This process has been altered as digital modeling and fabrication have become ever more present and evolved into a critical element in design education. These technologies have been adopted as a means to enable the designer and product to be more closely linked but this direct translation and lack of tactile feedback can be an incredibly daunting task for the beginning design student as the digital model requires the design aesthetic, material, connection and assembly to be simultaneously articulated. This paper presents two projects that explore the digital design and fabrication process from stages of three-dimensional modeling, fabrication, detailing and representation of assemblies as part of a digital curriculum with visualization and making as core values. These project usually consist of complex digital fabrications that prove difficult, if not impossible, to explain utilizing traditional orthographic techniques and as a result these exercises emphasize the process of material assembly as a key part of the fabrication process. As such, this has led to a search for and a development of a three-dimensional representational technique that clearly explains the process of assembly whilst aiding the students in the curation and articulation of concise and explicit drawing sets.

Digital Material

As beginning design students most have very limited experience with the act of making or the fundamental process of fabrication. These projects are designed to present fabrication to students in a clear and meaningful manner and engage the students through a process that investigates design not merely as an intellectual, non-material based activity, but instead as one that is rooted in the physical world. These exercises also fill the role of teaching the students software and a process to iteratively move fluidly between the digital and physical realms.

In many ways this inexperience with fabrication and assembly must be seen as both an opportunity and a limitation, as their inexperience leads them in design directions that, in many cases, are very difficult to construct. While this does lead to a slightly above average construction failure rate, as students are unable to reconcile construction issues during the design process, the lessons learned in the process are invaluable and without question emphasize the importance of materiality in the creation of a physical object. This inexperience in itself does not guarantee failure and instead allows the students to consider complex, and sometimes innovative, design strategies and material connection details. But, more often than not, results in some frustration when working iteratively between the digital and material worlds, as there is no longer a one-to-one haptic exchange between the material and the user. Additionally, the computers ability to 'simulate' the visual aspects of design has led to the belief that physical mockups and connection prototypes are no longer necessary when, in fact, the need for such studies has become more necessary as three-dimensional modeling software makes all design possible and appears feasible within its zero thickness environment, weightless environment. This creates a valuable lesson for the students, as failures in fabrication and assembly are part and parcel for this series of exercises, they are purposely allowed, and even encouraged, to pursue difficult design strategies and to have their constructions fail during the process.

Project Description

As disparate projects in Second Year Undergraduate Design Studio and Introductory Digital Fabrication courses respectively, the two projects outlined herein explore different methods for conceptualizing design and assembly. While the goals and outcomes of each project are conceptualized similarly, the methods and lessons embedded within each project differ substantially, though the intellectual outcome ultimately remains the same. These investigations cultivate a cross directional study between the digital and physical worlds through the use of modeling software and simple digital fabrication methods and expressly focused on the articulation and exploration of material and assembly throughout the process.

Model of Assembly (MoA)

The first project in an Introductory Digital Fabrication Course, the Model of Assembly project seeks to engage the students at a dimension and scale at which they are unaccustomed. A hybrid two / three dimensional fabrication and assembly exercise, this project calls for the creation of an object that leverages the power of a laser cutter to maximize material usage and exploit the consistency and accuracy of the technology by requiring the student to utilize one hundred percent of the material, in this case 0.12” Plexiglas. Compositionally difficult, the project requires the student to conceptualize design in two and three-dimensional space simultaneously as the object must be developed alongside the fabrication file. As there is no usage or aesthetic criteria for this project these object are generally approached in one of two manners; the object first approach where a known object is redesigned or graphically, where the cut file and graphic layout itself becomes the exercise for creating a sculptural or non-utilitarian form.

These two approaches ultimately do not affect the educational outcome, but instead provide insights into the students design thinking process and both yield interesting, if not divergent, results. To magnify this understanding and introducing the students to a level of precision with which they are uncomfortable the connections are limited to interlocking connections that themselves are part of the cut file and composition, as mechanical and adhesive connections are not allowed. This complex cutting and assembly process forces the students to engage the process of fabrication through the understanding of tool and material, all the while iteratively drawing and modeling both the construct and the file for cutting. While the creation of an object from a 10x15 sheet of stock is a complex operation in itself the intricacy of connection forces the students to conceptualize the most appropriate type and from where the connections will take place. While the laser cutter adds repeatability to the process it is also important to note that it is a machine that removes material, a kerf approximately 0.008” (dimensions vary per machine, lens, material and even environmental conditions). The removal of material simply means that connections aren’t simply able to be reconnected with their neighbor, instead the connected elements must come from somewhere else on the sheet in order to fit snuggly together and allow the object to be handled without falling apart. This, coupled with the projects ingrained geometric complexity, makes for a nearly untransferable assembly process without a complete and detailed set of instructions as in many cases the disparate parts do not appear to be in any discernable pattern and are instead merely a two dimensional composition of composed pieces and began the development of the design for assembly drawing sets.

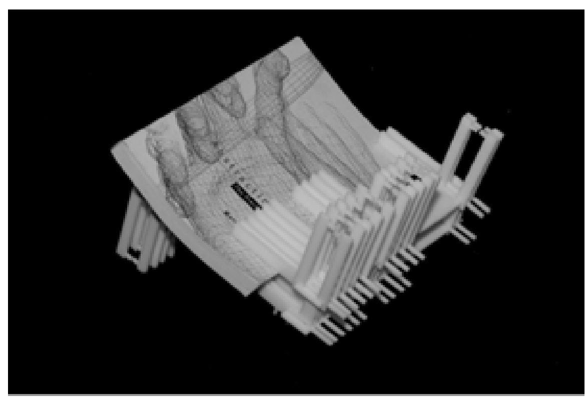


Figure 1: Model of Efficiency - Rachel Myers

Figure 2: Designed Cut File 93% Efficiency - Matt Gines

The Luminaires

Serving as an introduction to digital fabrication, three-dimensional modeling and techniques in the representation of three-dimensional information in a Second Year Undergraduate Design Studio the Luminaires are a series of three 'fixtures', roughly 12"x12"x16", each employing different introductory digital fabrication techniques. Utilizing methods of laminating, framing (egg crating) and skinning respectively, each project increases in complexity and introduces the students to new skills in modeling software, in this case Rhinoceros. Procedurally, the students are required to first design a lighting structure that is to be constructed utilizing predominantly corrugated cardboard and/or watercolor paper. This material composition and the techniques utilized in these exercises creates a requirement that the students become familiar with the material and discover and understand its specifications, limitations and opportunities throughout the design phase in ever increasing ways.

The stacking exercise, the most simple of the three exercises, emphasizes the utilization of the material with significant thickness that limits the overall articulation of a design. As most of the designs employed complex or curvilinear geometry, the students confront issues related to smoothness and articulation as the 3/32"(approx.) cardboard begin to give their design a jagged or pixelated appearance. Additionally, since the cardboard itself has a distinct grain that both provide rigidity in one direction, it also allows the visual penetration of light through the section of the material itself. This becomes both an important structural concern as well as an aesthetic consideration for this project and for the projects going forward. As an introduction to three-dimensional modeling this exercise teaches the students skills in geometric articulation and material simulation (thickness) but purposely omits investigations in connection and detail.

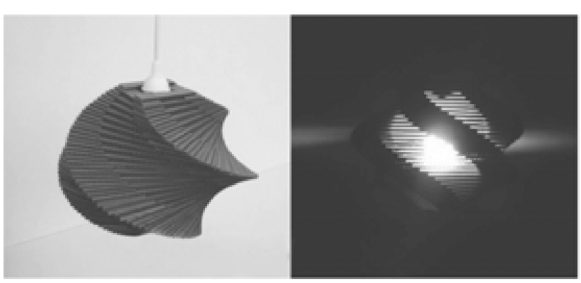


Figure 3: Stacking Lamp - Paul MacKnight

Second in the series, framing, adds connection and assembly as the predominant elements in the design and fabrication of the object. Framing, a relatively simple system with interlocking perpendicular pieces, forces the students to think about the manner in which pieces will interact with one another throughout the process of assembly. This process requires the students to simulate the assembly process digitally by articulating all of the connections through the use of digital solids that ultimately will become the fabrication files, as well as the basis for assembly drawings. While the process of construction is fully simulated within the digital world the failure rate for this project is the highest of the three projects as the sheer number of connections and pieces are difficult to simulate in the digital environment and collisions or complex geometric situations occur where pieces are unable to correctly become aligned. This is not seen as limitation of the project, instead it is viewed as a lesson in the iterative nature of design and prototyping. Similarly, this project teaches the students the value of connection and assembly mockups as part of the project.

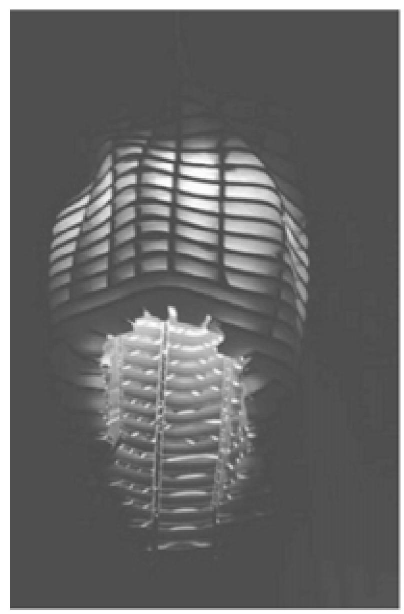


Figure 4: Framing Lamp - Shawn Backstrom

The final luminaire, skinning, is the most refined and capitalizes on all of the knowledge gained in the previous projects and begins to integrate a second material, in this case watercolor paper. In this project students are introduced to the powerful Rhinoceros plugin, Paneling Tools, a software package that allows for the articulation of complex surface compositions utilizing basic ordering principles across complex geometries. This plugin is utilized directly in the design and fabrication of articulate skins either over an articulated frame or independently as a structural skin. This implementation allows the students to begin to understand the larger opportunities offered by computer software but in a manner that requires them to consider the fabrication and relationship and connection details of multiple materials throughout the process. In this case special consideration must be made in the design of the object so that the thickness of the cardboard frame and the paper skin are simultaneously articulated and work together to maximize the structural capability of cardboard and the translucency and intricate articulation of the watercolor paper. This complexity, similar to structure and skin construction techniques in the architectural world, engages the students with a technique that is transferable directly to other large scale constructions and forms the basis for their understanding of structural principles in their studio projects as well.

Figure 5: Skinning Lamp without Cardboard Frame - Hunter Kirkland

Drawing and Assembly

The fundamental communicative language of architecture has remained unchanged since the widespread adoption of computer aided drawing techniques in the 1980's.[1] Additionally, this technology was introduced to raise the level of productivity of creating and editing standard orthographic drawings utilized for construction documents. But as digital and computational architecture has become more widespread these standard methods of representation have become to feel limited and are unable to truly explain the evolving intricacy and non-standard methods of assembly and complexity that even young design students are now leveraging. Additionally, as designers we are not usually the end users or constructor and the students must confront the notion that the most important product the designers produces is the graphic representation (instructions) of the object that is created. The student projects are searching to engage this void through the creation of series of assembly based instructions that are derived from the same drawings as the design, essentially making seamless the designers relationship between design, fabrication and assembly.

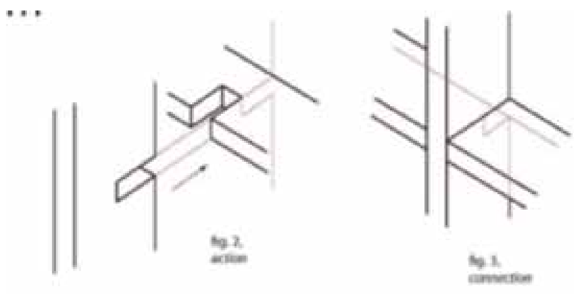


Figure 6: Connection Explanation - Justin Harrison

These assembly drawings are three-dimensional graphic representations that through simple and minimal articulation clearly and concisely express all of the requirements to assemble and /or construct any complex assemblage. Derived from some otherwise standard line drawings and leveraging the computers now innate ability to visualize three-dimensional information these drawings reduce information down to its most basic and express in a step-by-step manner the method by which these objects are composed. These drawings, as they are essentially the design drawings themselves, form a complete representation of the entire process and engage the end user in a matter of fact and aesthetically pleasing manner. Similar to the drawing system employed by the Ikea Corporation, these drawings simultaneously present the aggregation of parts, details in construction and assembly as well as methods of connection. Simply created in Rhinoceros utilizing the Make2D command the process for creating the drawings is simplistic and relatively painless, instead the emphasis is placed on the clear and precise curation of an instruction set. This has proven to be perhaps the most difficult aspect of the project and in future generations will be addressed through a peer reviewed assembly process. This curation requires the students to dissect every material connection, the correct order of assembly and in some ways anticipate or predetermine mistakes that would be made by the end user. While not presented to the students as a primary or fundamental goal of the project(s) this embedded exercise is the one that most clearly is seen in their future work as the students are far more capable of crafting and presenting information for their subsequent projects as they learn what information it takes to explain what is in this case the narrative of assembly.

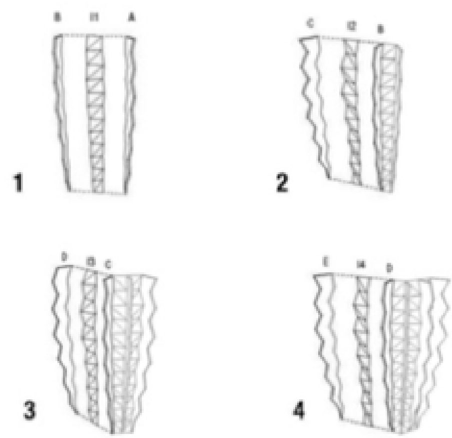


Figure 7: Selection of Instruction Skinning Construction Instructions - Shawn Backstrom

Conclusion

While the utilization of digital modeling and fabrication has now fully become embraced as a part of the lexicon of architecture it is now a skill that even first and second year architecture student are not only expected to understand, but also to quickly master and implement in their own studio projects. These projects seek to present these tools not as disparate elements or skills to be learned and instead are designed to be presented as tools within a well-articulated and complete design process. Ultimately, these projects become about the exploration of production from the inception of design, articulation of material, fabrication and assembly the process through a disciplined design process. Finally, the utilization of drawings is something that all designers must be capable of producing and as complex geometries become more commonplace we, as designers, must find inventive and novel ways to express our design intentions and their fabrications through the drawings and models that we produce. This continued investigation will continue to be altered as the technology that we employ and the designs that we create continue to diverge away from the norm. As designers this is merely a new skill that we must employ to communicate our ideas in the clearest and most explanatory manner possible in order to protect our design ideas and have them realized in the world.

Notes

[1] AutoCAD, widely considered the industry standard and forbearer of the computer revolution in architecture, was introduced in 1982 and widely accepted into offices around the world by the mid-1990's

Experiential Analysis
in Beginning Design Travel Studios

Erin Carraher

University of Utah – School of Architecture

Immersive Learning Experiences

All architecture programs recognize the importance of immersive learning experiences for their students. However, many reserve opportunities such as travel studios, organized studio research trips, design-build projects, and internship programs for advanced students later in the curriculum. At the University of Utah, we have taken the position that the earlier students are exposed to a critical examination of site context and analysis, a more full understanding of architecture firm structures, and a deeper appreciation of the culture and diversity of places, the richer their educational experience will be. According to Benjamin Bloom, "One of the major problems with regard to knowledge is determining what is knowable, for there are different ways in which something can be said to be known. Adding to this problem is the fact that different criteria of accuracy and authenticity are applied to knowledge in different areas, at least the knowledge to be learned in school.[1]" What does it mean to 'know' a site and how can this knowledge be translated into students' design projects? This question is at the heart of how and why our pedagogy has developed in its current form, and why we believe a range of experiences and ways of critically exploring the context (both the natural and cultural landscape in which architects operate) is of critical importance to beginning architecture students.

Students in schools located in rural areas or in areas that lack diversity and density of design culture (both of which are contexts I have taught in) are in particular need of this type of immersive experience, as students in these institutions tend to have less exposure to places unlike their own. This is not to say that students can't have a valuable learning experience by critically examining the place where they live or matriculate, but that removing students from familiar contexts can help them become better able to objectively evaluate their own surroundings.

Fig. 1. Sky analysis at Bonneville Salt Flats.

Site Analysis in the Natural Landscape

The way students are asked to begin this observation is through site analysis, which we see as a foundational skill. The initial exercises students are asked to address concern observation of natural phenomena (light, wind, temperature, etc) in a rural landscape. Rudolf Arnheim discusses fundamental concerns of observation as beginning with an awareness of light in his book, *Visual Thinking*: "If we had wished to begin with the first causes of visual perception, a discussion of light should have preceded all others, for without light the eyes can observe no shape, no color, no space or movement. But light is more than just the physical cause of what we see. Even psychologically it remains one of the most fundamental and powerful of human experiences...Yet, since man's attention is directed mostly toward objects and their actions, the debt owed to light is not widely acknowledged. We deal visually with human beings, buildings, or trees, not with the medium generating their images.[2]" By asking students to begin with an exercise as simple and yet as powerful as studying light in a place over the course of twenty-four hours, they are asked to slow down and reconnect with corporeal aspects of the landscape in an attempt to help them understand how these phenomena can be controlled, utilized, and manipulated when developing their buildings.

Fig. 2. Exploring cave dwellings outside Bluff, UT.

Travel-Based Studio Pedagogy

In the first-year undergraduate architecture studios, the year is bookended by two travel-based studio projects. The first is a rural design-build exploration that begins with an overnight camping trip in a remote location. The Utah landscape is remarkable in its beauty and diversity. From the Bonneville Salt Flats' vast expanse of shimmering level ground ringed by an unobstructed 360-degree view of the horizon, to Antelope Island's isolated position in the middle of the Great Salt Lake where sunrise and sunset are reflected off of the still plane of water, to southern Utah's red rock country where geological deep time is clearly visible in the bluffs, mesas, and escarpments marked by cave dwellings and paintings from the first peoples to occupy the land generations ago, the landscape is a unique and powerful teaching tool.

Observing and comprehending such immense sites is a challenging task for beginning students to take on thoughtfully but one that is particularly important and relevant to work in the intermountain western landscape where our university is sited as the landscape here has an unavoidable impact on all buildings built in Utah. "Immense and immediate. Efficient and wasteful. Brutal and spectacular. The American landscape, like the culture it embodies, is a magnificent paradox. For all of its clarity, beauty, and precision, there is an odd confusion lurking across the land, a terrifying and sweet errancy of measure that is at once ominous and promising. Poignantly expressed in all forms of social, economic, political, and aesthetic life, the grandeur of this irony is perhaps most concentrated in what I shall call the aporia of modern measure. This aporia is characterized by a general confusion of meaning and relationship between art and science, culture and nature, or objectivity and subjectivity. Our modern culture, particularly our relationship with the environment, is constructed upon dichotomies and oppositions that cannot seem to find a common measure.[3]" The question of how to measure their experience of and in the landscape is a task that faculty and students take on through conversation and critical reflection in advance of, during, and after the camping trip.

Observation and Discovery

Taking advantage of the natural laboratory in the backyard of the university, students benefit from the being removed from their comfortable surroundings away from technology and the trappings of their daily lives to be able to concentrate fully on exploring the landscape around them for twenty-four hours. Seeing a site at all times of day allows students the opportunity to understand in some small part the changing nature of a site through its light, smell, texture, temperature, and tactile qualities. Prior to traveling, students and faculty discuss the various types of analysis that take place when evaluating a site: analytical, scientific, experiential, and qualitative. Students conduct the objective and scientific analysis in advance of the trip and present their findings to each other to create a basis of knowledge for their personal observations on site. While traveling, they are asked to conduct experiential analysis based on a series of criteria and toward the development of an 'artifact' that embodies their personal, multi-sensory experience of the landscape. James Elkins in *How to Use Your Eyes* discusses the process of observation: "For me, looking is a kind of pure pleasure – it takes me out of myself and lets me think only of what I am seeing. Also, there is pleasure in discovering these things. It is good to know that the visual world is more than television, movies, and art museums, and it is especially good to know that the world is full of fascinating things that can be seen at leisure, when you are by yourself and there is nothing to distract you. Seeing, after all, is a soundless activity. It isn't talking, or listening, or smelling, or touching. It happens best in solitude, when there is nothing in the world but you and the object of your attention.[4]" We believe this act of consciously looking that Elkins describes can be achieved through isolation in the landscape over a period of time.

Developed over many years by a number of faculty members, the brief for the experiential analysis exercise includes the following directions: "Be aware of your body in the landscape. Begin by walking away from the group for ten minutes.

Stop and consider how far you have moved and what the experience of moving has been. Turn around and begin to walk back. Pay attention to changes in texture, views, and found objects, etc. Make a series of sketches and/or diagrams (for example, a series of sketches of found objects with a diagram showing their relative locations) which map/record the territory you have covered and the experience of moving through the landscape[5]." Students are encouraged to conduct their analysis several times throughout the day-long trip to gain a sense of how their perception of the site changes over the course of the day. They are asked to make experiential maps using themes such as color, edges, found objects, indigenous species, light, etc that serve as catalysts for thoughtful consideration and observation. Depending on the site and project brief, the faculty may ask that students focus on one quality, such as light or views, to help narrow the focus.

Fig. 3. Sunrise at Antelope Island, UT.

Experiential Analysis Framework

The resulting analysis is developed into what we refer to as an 'experiential artifact,' which serves as a heuristic device to help students translate their observations through abstraction to another scale and form. An artifact in this sense is defined as "an object that has been intentionally made or produced for a certain purpose[6]." Often used to refer to objects crafted by members of a particular culture, the word 'artifact' distinguishes objects made with intentional agency from naturally occurring objects (a hammer that has been designed for the purpose of hitting something as opposed to a rock used opportunistically for pulverizing). The *Oxford English Dictionary* defines an artifact (artefact) as something 'artificial' or the product of human efforts as evidenced by its Latin root words *arte*, ablative of *ars* (art), and *factum*, the past participle of *facere* (to make)[7]. Aristotle divided existing things into those that 'exist by nature' and those existing 'from other causes,' describing the latter as products of the art of making: "The art of making something involves intentional agency; thus an artifact may be defined as an object that has been intentionally made for some purpose[8]."

The artifact is intended to assist in developing students' proprioception, or their ability to understand their body's relationship to surrounding space through corporeal measurement, which is historically how things were understood before universal, rational measuring systems were introduced. "Traditional units of measure...derived from the interrelationship of labor, body, and site. Tailors measured cloth using 'arms' along its length and 'hands' across its width, for example. Horses, too, were so many 'hands' high, though this measure was not used with other animals. Similarly, a place a 'stone's throw away' was not equal that was at 'shouting distance.' The sources of traditional measures were concrete experiences of everyday life. Such measures were situated in the specific and were not necessarily applicable to other circumstances; they signified the value of a particular quantity along with its situational quality.[9]" This is a critical skill for architects to develop and one that can be uniquely explored while experiencing a powerful natural environment where senses are heightened and physical awareness is elevated and through the exercise of measuring experience through observation.

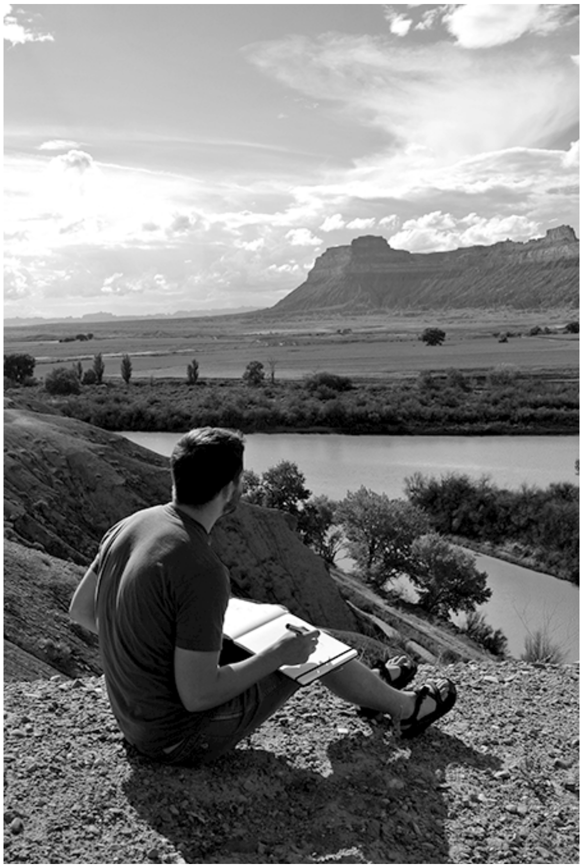


Fig. 4. Sketching at Goose Point, UT.

This internalization of these observations – in the best case scenario – is then translated as new understanding and knowledge to the students' work when they begin developing proposals for how to address the landscape. "Sketching and drawing are spatial and haptic exercises that fuse the external reality of space and matter, and the internal reality of perception, thought and mental imagery into singular and dialectic entities," states Juhani Pallasmaa in his book, *The Thinking Hand*. "As I sketch a contour of an object, human figure or landscape, I actually touch and feel the surface of the subject of my attention, and unconsciously I sense and internalize its character.[10]"


Fig. 5. Student installation at Goose Point, UT.

Synthesis of Observations and Design

Per Bloom's taxonometric structure of cognitive development, the objective of this trip is part of a synthesis of knowledge of the environment, facts learned in their prior analysis, and students' tectonic responses to the given program to develop a place-based sustainable ethic with regard to design on and for a given site. "Synthesis is here defined as the putting together of elements and parts so as to form a whole. This is a process of working with elements, parts, etc., and combining them in such a way as to constitute a pattern or structure not clearly there before. Generally this would involve a recombination of parts of previous experience with new material, reconstructed into a new and more or less well-integrated whole. This is the category in the cognitive domain which most clearly provides for creative behavior on the part of the learner. However, it should be emphasized that this is not completely free creative expression since generally the student is expected to work within the limits set by particular problems, materials, or some theoretical and methodological framework.[11]"

Though the corresponding studio project to these trips have evolved over the past several years, the current model is to develop a design-build installation for the site that students work on collaboratively and return to the site to mount. For example, in Fall 2013 forty-five first-year students worked in collaboration with the City of Green River and a local non-profit community development group, the Epicenter, on a design-build project to develop installations in and around Green River. These projects were the first tangible elements of a proposed trail system, which recently received funding from the National Parks

Service. The proposed hiking, biking, and equestrian trails will give residents and visitors access to the Green River as well as other powerful sites in the surrounding Utah landscape.

Throughout the project students were asked to engage with the local community, study and analyze significant natural and man-made landscapes, and develop programatic responses to their chosen site through their installations. Green River is located roughly 50 miles from Arches National Park and Moab and 60 miles from Canyonlands National Park. This town of 1,000 residents and 600 hotel rooms gains much of its economy from tourism, and the proposed trails system seeks to shift the perspective of Green River from a place which people pass through to a “Place of Pause.”

The previous year’s trip to Antelope Island yielded a studio-based development of a naked-eye observatory, which while successful at individually addressing each student’s personal interest in the landscape (whether it be the horizon, colors and textures of the site, or the disintegration of man-made artifacts by the site over time), was not as successful in developing a deeper understanding of the site by being required to build upon it that the design-build installations had.

Fig. 6. Tour of Cooper Union building in New York City.

Site Analysis in the Urban Landscape

To both counter and also build off of the skills developed through this project, in the latter part of the spring semester students explore an urban context by traveling to a major metropolitan area to study a particular cultural group and posit a small, mixed-use building for an urban infill site. Tasked with conducting immersive site analysis, students look more critically at the cultural landscape of the city following a similar structure to the previous landscape-based example. Again developed over several years by the collective faculty, the exercises for this trip are similar to the fall landscape assignments in that technical and scientific analysis is conducted in advance with personal, experiential analysis taking place on the ground. Rather than creating an artifact as discussed in the previous example, students are now asked to experientially map their movement through a site using the Situationalist concept of the *dérive* to explore and to create a psychogeographic map to document their understanding of the space. The assignment text reads:

Architects are often just visitors to a place; as such, they must develop their skills as observers in order to quickly, yet accurately, understand the context they will work within. This project is an elaboration of previous mapping exercises, emphasizing your experience of the neighborhood, and more particularly, your process of articulating this experience to others. While traveling, your primary task will be to understand the physical experience of the space, and its potential impact on visitors and inhabitants.

Fig. 7. Sketching at the FDR Memorial, New York City.

In theoretical terms, we are asking you to participate in a dérive: “an unplanned tour through an urban landscape directed entirely by the feelings evoked in the individual by their surroundings, serv[ing] as the primary means for mapping and investigating the psychogeography of these different areas[12].” Created by the Situationalist movement, this concept of urban wandering asks that the explorer put aside all preconceived notions of the place so that they can be drawn to whatever may attract them. By doing so, the wanderer experiences the place outside the conventions defined by the status quo and opens themselves to a new, self-determined narrative.

While exploring the site, document the attractors with photographs, sketches, artifacts, recordings, etc. With the information grouped into layers of content, create a pyschogeographic map of the site. The goal of a psychogeographic map is to create a narrative that describes your experience of the space. We are defining narrative as describing a sequence of events, thoughts, feelings, or experiences. The sequence does not have to be chronological but should somehow communicate relationships between the various elements being depicted, described, or represented[13].

Critique of the Framework

These travel studios bookend the first-year curriculum for our students and define a pedagogy that values a place-based, sustainable ethic at all levels of design. The trips have proven successful at helping students broaden their understanding of the tangible experience of a place. However, we have found that the extents to which an average first-year design student can critically explore the cultural, political, and logistical context of a site in a major metropolitan area in the course of three or four days – even when coupled with analysis prior to the trip as well as post-trip documentation – does not constitute a strong enough basis for design for our intended purposes.

There are two models currently being pursued in the program to address this critique. One model currently being used by the second-year students has students traveling to a city such as San Francisco, New York, or Chicago where they study precedents that will inform a design for a site in Salt Lake City. Alternately, the first-year students this year are building off of the work that students developed in an applied research lab this past summer in Chicago. The six weeks of master plan development, community group meetings, consultations with city officials and community organizers will be available to the younger students and allow them to (in as much a way as possible) develop projects for the Chicago site. "An architectural project is not only a result of a problem-solving process, as it is also a metaphysical proposition that expresses the maker's mental world and his/her understanding of the human life world. The design process simultaneously scans the inner and the outer worlds and intertwines the two universes.[14]"

Additional critiques of the urban site project include the fact that there are many elements of the design that can't be fully addressed in a half-semester timeframe. We are however integrating the first-half of the semester's work (the development of a parametric sunscreen system) into the development of the urban site project to help facilitate the thoughtful and thorough analysis of a façade system that is performative and adaptable to a particular set of site conditions.

Conclusion

We believe that this early exposure to site analysis through studio projects that have an immersive site visit component helps beginning students understand the value that a place-based response to site context can add to a building design. Additionally, through their travels students are exposed to a range of diverse models of architectural practice through office visits and begin to make connections between how the exercises they are asked to address in school relate to the development of an actual architectural project. By exposing beginning students to architecture offices first-hand, by having in situ discussions of architectural principles in contexts where they can be directly observed, and by empowering students to parse information gathered from experiential analysis on site to inform their design response, immersive experiences can create significant value for beginning design students.

Notes

[1] Bloom, Benjamin S., et al. *Taxonomy of Educational Objectives: Handbook I:* Cognitive Domain. New York: David McKay (1956). p. 31.

[2] Arnheim, Rudolf. Art and Visual Perception: A Psychology of the Creative Eye. University of California Press (1974). p. 303.

[3] Corner, James, and Alex S. MacLean, eds. Taking Measures Across the American Landscape. Yale University Press (1996). p. 25.

[4] Elkins, James. How to Use Your Eyes. Routledge (2007). p. XI.

[5] Faculty contributing to the first-year exercises over the 2011-14 academic years include: Verl Adams, Mira Locher, Darin Mano, Heber Slabbert, Elpitha Tsoutsounakis, Dan Hoffman, and the author.

[6] http://plato.stanford.edu/entries/artifact/

[7] ibid (http://plato.stanford.edu/entries/artifact/)

[8] ibid (http://plato.stanford.edu/entries/artifact/)

[9] Corner, James, and Alex S. MacLean, eds. Taking Measures Across the American Landscape. Yale University Press (1996). p. 27.

[10] Pallasmaa, Juhani. The Thinking Hand: Existential and Embodied Wisdom in Architecture. Chichester: Wiley (2009). p. 89.

[11] Bloom, Benjamin S., et al. Taxonomy of Educational Objectives: Handbook I: Cognitive Domain. New York: David McKay (1956). p. 162.

[12] "dérive," www.wikipedia.org, Feb. 7, 2014.

[13] Faculty contributing to the first-year exercises over the 2011-14 academic years include: Verl Adams, Charlott Greub, Dwight Yee, Krysta Dimick, Elpitha Tsoutsounakis, Dan Hoffman, and the author. This particular text was written by Dwight Yee.

[14] Pallasmaa, Juhani. The Thinking Hand*: Existential and Embodied Wisdom in Architecture*. Chichester: Wiley (2009). p. 108.

Pre-Tectonic Formations

Christopher Falliers, Antje Steinmuller

California College of the Arts

Introduction

From Gaudi's chain and weight constructions to Zaha Hadid's simple cut paper studies, understandings of material manipulation and resultant performance have long been an integral part of the design process. Direct material explorations can be extended into early conceptual modeling and diagramming by evaluating properties and behaviors of material/matter as analogs of architectural conditions. In this, material constructs are 'pre-tectonic', or, *warped paper is not necessarily read as a concrete shell construction.* Instead, focus is placed on the spatial and organizational performance of the material construct, or, *the warped paper articulates a range of fluid transitions between a space articulated horizontally then vertically.*

This design methodology is situated theoretically as an interpretation and extension of Gilles Deleuze's 'abstract machine', Manuel DeLanda's 'body plan'[1], and Jesse Reiser's 'crude type'[2], in that the construct/diagram strives to simultaneously contain essential latent attributes while being abstract enough to offer a range of potential performative conditions and interpretations. These theorists teach us that a specific type of abstraction is necessary to understand and transform the underlying principles of an artifact. These 'machines', 'types' and 'body plans' remove imagery, completeness, and autonomy of an entity, while isolating the actions and influences embedded in, effecting, and produced by its formation.

For early design, this can be more simply stated as the construction of a 'model' as a dialogue between material manipulations and spatial effects, or a 'machine' to visualize cause and effect. The construct is focused on its 'verb', or what it does, and the production of architectural conditions to be mined in later design phases. The generative potential of this method is present when embedding the material construct/diagram with four criteria: analytical and qualitative understandings of specific relationships, a technique for manipulation initiating a transformative design intervention, an abstract understanding of its typological potential, and a focus on spatial and organizational conditions produced. The attributes and performance of manipulated material become integral understandings in the early synthesis of analysis, concept, and architectural potentiality.

This paper describes the use of such 'pre-tectonic' constructs as dynamic diagrammatic studies of both beginning architectural design form + space explorations and more advanced urban typologies and behaviors. Comparing these two types of work, the generative potential leads to tectonic and/or conceptual transformations in later phases of design. It will focus on the necessity for an abstraction embedded with material/spatial behaviors, and models that produce a varied set of conditions within a limited design palette.

Practice and research

To articulate these varied uses, the paper will focus on two different trajectories, explorations that stress the tectonic throughout the design process and early urban-scale explorations that model urban behaviors as analogous models. Architectural and urban case studies will provide examples for these trajectories.

Zaha Hadid Architects' use of simple, paper models are an essential part of the practice's design process. The design team generates early model studies based on Hadid's sketches. Describing the process for the BMW Central Building, the firm states their function.

> *Someone had made a little paper model- a quick three-dimensional sketch of the scheme. From that little model we discovered the essence of the project. ... It was a tiny paper model that distilled the flows of the site. As we discussed the model, we began to bend the paper up and down and quickly realized a way that we could avoid the simple stacking of floors. We could treat the interior as a series of cascades and ramped surfaces that would touch down and connect at various levels. That was when the section appeared.* [3]

These models appear in many projects, and arguably include the primary spatial attributes of the firm's oeuvre. Subtle changes in spatial articulation are produced via canted or warped floors and envelopes, or the bending of semi-resistant paper. Geometric merging of linear and curve geometries enhance the flow of directional space, produced in the models by a blade cutting paper. More abrupt spatial framing produced in the cross-direction are seen as 3D ruptures of the cut paper. The section and spatial experience are often discovered through the material manipulation.

A case of reverse engineering can articulate the use of a structural diagram to establish a coherent architectural construct. Mark Burry, Executive Architect and Researcher for Gaudi's Sagrada Familia, theorized that Gaudi's architectural and decorative articulations reference the underlying structural geometries. Burry terms this underlying armature as "virtually present as a point to anchor cohesion to a formal spatial construct". [4] In preparing the nave roof for construction, Burry noted a significant challenge to reconcile Gaudi's' finished model studies with the theory that the roof is an assemblage of structurally-derived hyperbolic paraboloids, all meeting at a point.

In considering the 1:25 scaled gypsum plaster model, this observation is not readily substantiated by the eye. If, however, we reduce the surfaces to their underlying geometry, we can see that with the right combination of parameters the hyperbolic skins relax into their original surfaces. [5]

This, then, references Gaudi's chain-and-weight models as an operative principle. Burry's knowledge of this tectonic framework gave him the clue to reconstruct this complex architecture within a digital environment.

Drawings can also visualize approximations of tectonic presence. Peter Zumthor's two primary intentions for the Thermal Baths Vals project (Vals, Switzerland, 1990-1996) were to establish a "special relationship with the mountain landscape, its natural power, geological substance, and impressive topography", and for the building be a "continuous internal space, like a geometric cave system."[6] To engage in a design dialogue with these intentions, Zumthor sketched and drew tectonically. "The design process was a playful but patient process of exploration independent of rigid formal models".[7] Similar to artist Frank Stella's black paintings and lithographs, where the adjacencies of wide black lines reveal resultant linear canvas voids, Zumthor's early plan sketch evokes a direct reciprocity between mass and void. Using wide graphite strokes, he approximates the mass of stones and the cave-like spaces between. These 'stones' are articulated later as chambers, and developed similarly in section. Horizontal graphite strokes visualize the strata of stone constructing the wall. The sense of enclosure, slit apertures, and niches are given more presence by this tectonic poché.

To retain the tectonic sensibility through the process, Zumthor maintains the 'stone', as they develop an appropriate organizational strategy.

The blocks are loosely assembled in recurring figurative patterns, which are often tied into various orthogonal ordering lines. Underlying this informal layout is a carefully modeled path of circulation which leads bathers to curtained predetermined points but lets them explore others areas for themselves. The large continuous space between the blocks is build up sequentially. The perspective is always controlled. It either ensures of denies the view, guaranteeing the distinct spatial quality of each element of the sequence while respecting the function and meaning within the whole.[8]

The continuous use of the word 'block' retains the tectonic value through the organizational explorations, ensuring the sequence of experiences and articulation of light and privacy reinforce the tectonic theme.

Case studies can argue for the potential for these methods within urban/large architectural problems. Under the direction of historian/theorist Stanford Anderson, Wes Henderson's "Space of Public Claim" map (1973) of the area of Avenue Victor-Hugo in Paris relates building tectonics directly to urban space. Seen as an extension of Giambattista Nolli's Map of Rome (1748), the Paris map visualizes the dialogue between the porosity of urban architecture and the form/space of a street. Focusing on a swath of Paris' urban fabric, only the primary building elements, party walls, columns/piers and beams dashed above are rendered. Facades and sidewalks are removed. The result highlights the porosity, public life, building ownership, and architectural rhythm of the street directly through tectonics. It eliminates the image of the city, in favor of how architectural artifacts collectively, produce urban street space.

The work of Frei Otto and the Institute for Lightweight Structures (ILEK) produced what can be described as 'analogous urban models'. Both

Otto's 'attractive occupations' model (1992), and Marek Kolodziejczyk's 'wool-thread detour path networks model' (1991), act as 'machines' producing behaviors found in urban form. Parametric urbanism expert Patrik Schumacher cites this work as both an "analysis of existing patterns paralleled by analogue experiments modeling crucial features of the settlement process."[9] In Otto's model, magnetic needles floating in a water bed magnetically 'distance' themselves from each other, analogous to the 'distancing' of medieval towns due to availability of supporting agricultural land. Floating chips of polystyrene are pulled to these pseudo town centers in forms remarkably similar to informal urban settlement patterns. The combination of distancing and attraction produce analogous urban formations.

Kolodziejczyk's 'wool-thread' model is know more recently as the basis for Zaha Hadid Architects Kartel-Pendik Masterplan, Istanbul (2006). Schumacher constructed a Maya wool-thread model as the organizational strategy for Hadid's design. In both, roads are modeled as interconnected threads crossing a site from its surrounding perimeter. Interconnected, they do not cross the site in isolation. Pulling on one thread, deforms them all. To minimize detours, organize and give preference to the numerous roadways engaging a site, the designer of either model 'pulls' to tune the construct, producing an emergent aggregate form. Schumacher articulates the potential of these analogous 'machines' in his overview of the Otto's work.

Frei Otto's form-finding models bring a large number of components into a simultaneous organizing force-field. Any variation of the parametric profile of any of the elements is being lawfully responded to by all other elements within the system. Such quantitative adaptations often cross thresholds into emergent qualities. ...If such an associative sensitivity holds sway within a system we can talk about relational fields. Relational fields comprise mutually correlated sub-layers, for instance the correlation of patterns of occupation with patterns of connection. ...The continuous differentiation of the path-network - linear stretches, forks, crossing points– lawfully correlates with the continuous differentiation of the occupying fabric in terms of its density, programmatic type and morphology.[10]

In other worlds, the constructs are machines for visualizing urban behaviors. Their physicality and manipulation allows active control over and immediate visualization of change within a dynamic set of urban relationships.

The isolation of urban behaviors as the focus of early generative diagrams has great potential in parametric modeling. Falliers' own research in 'ufm - urban formation machines', models reductive sets of urban relationships (Fig. 1,2). One example, 'Grid Transmissions', visualizes the street space as intervals and magnitudes of 'events'. These 'events', depicted as a rhythm and magnitude of drawn marks, equates to the porosity of storefronts or programmatic distribution. Parametric relationships are used to control changes to base rhythms by features such as predominant directionality, the effect of a local attractor (a neighborhood center), or an environmental feature (a river or highway).

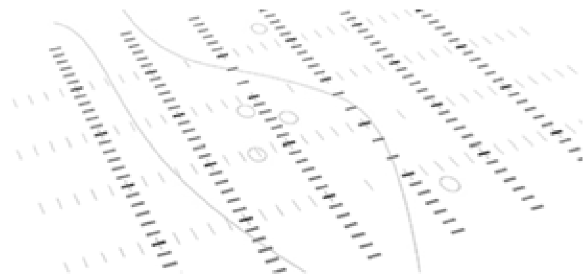


Fig. 1. ufm, Grid Transmissions_01.16

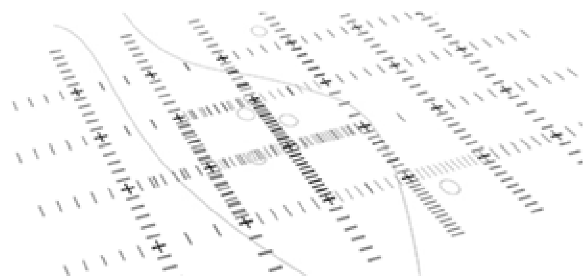


Fig. 2. ufm, Grid Transmissions_01.27

pedagogy

Within the graduate program California College of the Arts, this method is used both in introductory architectural design exercises and with advanced students engaged in urban/architectural explorations. The pre-tectonic constructs, in either case, constitute a dynamic spatial diagram - an extension of an abstracted two-dimensional diagram fueled by potentials of material and spatial performance. In both exercises described in this paper, these constructs are embedded in larger iterative processes. Translations from 2D to 3D (and back) are understood as integral to uncovering transformational potentials[11]. 2D drawings are integral to the process, used prior to, or in conjunction with material manipulations. Both exploratory and analytical in nature, these drawings enable students to embed the material constructs with specific criteria: an analytical of relationships, a clear transformative technique, and an abstraction of typological potential. 2D translations also participate as graphic indexes inscribing the material surface some organizational departure points for later iterations. Finally, they document and clarify attributes and performances within the spatial and organizational conditions produced.

exercise one: formations + space

Introductory form + space exercises within the MArch program capitalize on the generative potential in pre-tectonic, dynamic models. They introduce the design process as iterative, critical, and exploratory. The early introduction of conceptual modeling and dynamic diagramming is particularly critical to shape a way of thinking that is based on an understanding of material properties, possible manipulations and resulting spatial performance. In this introductory studio exercise, students begin with card stock manipulations guided by operational verbs (folding, splitting, faceting, refracting, etc.). These initial constructs are studied for their material and spatial performance, their qualitative and organizational qualities. While not a building material, the malleability and resistance of card stock allows students to observe the direct translation of design actions into qualities of structural stiffening, bending/warping, transparency/ opacity, surface continuity, light interaction etc. Drawings document these performative aspects, and act as a departure point for aggregation and further manipulation.

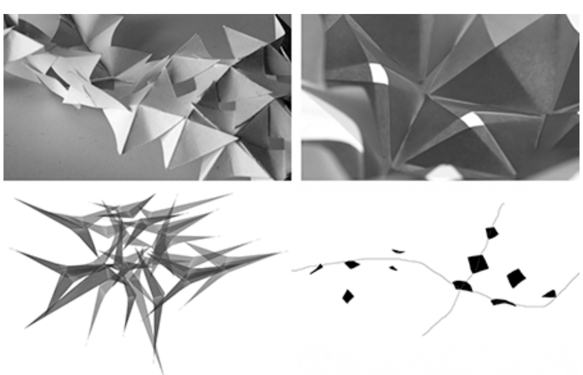


Fig. 3. card stock constructs and analytical drawings

The exercise concludes with a translation into a final material/spatial construct. Material is now chosen critically, according to the particular performative aspects discovered in the card stock and drawing studies. This focus on the behaviors and attributes within the spatial exploration promotes assessing its potential for architectural development. Un-sited, the exercise introduces simple performance criteria like spanning a certain distance (a small bridge), and/or producing a specific range of conditions (shelter for an individual, a small group, a large team). These performance criteria visualize the range of resulting architectural conditions, vs. reading these as complete architectures.

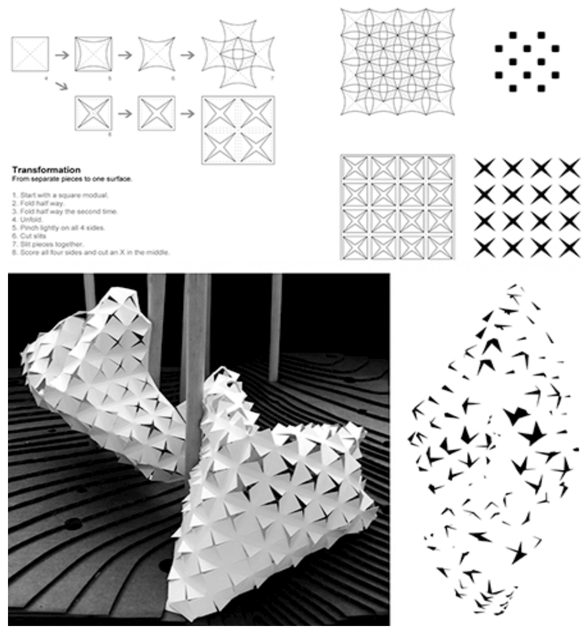


Fig. 4. drawings and material translation

The student project in Fig. 3-4 began with crossed folds in a card stock square. This strengthening articulates volume and surface curvature. Aggregation through notching and overlap along the folds produces linear axes and spines, stiffness, as well as larger scale curvature. Qualitatively, degrees of overlap leave moments of transparency and vary material opacity. Photographic documentation and subsequent drawings reveal relationships between constructing form and the range of conditions produced. Additional drawings extend and/or transform these effects. One drawing inverts the light effect to track the relationship between global curvature and openings (black figures along spines). Understanding these relationships led to an inverse method for making: crossed slits in an otherwise continuous surface produce local weakness, controlled bending, and conditions of relative strength and stability along bends/spines. Through directly manipulation, the student discovered and studied the relationship between 'global' bending and the transformation of 'local' cuts into intensified, volumetric apertures. The final 'shelter' project differentiated spaces both through both the proportions and position of the overall curvature, and the degrees of porosity in the surface (Fig. 4).

A second example of student work depicts a material translation. Initial parallel cuts in the card stock were subsequently bent and re-slotted to produce a strengthened volume. The drawing sequence examined volume, curvature and directionality, as rendered by linear description (Fig. 5, 6). Converging tangents became the transitional focus, in which the resulting material translations produced an interdependent dialog between 3D base curves and resulting tangent lines. Within the final material construct (Fig. 7), a sewing technique (binding sheets and strings) controlled tensile behavior and highlighted the resultant complexity of interdependent, volumetric curvatures.

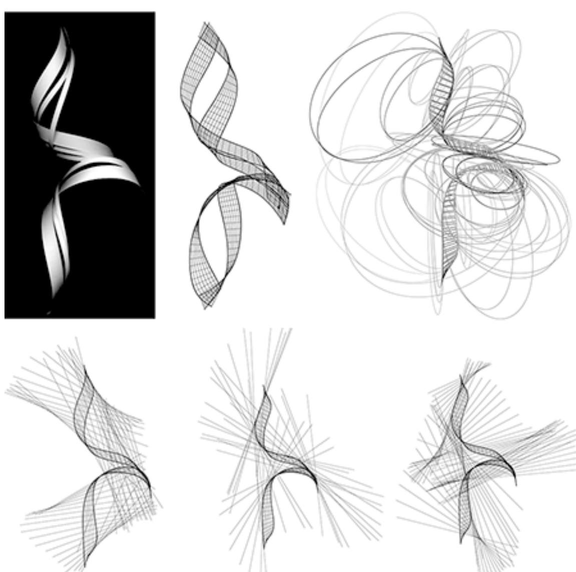


Fig. 5. initial construct and study of origin curve in relationship to lines describing volumes and directions

The pre-tectonic constructs introduce a method based on recognizing material and spatial properties and behaviors. The method stresses understanding the embedded variables that control and produce architectural conditions and effects. Approximating full-scale parameters and restrictions, the method also raises awareness of the latent potential of material, geometry and assembly technique.

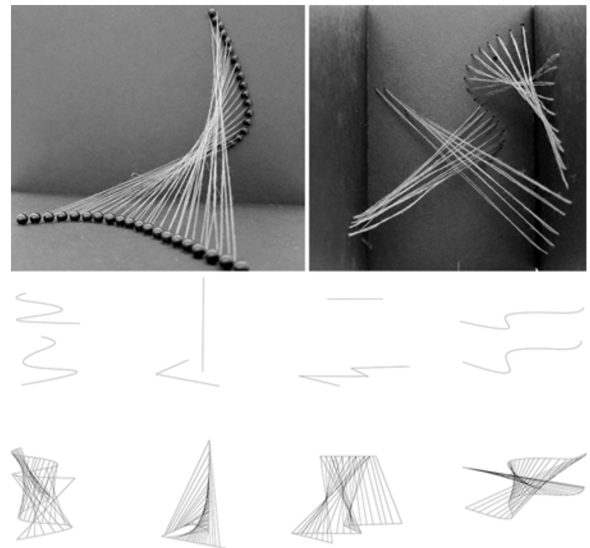


Fig. 6. dialog between 3D base curves and tangents

The iteration of material constructs - from card stock to drawing to secondary material choice – stresses the acts of manipulation and transformation to unlock a material's tial. Grounded in a belief that these embedded properties and potentials can, and should be formative to the evolution of a design, this method engages dialogues between material, strategies for its manipulation, and the recognition of emerging spatial and material behavior.

Fig. 7. final material translation

exercise two: urban analogs

This method has an obvious analog in the design of full-scale material installations, and in any exploration of the spatial potentials of specific tectonic assemblies. With this paper, we argue that the methodology is also generative in the transformation of urban scale conditions. As demonstrated by Otto, analytical understandings of many urban relationships can be seen as analogous to material behavior. Pre-tectonic constructs as three-dimensional dynamic diagrams can act as vehicles for the exploration of variability within the initial analysis. Analogous behavior in urban modeling, as pioneered by Otto, offers potential to prioritize and visualize a range of conditions produced through transformational studies. It allows students to develop a diagrammatic mechanism - a 'formation machine' - that carries forward specific relationships within an organizational analog, and propagates strategies for their manipulation. Regardless of the scale this mechanism is applied to, the space-making strategies are informed and shaped by material behavior.

This analog method was tested in a 3-week summer studio in which pre-tectonic constructs were used as dynamic diagrammatic studies of specific urban space typologies: fields, fabrics, figures and spatial lines. Analytical field drawings focused on criteria and organizational relationships that inform urban space typologies. Grasshopper models or iterative transformational drawings were developed to gain control over the range of these formative relationships. Graphically indexed with this information, simple card stock constructs translated spatial and organizational relationships, their variability and resulting effects, into three dimensions. As in the introductory design exercise, the method for material manipulation, in conjunction with the pliability of the material, offers a specific range of conditions and transformations within this typology. These manipulations and their resulting effects operate as spatial and organizational analogs for much larger urban conditions. The constructs hold precise relational information. Manipulations are understood as transforming conditions recognized as characteristic to the given urban space typology.

In the form of a physical construct - a formation machine - the final phase of the studio asked students to apply the analogs as transformational strategies to a site at the edge of the urban fabric and a large open space. The final proposals remain diagrammatic in nature, highlighting potentials as frameworks for design rather than solutions.

The work in Fig. 8-10 focused on the expansion and compression of space in a directional field. It examined possible singularities within the field produced via cross-directional shifts and voids. The initial line drawings extract basic organizational principles and dependencies (Fig. 8). This underlays a 3d model, which used cuts and folds as mechanisms for intersecting directions, and heightening 3D conditions of compression or expansion. The final material construct capitalized on planar surface qualities in dialog with folded geometry and local breaks to produce a fully three-dimensional landscape of directional spaces. It carried qualities akin to the linear field typology studied in the urban space, yet translated them within a suggestive tectonic theme. The pre-tectonic constructs (Fig. 9-10) re-interpret an understood organizational behavior to produce spatial conditions present beyond the original urban space typology.

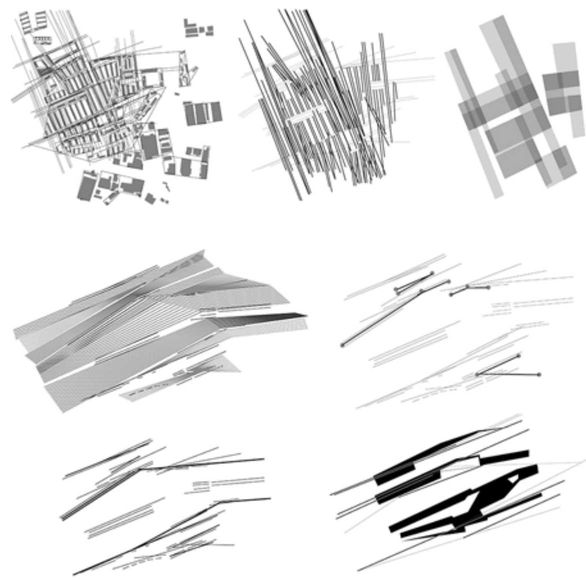


Fig. 8. initial urban space typology study and dynamic 2D diagrams of spatial compression and expansion

In this series, the early performative models hold precise relational information. The constructs make physically tangible a range of potential transformations of the base typology. Rather than representing a singular typological form, they provide generative tools for the formation of architectural or urban space. For students, this working method links analysis of the given material of urban condition with an understanding of inherent potential transformation via material performance.

Fig. 9. pre-tectonic constructs using cuts and folds

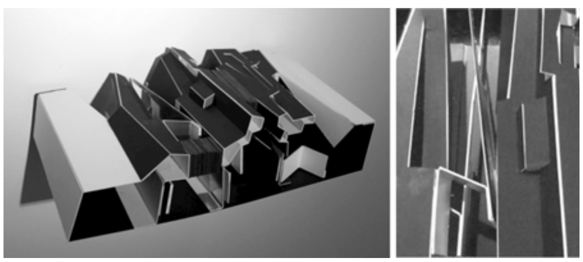


Fig. 10. final 'formation machine'

Conclusion

Pre-tectonic design exercises rely on an analytical basis for successful material diagrams: understandings of specific relationships (identified through iterative drawings, Grasshopper manipulations, etc.), a material and manipulation technique initiating a transformative design intervention (3D transformations with inherent material qualities and responsiveness), an abstract understanding of its typological potential (through manipulation techniques and organizational principles), and a focus on the spatial and organizational conditions produced (recognizing, filtering, and heightening difference).

The pre-tectonic method promotes establishing performance-based models and drawings as an integral part of the design process. It necessitates abstracted explorations that control and visualize a cause-and-effect between material manipulation and spatial effect. Productive use of this method is seen in practice, ranging from short-hand schematics within a thematic spatial oeuvre to models analogous of urban behavior. Citing theory and practice, a pre-tectonic method can be taught as a viable way to explore and emphasize architectural performance, or what form does.

Figures

Figures 1, 2 : Christopher Falliers, Urban Formation Machines research project

Figures 3, 4 : Ling Hu, MArch Studio 0, 2011

Figures 5, 6, 7 : Mallory Van Ness, MArch Studio 0, 2012

Figures 8, 9, 10 : Maryam Nassajian, Formations of Urban Space Studio, 2013

Figures 11, 12 : Frances Reid, Formations of Urban Space Studio, 2013.

Notes

[1] Manuel DeLanda. "Deleuze and the Use of the Genetic Algorithm in Architecture," *Architectural Design* 71, no. 7 (2002): 9-12.

[2] Jesse Reiser, Nanako Umemoto. *Atlas of Novel Tectonics*. (New York, Princeton Architectural Press, 2006), 68.

[3] Hadid, Zaha, and Todd Gannon. *Zaha Hadid: Bmw Central Building, Leipzig, Germany* (New York: Princeton Architectural Press, 2006), 43.

[4] Burry, Mark. *Scripting Cultures: Architectural Design and Programming* (Chichester, UK: Wiley, 201),167.

[5] Burry, *Scripting Cultures*, 167.

[6] Zumthor, Peter. *Peter Zumthor =: Pītā Zuntō* (Tokyo, Japan: A+u Pub. Co, 1998), 138.

[7] Zumthor, *Zumthor*, 138.

[8] Zumthor, *Zumthor*, 141.

[9] Schumacher, Patrik. "Parametricism - A New Global Style for Architecture and Urban Design." *AD Architectural Design - Digital Cities*, Vol 79, No 4, July/August 2009 (London: St. Martin's Press, 2009), 18

[10] Schumacher, *Parametricism*, 19.

[11] Steinmuller, Antje. "Operative Translations" (paper presented at the ACSA International Conference, Barcelona, Spain, June 20-22, 2012).

The Fate of the Albertian Paradigm:
A Pedagogy of Architectural Visualization in Digital Media

Thomas Forget and Nicholas Senske

University of North Carolina at Charlotte

Questions Concerning a Paradigm Shift

Architecture culture is currently embroiled in an awkward transitional phase between established traditions and emerging potentials. While the Modern paradigm of design and fabrication codified by Brunelleschi and Alberti in the early Renaissance still regulates contemporary practice and education, new digital processes are raising questions concerning the extent to which the trajectory of Modernity has finally run its course. Patrik Schumacher, for example, has attempted to codify "Parametricism" as a new paradigm that resolves the transitional confusion of late Modernity and signals the onset of a new aesthetic consciousness;[1] however, both the logic of his argument and the nature of the work that he espouses demonstrate the persistence of Modern thinking. Like the paintings of Giotto, Duccio, and Lorenzetti in the late-medieval era, experiments in digital architecture today are propelling us toward a new aesthetic paradigm, but their significance cannot be compared to that of the work of Brunelleschi and Alberti. The false equivalency in this analogy between late-medieval painters and early-digital architects is intentional. The revolutionary architecture of the early Modern era is rooted in a transformative notion of visualization, and we contend that the next revolution in architecture will be indebted to radical new modes of digital visualization. The current transitional era will unfold over generations, and we seek to interpret it.

This paper summarizes the premises and methods of an evolving digital pedagogy that attempts to raise questions and refuses to stipulate answers regarding the role of visualization in digital design methodologies. Our modest objective is to contextualize recent trends and inevitable developments in digital design within a historical trajectory of visualization that acknowledges the emergence of a paradigm shift and dispels the notion of an imminent revolution. Our pedagogy confronts two primary variables of architectural visualization: graphic manner (i.e., rendering quality) and point of view (i.e., camera position). We integrate tenets of the Modern paradigm of visualization, which privileges analytical drawing over pictorial rendering, into digital practices in order to scrutinize their relevance to and/or dissonance with unfolding trends in digital design.

The pedagogy responds to a disturbing disregard of visualization ethics in the early digital age. Students in particular typically fail to appreciate the profundity of visualization—the ways in which depictions of the built environment during the design process regulate understandings of space and construction. We contend that the spirit, if not the letter, of the Modern paradigm of analytical visualization should be either reinterpreted for digital media or consciously supplanted by a new and natively digital model of visualization. Our current pedagogy argues for reinterpretation instead of replacement, not because we cannot imagine a new paradigm in the future, but rather because we believe that the new paradigm will be somehow rooted in the old one. Without assuming to know the outcome, we commit ourselves to experimentation and, above all, to the development of critical and self-aware design processes that revel in the enigma of architectural visualization.

The Modern Paradigm

Alberti codified the Modern paradigm of architectural visualization in his treatise, *De re Aedificatoria* (*On the Art of Building*), and his argument addresses both aesthetic and practical concerns (design and fabrication). His plea for orthographic drawings and unadorned models, as opposed to linear perspectives, reflects an aesthetic understanding of architecture as a complex system of space, material, and proportion that cannot be understood simply by *looking at* it.[2] The architect's perception is abstract, not literal—a "multi-view" mode of visualization in which each plan, section, elevation, and unadorned model provides a unique but complementary view. Unlike phenomenological visualizations of lay people, multi-view visualizations provide an almost God-like perspective onto a work of architecture (and the theological implications were apparent to Alberti).[3] The phenomenal reception of the final work is paramount, but the process that leads to an architectural phenomenon is rooted in abstraction: a building will *look good* if and only if its architectonic logic *is* good. Architecture embodies underlying qualities that escape the naked eye, and architects must visualize their intentions through analytical lenses.[4]

The conceptualization of a work of architecture, according to the Albertian model, entails multiple rounds of analytical visualization, and the completion of the design process motivates an even higher degree of visual abstraction, a notational system that allows an architect to script the fabrication process through a set of construction documents, so that builders do not stray from his authorial concept.[5] As Mario Carpo explains in *The Alphabet and the Algorithm*, Alberti considered construction documents to be the original work of architecture and the resulting building to be an identical copy of the documentation.[6] In the Modern paradigm, both conceptualization and construction are rooted in the same modes of multi-view analytical visualization, but they are distinct from each other—design and fabrication are separate and incompatible spheres. As a result, architecture becomes a liberal art and surrenders its pre-Modern identity as a craft.

The Information Model

Carpo suggests that digital processes offer architecture culture an opportunity to reclaim that lost identity through a looser notion of authorship that reintegrates design and fabrication.[6] Building Information Modeling (BIM) is the current vehicle of the paradigm shift envisioned by Carpo, and it is likely the technology that will culminate an inevitable revolution. While BIM began as a production tool that simply optimized the Modern paradigm of construction documentation, it is quickly evolving into a comprehensive platform that regulates design, fabrication, assembly, maintenance, and even demolition.[8] BIM's reintegration of conceptualization and construction may result either in a medieval-like balance between concept and craft or in an overcorrection of the Modern paradigm that diminishes, or even eliminates, the traditional sense of a design concept. While that traditional sense may be anachronistic, we seek to uphold the relevance of an aesthetic position on form within the overall apparatus of the built environment, which means inquiring into the ways in which BIM may operate as a tool of design thinking.

The implications of BIM are still evolving, especially in terms of its viability as a conceptualization tool. BIM itself will not dictate the fate of the Modern notion of the author. Whereas Carpo urges architects to embrace a notion of design authorship that adheres both to a pre-Modern notion of architecture as a craft and to a digital notion of systems-design (as opposed to object-design), others may interpret BIM as the ultimate realization of a Modern notion authorship that allows an architect to control the entire process.[9] Regardless, even information models are scrutinized through visualizations, and theories of visualization must be posited in conjunction with theories of conceptualization and authorship. This paper focuses on visualization because it underlies any potential notion of the design process.

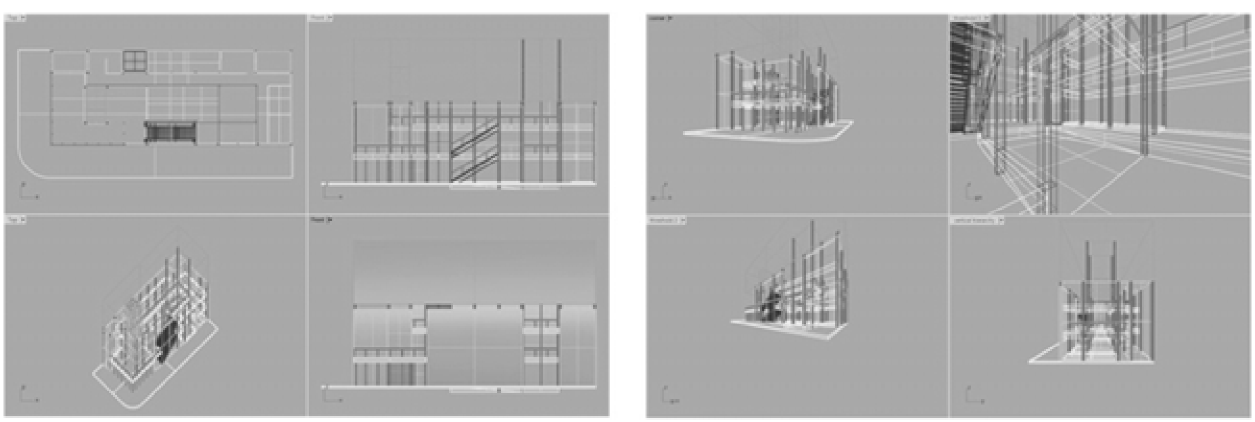


Fig. 1. Left - multi-view orthographic drawings; right - a multi-view perspective setup

Visualization in BIM is infinitely customizable, and it accommodates every canonical mode of architectural visualization from the Modern era: orthographic drawing, perspectival and axonometric projection, and physical modeling. A varying number of viewing windows may occupy a user's screen, and each window may offer a different point of view and rendering style. Furthermore, the parameters of the windows may be changed multiple times during the design process according to the idiosyncrasies of a user. While infinite possibilities may seem to complicate (if not prevent) the establishment of a visualization paradigm for information modeling, all tools accommodate infinite customization, and the variables of analog tools did not prevent the emergence of the Modern paradigm. Visualization at its best is a theoretical construct rooted in graphic technologies, not a rote byproduct beholden to them. Today, theories of BIM-based visualization are far less advanced than those of analog tools. Our pedagogy attempts to discern the potential of BIM-based visualization through a consideration of the extent to which it coincides, overlaps, and/or rejects the Modern paradigm. We scrutinize possibilities for the sake of experimentation, not resolution, and we instill in our students a sense that digital design technologies are vehicles of inquiry, not (only) marketable job skills.

Seeing Models

Most contemporary users of BIM visualize their projects through an unintentional multitude of perspectival, axonometric, and orthographic views. Multiple views, of course, do not necessarily entail a "multi-view" (or analytical) mode of visualization in the Modern sense, and rigor in BIM-based visualization (Modern or otherwise) is largely absent. Views in digital modeling programs are easy to generate and therefore cheap in the economy of process. While the benefits of ease and affordability should not be discounted (the fluidness of freehand sketching, for example, is an undeniably valuable mode of design thinking), architectural inquiry requires more rigorous methods of visualization, and the infinite variables of BIM-based visualization provide plenty of fodder for consideration and debate.

Students, we find, gravitate toward perspectival views that are (at least in principle) antithetical to the Modern paradigm of process. Alberti discourages the use of linear perspective as a tool of architectural inquiry because, as a pictorial mode of visualization, it is deceptive and incompatible with analysis. The perspectival bias of digital modeling, however, may either affirm the validity of that position (if a given designer considers windows to be phenomenal viewpoints that are detached from a work of architecture and unrelated to it), or it may signal a productive evolution of the Modern paradigm (if a given designer considers windows to be analytical viewpoints that are inscribed within a work and resonant with its architectonic logic in ways not imagined by Alberti). Our pedagogy strives for the latter. While we uphold Alberti's ethic of analysis, we find it where he does not, in linear perspective (and potentially in the perspectival windows of BIM).

In his treatise *On Painting*, Alberti instructs readers how to construct a linear perspective through a "visual pyramid" method, which relies on the use of two drawing views, neither of which bear an immediate resemblance to an orthographic drawing view.[10] The logic of plan and section, however, are embedded within the drawing views of his method, as linear perspective and orthographic drawing belong to the same Euclidian-based drawing system. Beyond their obvious differences, each type of drawing is mathematically embedded within each other and may be extracted from each other, and Alberti's concealment of their correspondence may reflect his argument against the use of perspective by architects.[11] Once understood, the reciprocity between linear perspective and orthographic drawing allows for an analytical approach to perspectival drawing that problematizes Alberti's distinction between them—to draw in linear perspective, in a sense, is to draw in plan and section at the same time, and the well established analytical properties of orthographic drawing may be applied to perspective. For example, once liberated from a notion of pictorial immediacy and an affiliation with the human eye, perspectives may include regulating lines and other analytical notations, and their points of view may be integrated into the architectonic and proportional logic of a project. We promote perspectival abstraction through analytical methods of line construction, rendering, and viewpoint that acknowledges but overcomes the limitations of human experience

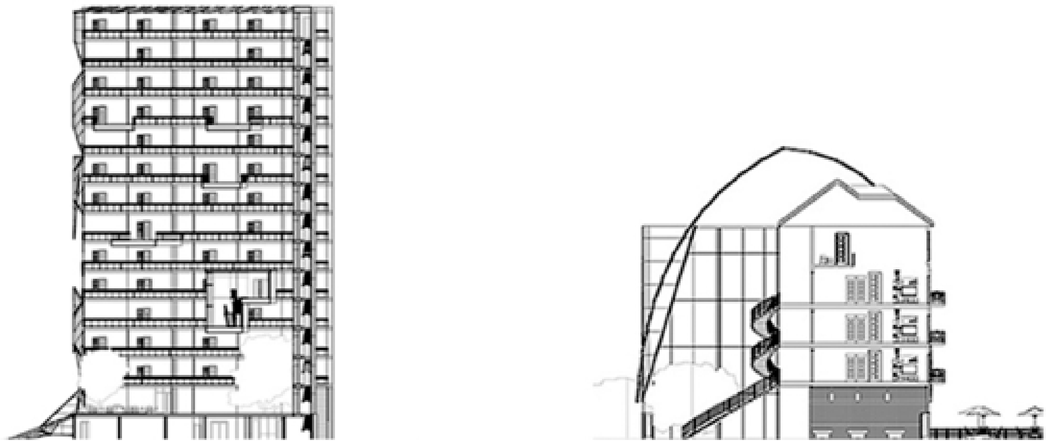


Fig. 2. Two examples of "illiterate" line drawings automatically extracted from BIM models

BIM seems to uphold the Modern paradigm in a more conventional way through its capacity to generate orthographic views *ad infinitum* from a model. The extraction of plans, sections, and elevations from a digital model, however, is profoundly different from (and perhaps even antithetical to) the construction of drawings in a two-dimensional environment (digital or analog). Whereas the construction of drawings relies on a comprehensive literacy in line (an ability to both read and write lines), the automated generation of drawings expects designers to read lines without the capacity to write, or even "speak," them. The extraction of drawings from models, then, may be a "false friend" to Modern design methodologies. Visualizations of digital models contain lines that define the edges of planes and solids, but users do not construct lines *per se*.

While this pseudo-orthographic method will inevitably become less relevant as generations trained under the Modern paradigm retire from practice and pedagogy, the matter of line literacy will remain critical. Architecture will always be geometric, and geometry will always consist of points, lines, planes, and solids. Our pedagogy on visualization is rooted in line literacy because it is the dimension of geometry that is least evident in digital modeling. Whereas points, planes, and solids have relatively clear roles in modeling environments, line is somewhat elusive. A heightened consciousness of line in modeling environments is therefore important to digital analytical visualization, especially as BIM technologies develop more model-centric modes of visualizations.

The fact that BIM is a model-based environment raises a final provocative question regarding the technology's relationship to the Modern paradigm. The analytical use of a digital model may indeed perfectly align with Alberti's promotion of the unadorned physical model as a key component of the design process. Alberti valued process models for their analytical potential, and the architecture culture of the Renaissance includes a rich tradition of large scale modeling in the service of formal and tectonic design investigations.[12] Through its model-based environment, BIM has the same potential. As this brief survey of BIM's relationship to perspective, orthographic drawing, and modeling demonstrate, BIM may or may not be as new as it seems. Its relationship to the Modern paradigm is complex and begs experimentation

Pedagogical Premises

Our pedagogy foregrounds the application of constraints as a means through which to develop analytical sensibilities. To cultivate depth and rigor, each assignment is constructed to present students with a limited set of tools and prescribed moves. In our experience, restrictions produce more creative results. Rather than searching broadly for solutions or novelty, students focus on narrow themes and iterate them. At the same time, rules enable a degree of recklessness that fosters experimentation.

Our pedagogy introduces students to two-dimensional digital drawing (AutoCAD) and three-dimensional digital modeling (Rhino). In each case, students first utilize the software through an analysis exercise, not a design project. The limited scope of their initial investigations foregrounds the biases and strengths of the tools. As opposed to basic operational knowledge of software, which is easy to acquire, our pedagogy motivates a critical use of limited commands, as well as a mode of design thinking that overcomes preconceptions and conventions. Our goal is intentionality and agility, not technical mastery.

Our pedagogy so far engages only “first-generation” 2D and 3D digital visualization tools, as opposed to BIM itself, because, as many have argued, the latter’s ability to operate as a vehicle for conceptual design thinking is questionable.[13] In particular, our emphasis on diagramming, abstraction, and line are incompatible with the current state of the technology. Lines in BIM visualizations are simply "smarter" than the ones in our notion of analytical linear perspective. Whereas lines seen in BIM possess building information, the lines in our drawings may not even represent an actual building component. Furthermore, the representational hierarchies that we promote through weights, types, and colors are meaningless in the context of a database. For the moment, the limitations of AutoCad and Rhino better enable us to study digital modes of visualization related to design thinking. As Renee Cheng writes, "BIM is inherently answer-driven, design thinking is question-driven.[14]" The latter is especially important to foundation design.

Phillip Bernstein of Autodesk posits that the integrated model has already superseded the orthographic drawing as the standard of construction documentation[15]. Because BIM is so comprehensive, he argues, it is "a more interesting pedagogical platform" than conventional drawings and models,[16] Technology, however, may short-circuit critical thinking, as the use of defaults is sometimes misunderstood as true agency. In the future, BIM will undoubtedly be able to accommodate more conceptual forms of visualization. Until then, we find advantages in forms of representation that combine traditional theories of architectural representation with the powerful attributes of digital media. BIM is the inevitable platform on which our students will work, and our pedagogy prepares them to confront it with critical eyes.

Line; Viewpoint; Camera; Line

Our pedagogy is structured as a parabolic trajectory, not a linear progression, of projects. It begins and ends with analytical line drawings. In between, students learn how to construct Albertian linear perspectives in 2D CAD (“by hand,” as it were) and how to manage virtual cameras in 3D modeling programs. The overall objective of the pedagogy is to instill a "consciousness of line" in digital media that both derives from and overcomes the limits of analog line drawing. We seek to interrogate the relevance of theories and methods from old media to new media.

The first exercise focuses on the analysis of precedents through what we call “orthographic diagrams,” which are simple line drawings that distill the logic of a work of architecture while upholding the relative scale and proportion of its components.[17] Students are asked not simply to draw the precedent, but rather to interpret both its built form and its underlying logic (hierarchies, regulating lines, et cetera). Line is the only graphic instrument of the analytical process; tone, textures, and hatching are not allowed. Color is used to “render” lines, but only sparingly. These diagrams establish abstraction as a vehicle of analysis, and the resulting presentations seem both familiar and unusual. They resemble normative line drawing but also challenge the conventions of how and what lines communicate.

The exercise takes advantage of the properties and two-dimensional logic of CAD in order to promote the disciplined construction of digital lines. The precision of CAD, its layering structure, and its ability to produce iteration through copy/paste operations are key features of the exercises. The limitations of the 2D interface program are also beneficial, as students are forced to scrutinize the potential of digital line as an analytical mode of architectural visualization. Their drawings cannot be reduced to digital translations of an analog method. Indeed, they raise critical questions regarding the extent to which analog and digital processes may, should, and should not resonate with each other.

In the second exercise, students construct classical Albertian perspectives through a decidedly non-classical, point-based method that demystifies the reciprocity between orthographic drawing and linear perspective and promotes analytical strategies of visualization. Again, CAD offers unique 2D properties (such as point-based precision and an infinite and infinitely malleable drawing surface) that escape the limits of analog methods. The construction of digital linear perspectives, however, is primarily a means to a greater end: an analytical approach to digital modeling. This exercise demonstrates both the analytical potential of lines in perspective and certain ethics regarding the management of the perspectival camera in a digital modeling program. The analytical potential of the viewing point is paramount, as we seek to dispel the pictorial assumptions commonly associated with the use virtual cameras, such as helicoptering around, walking through, and looking at a digital model. We promote seeing over looking, and the process of translating "data points" (i.e., points that describe a Euclidean object in three dimensions) from orthographic drawings into a linear perspective illuminates the potential of three-dimensional visualizations to engage the logic of analytical drawing. Rather than learning a rote process through which to construct phenomenal imagery, our students learn the meaning of points and lines within a system of spatial information. Students are expected to defend the analytical intention of their visualizations through the architectonic logic of a precedent or project.

To catalyze the analytical intention of the digital linear perspectives, students construct them from orthographic diagrams, not full plans and sections. Students therefore begin the construction of perspectives from an analytical starting point, which means there is less need to "convert" their perspectives into analytical drawings. Additional analysis may be achieved through the rendering of lines during and after the construction process, but the base drawings are analytical in themselves. At the same time, the three-dimensional visualization of diagrams, even through non-literal viewpoints, allows student to understand architectural space more abstractly and even may suggest ways in which diagrammatic ideas may be translated into real spatial phenomena. Final drawings contain both a perspectival drawing and the orthographic roots of its construction; the inclusion of base diagrams and selective perspectival construction lines richen the presentation strategies of the students' work. The layering structure of CAD allows students to hide (but not delete) certain construction lines, so that all lines in the final drawings are included for an intentional reason, not just because they were part of the process. Lines of all kinds fill challenge students to interpret both their phenomenal and

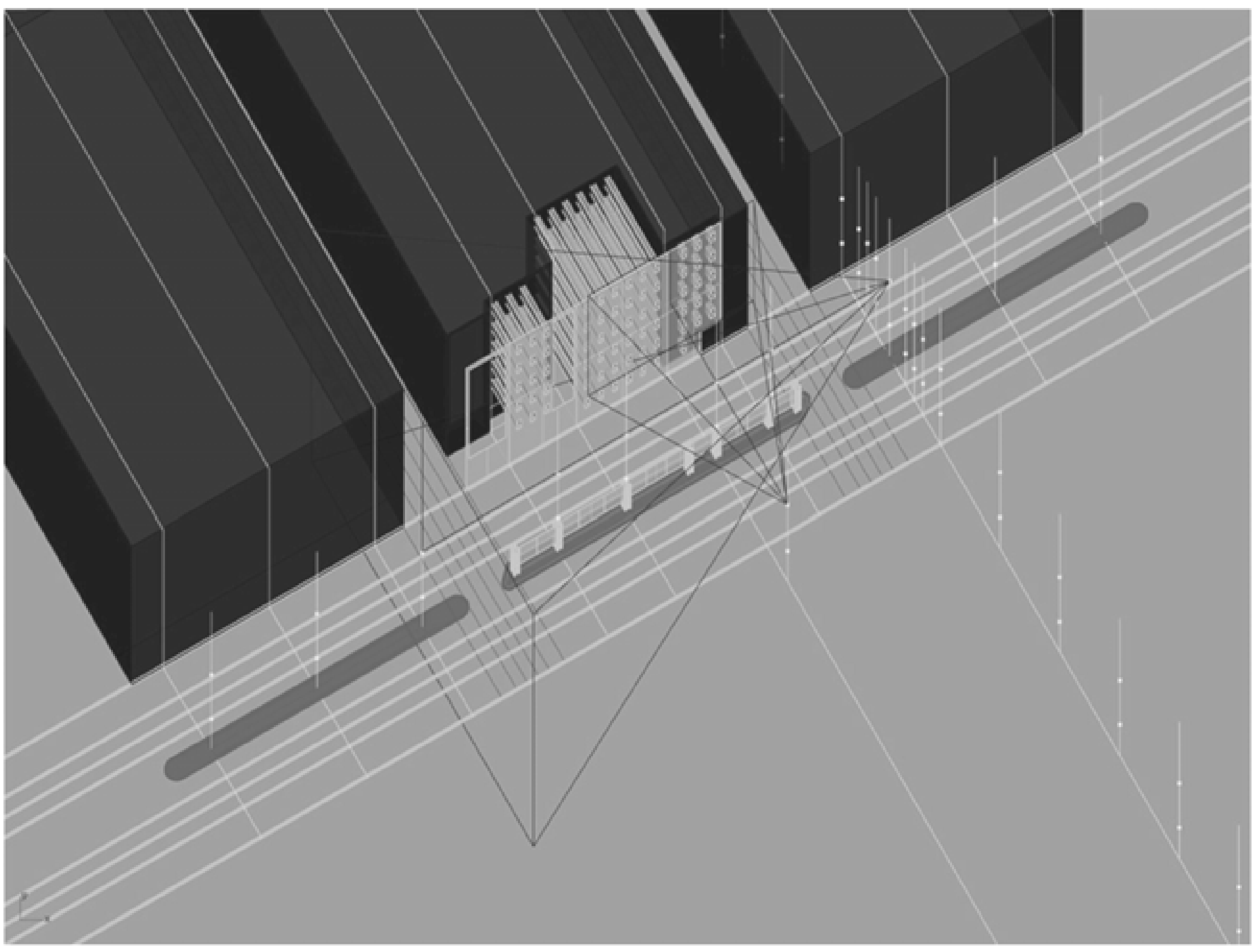


Fig. 3. A student design project with integrated camera (the smaller viewing cone) and extended camera (larger cone)

analytical meaning.

The third exercise of the process asks them to integrate a virtual camera in a digital modeling environment into a given model of a simple three-story building (designed by instructors in the spirit of already studied precedents). The objective of the camera integration is to confront the common misuse (or even abuse) of virtual cameras by digital designers of all ages and levels of experience. During a 3D modeling process, designers typically steer their cameras through the model, so that that they can "look at it" in multiple ways. Such processes treat the model as a detached object, not as a subject of analysis. They also conceal the settings of the camera, like the x,y,z coordinates of the viewpoint, targetpoint, and focal angle of the view, all of which affect the analytical potential of the resulting visualization.

In our pedagogy, the camera is either integrated into or extended from the architecture. In other words, it is a data point, not an eye. In this exercise, students are asked to integrate the camera into the given model in Rhino in multiple ways that test the analytical potential of perspectival views. Previous lessons from the precedent analyses and the construction of linear perspectives are foregrounded through demonstrations of their relevance to how the control of a virtual camera affects the reading of a work of architecture. Rhino, like our method of perspectival construction, is a point-based system of geometry. Students, therefore, are well prepared to forego processes that take advantage of its automated, intuitive tools of visualization (i.e., the mouse-driven, helicopter-mounted camera). Instead, students understand the camera as a strategic set point within the spatial logic of the model, and they learn how to snap that point both to the geometry of the model and to regulating lines that extend through and/or from it. Furthermore, students manipulate the settings of the camera numerically through a text field, not through the use of the mouse, which is used only to study the general location of potential viewpoints. For example, the viewpoint and targetpoint in the digital equivalent of an Albertian frontal perspective share the same X and Z coordinates, and while analytical perspectives do not necessarily need to maintain these control of their divergences from them and to argue their reasoning on grounds of analytical intent. Numeric control over the camera settings in many cases also produces a more deliberate, even contemplative, relationship to the digital interface than the handling of a mouse. We therefore encourage students to think with their hands on the keyboard as they study the engagement between model and camera.

The final exercise returns students to the construction of line drawings. From Rhino, they export their camera views to 2D vector lines, which they then "render" in Adobe Illustrator. As in "manual" linear perspectives, line weight, line type, and color become tools of analytical intent. The result is a mode of digital visualization distinct from typical production renderings. As in the work of LTL Architects, a digital model is a means to an end that involves a patient and methodical multi-media process.[18] With the creation of the final drawings in Illustrator, the project completes its parabolic cycle: from line-based diagram, to perspective, to model, to line-based diagram.

The final step is to integrate this iterative cycle of analytical methods into a design process. Students are asked to establish a series of coordinated, analytical camera views that allow them to scrutinize the progress of their design work in a controlled and strategic manner that is antithetical to their normal practice of helicopter steering through a digital model. The resulting system of numerically-controlled visualizations (four of which are typically viewable at one time) regulates (and limits in a productive manner) their perspective, so to speak, of the formal manipulations that occur during a design process. This collection of perspectival views, in one sense, seems different from a Modern notion of a multiwindow workspace in which plan, section, elevation, and perhaps axonometric views are displayed; however, depending on how one understands linear perspective, it may be more similar to a "multi-view" analytical mentality than it seems. The discipline students learn from our pedagogy allows them to design in perspective with rigor and analytical intent.

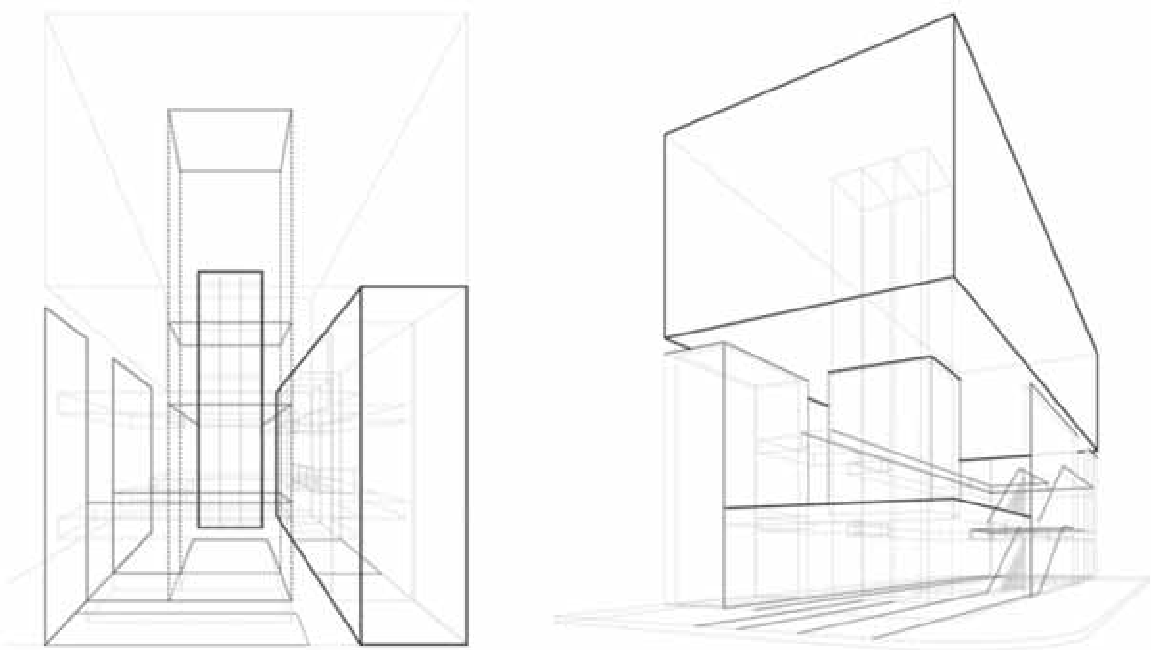


Fig. 4. The final student exercise: lines from the digital camera are reworked into an abstract, analytical composition

The Alberti Code

To return to the primary theme of this paper—the extent to which BIM may challenge the Modern paradigm of architectural visualization—we hope to convey that the technology has multiple capacities. It may replicate the Modern paradigm in both regressive and progressive ways, and it may escape (or at least extend) the known limits of the Modern paradigm. Alberti's notion of the design process helps us to discern the meaning of some of the possibilities and the deep complexity of the questions. For example, two extreme possibilities (the use of multiple orthographic views to uphold traditional standards of visualization and the use of pure digital code to reject graphic visualization altogether) are simultaneously antithetical to each other and perfectly alike with respect to the Albertian model of the design process. Whereas the former fulfills the classic notion of "multi-view" analytical visualization, the latter posits a different but compatible notion of analytical visualization that strips the process of all phenomenal connotations (literal or abstract). Information modeling (like all data) is neither new nor old, and it does not necessitate a revolution in architecture. Instead, it enables architects to forge perhaps multiple revolutions through varying interpretations of its potential, none of which are more valid than any other. We contend that aesthetic and technical discourses should guide the revolution(s), and that modes of visualization should play a significant role in the formation of those discourses.

Notes

[1] Schumacher, Patrik. "Parametricism: A new global style for architecture and urban design." Architectural Design 79.4 (2009): p. 14-23.

[2] Alberti, Leon Battista, *On the Art of Building in Ten Books*, trans. Joseph Rykwert, Neil Leach, Robert Tavernor. Cambridge, MA: MIT Press, 1988. p. 33–35.

[3] Our notion of "analysis" refers to graphic-based critical inquiry, not the interpretation of scientific data.

[4] Aberti's metaphysical agenda is discussed in Carpo, Mario. *The Alphabet and the Algorithm*. MIT Press: Cambridge, MA. 2011. p. 61, 69.

[5] See Alberti, p. 315-319, and Carpo, p. 1-48, and notes.

[6] Carpo, p. 26.

[7] Carpo, p. 44-48.

[8] Eastman, Chuck, et al. *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. New York: John Wiley & Sons, Inc., 2008. p. xi-xiii.

[9] Carpo, p. 48.

[10] One view in Alberti's visual pyramid method recalls the logic but not the conventions of a section.

[11] See Forget, Thomas. *The Construction of Drawings and Movies: Models for Architectural Design and Analysis*. New York: Routledge 2012. p. 121-166. The mathematical understanding of the reciprocity was not commonly understood until the seventeenth century, but multiple methods implicitly reveal it before then.

[12] See Millon, Henry A. *The Renaissance: From Brunelleschi to Michelangelo, The Representation of Architecture*. New York: Rizzoli, 1994.

[13] Coates, P., et al. "The Limitations of BIM in the Architectural Process." in Teng, J.G., et al. *Proceedings of the First International Conference on Sustainable Urbanization* (Icsu 2010): 15-17 December 2010, The Hong Kong Polytechnic University, 2010.

[14] Cheng, Renee. "Questioning the Role of BIM in Architectural Education." 2006. Retrieved January 21, 2014, from http://www.aecbytes.com/viewpoint/2006/issue_26.html.

[15] Deamer, Peggy, and Phillip G. Bernstein. *BIM in Academia*. New Haven: Yale School of Architecture, 2011.

[16] Bernstein, Phillip. "Symposium: Integrated Project Delivery (IPD) & Building Information Modeling (BIM)." University of North Carolina at Charlotte. City Center Building, Charlotte, NC. 5 February 2013. Panel discussion.

[17] See Forget. p. 206-213.

[18] Lewis, Paul, Marc Tsurumaki, and David J. Lewis. *Lewis. Tsurumaki. Lewis: Opportunistic Architecture*. New York: Princeton Architectural Press, 2008. p. 176-177.

Multiple Benefits of Teaching Second-Year Design with Cargo Containers

Craig Griffen

Philadelphia University

Architects and architecture students alike have been experimenting with cargo containers in their design projects for years because the properties of these modular units make them attractive as spatial building blocks. But container architecture has its advantages and disadvantages. Benefits include the use of a structurally strong, greatly available product that is modular, can be prefabricated, is easy to transport and is easy to assemble. Disadvantages include a product that needs to be well insulated against the climate, needs a crane for assembly and may have toxic finishes that need removal. Another major detraction to the use of containers is the limiting spatial possibilities due to their compact size. With each container under 8 feet in both the width and height dimensions, space can be cramped and confining. Care must be taken when requiring the use of containers that the students don't blindly stack them into 'filing cabinets' of buildings better suited for their intended storage purposes instead of human habitation. Even with these restrictions I have found them to be especially effective learning tools in our second year housing design studios to demonstrate first-hand many important topics of architecture in general, and row house design in particular.

Fig. 1 – Collage by author of "Filing Cabinet" approach to container design

Listed below are 8 topics of architectural design that are easy to convey through the use of containers as well as the descriptions of material modeling techniques I use to achieve this purpose.

Negative/Service Space

As mentioned above, a major disadvantage of cargo container architecture is the limit to spatial possibilities. Stacking them directly adjacent to each other creates compartmentalized, restricted spaces that modern architecture, through the use of the steel frame, broke away from a century ago. So that students do not fall into that routine, I teach how containers can be used as negative space to define positive space; or as Louis Kahn might say, how *service* spaces support *served* spaces as in the Richards Medical Research building.

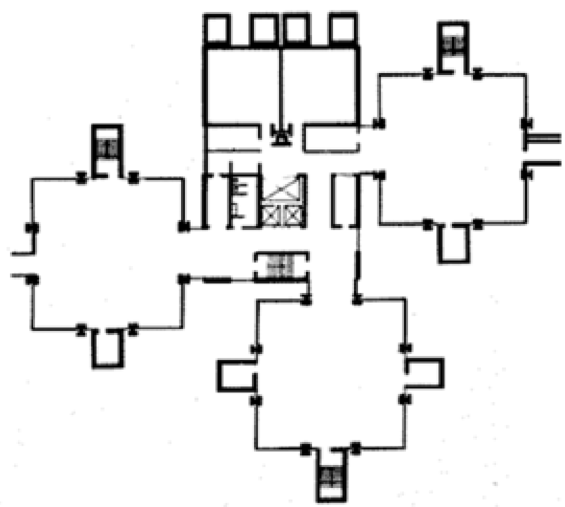


Fig. 2 Plan of Richards Medical Research Building by Louis Kahn

To achieve this we establish programmatic requirements for the housing project that allow only smaller scale functions, that are best suited for the tight dimensions, to be assigned to containers. Therefore rooms such as bathrooms, closets, laundry, mechanical, circulation, storage and small bedrooms are encouraged to be located in containers. Medium scale functions such as kitchen, master bedroom and office may be used in open-sided or combined containers. But the main spaces for living and dining are not allowed to be located in containers at all and must have "double-height" ceilings. This use of containers as boundaries for larger 'served' spaces teaches hierarchy of functions and degrees of separation of public and private. It also encourages students to create a spatial richness not typically found in the traditional row house with their even-height floors stacked like pancakes.

Immediacy in Modeling

Students are often hesitant about building physical models until they have sufficiently developed their idea in drawing form. Traditional chipboard models can be time-consuming to construct so students delay starting one until they feel it is worth the effort. But designing only in drawing form only limits their understanding of the 3 dimensional space and first semester second–year students usually do not yet have the required skills or access to digital methods of reproduction. Even when they build study models, the time required to modify them inhibits making major changes to the design and that, in effect, limits iterations.

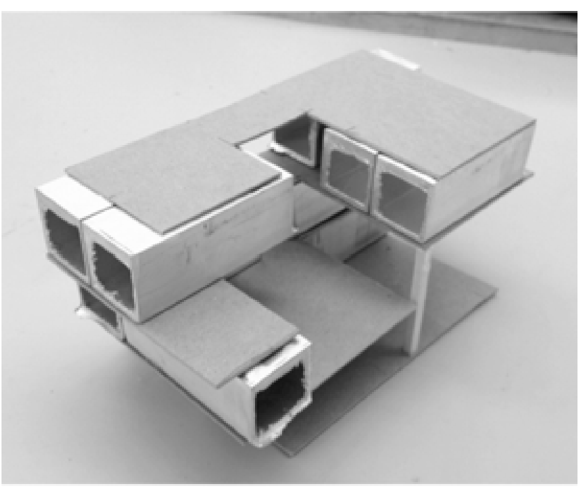


Fig. 3 - Aluminum Tube Study Model by Jennifer McElroy

The use of cargo containers creates a common building block that can be stacked and re-stacked like Lego blocks to test multiple iterations of an idea quickly to show three dimensional space. Therefore I require the students to make scale models of the containers out of 1" square aluminum tubes at a scale of 1/8" = 1'-0" that can be quickly taped or hot glued together with floor and roof planes to make spatial models. Using hollow tubes instead of a solid material like wood blocks gives a much better representation of the spatial conditions inside the containers as well as the spaces in between; something that is not achievable by chipboard massing models that show only the exterior envelope.

Materiality

Our school still strongly believes in the importance of physical models, rather than only digital models, as design tools to understand issues of space, materiality, structure and joining. This is especially the case for second year students who have under-developed computer design skills and are not accustomed to visualizing three-dimensional space from orthographic plans. Often chipboard is the sole, homogenous material used to construct models but chipboard can be very misleading as a representative of the diversity of different materials involved in building construction. For example, while it is very easy to glue together two pieces of cardboard, that same connection in actual construction would be much more complex if not impossible. By using metal tubes to represent the containers, students are even more aware that buildings are constructed of a range of materials. Since they are not able to glue chipboard directly to the aluminum, they must devise other means of connection that (hopefully) more closely mimic actual construction methods.

Structure

Second year students are only beginning to understand buildings as load bearing structures that need to bring their forces down to the ground. Since they have only rudimentary concepts of structural performance, gravity sometimes seems optional to them. The use of containers as load-bearing *wide walls* or occupiable columns allows us to introduce both the concepts of gravity and lateral loading into a design project.

Unlike massing models, we can push on these to demonstrate deflection to determine where additional support is required. Since each container weighs 3 tons empty, we discuss the efficiency of stacking them along their lines of resistance on their sides as an efficient way of loading. As long as they bear along the sides (with possible minor additional bracing) and not on the weak tops of the containers, there are many combinations for stacking beyond just directly above one another. They may slide in and out to form cantilevers but if they go too far, will require a structural column.

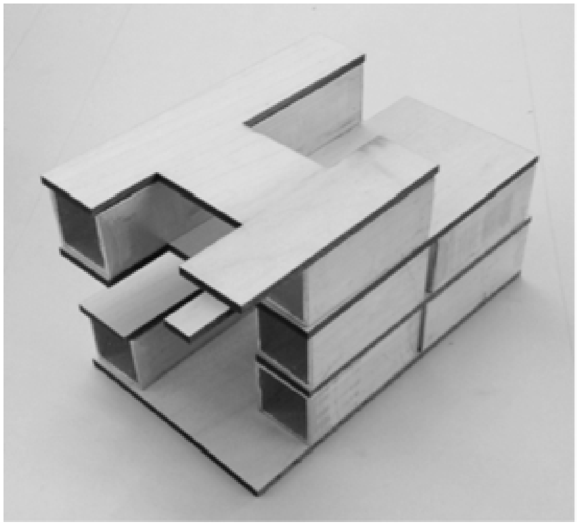


Fig. 4 - Aluminum Tube Study Model by Clarissa Kelly

Containers that do not sit above another at all may be acceptable but the significant expense for the additional structural framing required is taken into consideration in the decision. Since the metal side walls of each container act as built-in shear walls, we discuss how they can be used to resist lateral loads. When a student proposes removing a wall or 2 to open up the space, we first discuss how it will affect the containers above in its role as a lateral brace to decide if it would be prudent to remove it.

Modularity

To some instructors, teaching building design with modular, repetitive units may feel too restrictive to the student's creativity but I argue the beginning of second year design is just the right time to apply a set of defined rules; falling under the concept of learning to crawl before learning to walk. Using a kit of parts is something architects must deal with on over 99% of projects and it is convenient that the 8-foot module of the container width and height matches the same industry standard for many building materials. Most students are familiar with modular building as many developed their interest in architecture by playing with Legos blocks where a limited set of shapes, sizes and colors can lead to unlimited designs. We in fact discuss how limits in architecture do not necessarily hinder imagination but rather help provide inspiration for the design. The repetitive 8' x 20' dimensions of the container footprint provide the opportunity to discuss how a modular grid can help instill a sense of order to the design.

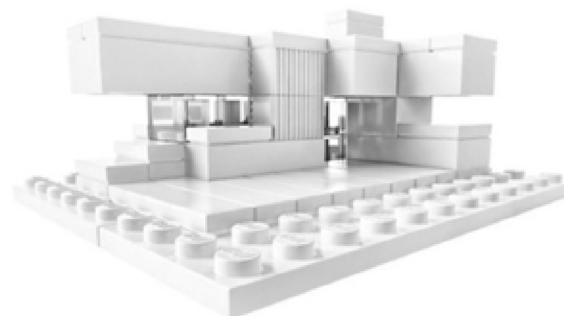


Fig. 5 – Lego Building Blocks

Units can be lined side-by-side, turned perpendicular to each other or left out entirely in a numbers of combinations that can change as the stories are built up. Another game that serves as a metaphor is the stacking game called Jenga in which similar sized blocks slide in and out to create different spatial conditions. The modular proportions of the rectangular cargo container are conveniently very similar to those of a typical row house; long and thin with open ends and solid side walls. They also share common traits of stacking tightly together in a dense orthogonal urban environment so we found the

Fig. 6 – Jenga Game

shape works well with the existing urban housing design patterns of the city.

Prefabrication

With the rise of prefabricated construction, the use of cargo containers is a good opportunity to discuss the benefits and limitations of this increasingly popular method of construction. The most obvious advantage is their inherent property of being set into place by crane. We discuss how ‘time is money’ during construction so the more containers they use, the quicker the building will be constructed and costs will be reduced. Conversely they are made aware that any large spaces between containers will require infill with custom on-site construction that slows down the schedule and increases the budget. We also talk about the convenience of how some functions that fit well into the tight containers such as bathroom, mechanical and kitchens, are also those that require the most plumbing and electrical systems. So these containers can serve as service cores that can have their utilities installed in a controlled factory setting prior to arrival.

Fig. 7 – Stacking Containers by Crane

Human Comfort

The course that teaches how climatic and environmental factors affect building design is not taken until the following semester, so students have little knowledge of how these issues, especially thermal and solar, affect our buildings envelopes. Cargo containers serve as a teaching opportunity since they are simply large metal boxes designed for shipping goods that need to be converted for human habitation. Because steel conducts heat so efficiently we discuss how unsuitable the boxes are for living and will need to be conditioned. In particular we talk about which walls (exterior and roof vs. internal) will need to be insulated against both winter and summer weather conditions. This requires consideration of how much space the insulation may take away from the interior area if it is located on the inside of the steel wall. The thinness of the container roof also allows little space for utilities. So we can discuss why the floor slab they initially drew at 4” thick is insufficient to contain the myriad number of ducts, cables, pipes and beams that must fit into a much deeper space. Basic strategies to address this are considered, such as vertical chases and the use of a deep plenum above high ceiling spaces where there is enough room for ductwork. While rudimentary, this is their first real understanding of the space planning required for mechanical systems and its application to a design.

Economics

Upper level architecture students lightly touch upon construction budgets as part of design projects, but for beginnings students it is rarely mentioned. The extremely large surplus of containers in the US provides an opportunity to discuss the sustainable and economic benefits of product reuse. With tens of thousands of units slowly rusting in storage yards because they are not economical to ship back overseas empty, we demonstrate the value of reusing “waste” products over the costs involved with recycling.

Fig. 8 – Surplus Containers in Storage Yard

Using a product close to its original form eliminates the large costs and amounts of wasted energy to melt them down for recycling into other forms of building materials. The abundance of containers available at a relatively low price, sometimes as low as a thousand dollars, would lead one to believe they are a clear, economic solution to building construction costs. However the degree to which they need alterations to become habitable greatly cuts into the profitability. This provides a good first lesson of the magnitude of labor costs in construction budgets to explain why the more a container is altered; the more the increased labor costs will affect the overall budget. Paying workers to remove toxic paint finishes and insecticide laden wood floors decreases the cost effectiveness of using the containers in the first place, so any additional labor is only going to cut further into the budget. So when a student proposes multiple cuts into the box to install windows or remove a wall, we stress the prudent economics of using the containers "as is", with windows at the easily removed door end, as much as possible. As few real-world projects have unlimited budgets, demonstrating that quality design can still be achieved on a limited budget is a good lesson to establish early.

Conclusion

While cargo containers work well for limited types of building functions, I do not think their use in architecture will ever be a major solution to issues of the built environment. So I am not under the delusion we are teaching them about a critical new construction system they will necessarily use in the field. However, the use of cargo containers as a teaching tool has a surprising number of synergistic benefits. From understanding materiality and space by creating quick and easy study models, to introducing them to basic overlaps of technology systems and design, the advantages as an instructional technique to encourage second year students to (ironically) think out of the box are, in my view, very evident.

Embracing Imperfections:

Bridging Digital Tools with Physical Reality

Lee-Su Huang

University of Florida School of Architecture

But, as nothing in "real" reality is exact, and as the software is fully exact, we also had to define small gaps to account for "errors" in the production and assembly...
- Bernard Cache, *Towards a Fully Associative Architecture*[1]

Imperfections in materials and processes are inherent to the nature of building. The master craftsman brings with him the ability to pre-empt, adjust, and accommodate for imperfections, honed through countless hours of practice. Increasingly widespread access to digital fabrication tools such as laser cutters and CNC mills provide the opportunity for students to engage in the direct process of fabricating and prototyping, confronting the literal translation of the digital line into reality. As argued by Kolarevic, "craft is no longer entrusted to the realm of production, which was its operative domain historically; it is manifest everywhere - in the definition of geometry and its manipulation, the engagement of the material and its production process..."[2] As authorship over material and process become ever more complete, so too are the flaws and mistakes. While the profession embraces these "precise" methods of production and design, how do we prepare students to design for imperfections in the physical world with perfect digital models? When does physical reality begin to inform and supersede the digital construct? Can we structure a course to embrace material and process imperfections, imparting students with the ability to become the master craftsman?

We attempt to answer these questions through the formulation of a design+build digital fabrication independent study course primarily focusing on CNC milling techniques with a short but intense 3-4 week production time frame. Aptly titled "Fabricated Realities", students engage in the process of translating their digital constructs into physical constructs, culminating in a series of full-scale installations or furniture objects. Two iterations of the course have been offered, with conceptually opposite approaches.

First Iteration

The first iteration of the course was more exploratory in nature, and students were allowed to formulate their own proposals for installations. A preliminary research phase was initiated with a series of relevant readings introducing students to the fabrication processes and issues involved. Additional research was carried out regarding precedents of installations and constructs engaging the direct linkage of drawing to fabrication. Workshops were given to familiarize students with the workflow, as well as the constraints and limitations of 3-axis CNC milling in regards to geometry, materials, and dimensional constraints. Indeed, the fundamental precept of the class at this stage could be summarized by the following statement from Stephen Kieran and James Timberlake's book *Refabricating Architecture*: "Lacking at the start of the twentieth century was the information needed to effect real change in the way we build. Tools to represent and transfer information instantly and completely are with us today. They allow connections among research, design, depiction, and making that have not existed since specialization began during the Renaissance."[3] This was bound by the instructor's optimism and confidence in the precision of the technology. Student project proposals were developed solely in the digital realm, with all discussion and critique of the design assemblies carried out in the virtual realm. The issue of tolerances was addressed within the digital models which were moved directly into final fabrication with virtually no physical prototyping. While a series of 8 projects resulted out of this process, the following are of particular interest.

Hex Shelf

Fig. 1. Hex Shelf detail (photograph by author)

Conceived of as a series of distorted hexagonal cells made of layered profiles to form a shelving system, by breaking the constituent geometries to its most granular level this project pushes the limits of material efficiency with an extremely dense milling layout. Essentially consisting of two types of components, linear profiles and a tri-directional connection node fixed mechanically with long bolts, the components are stacked in an alternating configuration to create the depth of the hexagonal cells. In particular this project had no tolerances built into the digital model, with the linear profiles joining seamlessly with unique end profile angles dependent on the cellular configuration. In reality the tolerances ended up being too tight, and the end profiles required sanding off roughly 1/32” thickness for the fastening bolts to thread properly through the multiple layers (Fig. 1). Since the sanding process was manual and the thickness removed could only be judged somewhat intuitively, this resulted in looser joints than anticipated. The interesting unplanned side effect is that the looseness created the possibility for a limited range of movement and configurability that was completely unanticipated.

Counterpoint: Line / Surface (CPLS)

Fig. 2. CPLS (photograph by author)

CPLS is a mobile screen/stage backdrop that dynamically catches light and shadow for musical performances, designed to be deployed for performances then packed for transportation in minutes. Designed parametrically from the ground up with Grasshopper, the project consists of several curvilinear profile stands that form the depth basis for two intersecting surfaces. One surface is delineated through a series of differentially distributed lines substantiated as thin tensioned cords, while the second is a series of surfaces manifested with flexible 5mm white polystyrene (Fig. 2). A dynamic lighting system connected to the performing band's audio synthesizer projects colored and varied lighting effects onto the cords and surfaces, in synchronization to the music. This project actually sidesteps the main issue of tolerance since the connecting geometries are all flexible materials; however the gap between digital and physical reality comes from the inability to tension the cords taut enough to get the desired effect of geometrically precise ruled surface lines.

1186 Bench

Fig. 3. 1186 Bench detail (photograph by author)

Intended as a more permanent furniture installation, this project incorporates multiple programmatic elements of standard seating, relaxed lounge seating, and a napping cove leading to the integrated "loop" form of the bench (Fig. 4). Beginning with a simple surface model in Rhino to test out ergonomics, proportions, and material dimensions, this control surface eventually developed into the generating geometry for all subsequent final model elements. As a more intricate assembly with a multitude of parts, the digital model served not only as a verification process for the assembly of parts, but also helped plan the assembly sequence (Fig. 5). Minimal finishing work was required as careful planning accounted for the positioning of all mechanical fasteners and pre-drilling holes to assist in the alignment and assembly sequence.

Fig. 4. 1186 Bench (photograph by author)

The overall assembly relies on distributed bolts to provide tension and compression that allows the 4 foot cantilever (Fig. 3). Randomized spacers keep the bench in form while a tensioned cable in the seating area supplies ample tension for added structural support. The entire design to fabrication process spanned only two weeks. No small-scale physical models were produced beforehand; prototyping of the tolerances and fitting of elements was carried out 5 minutes prior to final fabrication. This proved to be problematic during final assembly, as the small section prototyped was not representative of some of the larger systemic tolerance issues that would manifest in the assembly process. What was initially estimated to be a 1.5 day assembly process ended up taking almost 5 days due to these tolerance issues and implementing the field modifications required to resolve them.

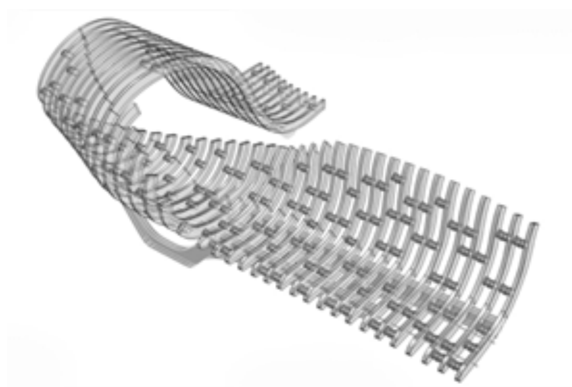


Fig. 5. 1186 Bench component diagram (Image courtesy of author)

For example, the pre-drilled holes for bolts were calibrated very precisely to the bolt diameters, but did not account for manufacturing tolerances in the bolts themselves. In the end roughly 15% of the bolts were too large in diameter to fit and had to be rejected. While some tolerance was built into the slots of the longitudinal support rib that holds the curved sectional profiles of the seating, we ended up vastly underestimating the amount of accumulated "creep" that would occur across the assembly due to minute variances in material thickness and torquing of the bolts. The initial assumed assembly sequence of starting on one end also proved to be problematic; the profiles started torquing unpredictably due to accumulated tension points in the uneven fastening bolt patterns. It was soon discovered the correct sequence was to assemble loosely all the profile sections, then with the longitudinal support ribs in place gradually and evenly tighten the connector bolts. The process of working through these issues, understanding the reasons, and finding a way to resolve them was an invaluable experience for all involved, especially in pre-empting tolerance issues or even avoiding them outright by modifying the design to be less reliant on the specific dimensional precision of assembly components.

Slakate

Fig. 6. Slakate process (Image courtesy of Mary Carver)

This is a project that sought to use the CNC as part of a larger process and not the end result. A digital model was used to create an inverse mold, constructed with a layered logic to intentionally create striation in the end product. Intentionally using low-grade plywood of varying thickness, a series of CNC cut profiles were assembled to create three inverse molds that were poured with concrete and given time to cure. They were then doused with kerosene and fired in a fire pit for 6 hours to extract the individual concrete blocks, which were designed to interlock as a whole (Fig. 6). This is an example where the project engages the unpredictability of both the process and the material, embracing and incorporating its imperfect nature as part of the design intention. Here the digital process takes a secondary role in the fabrication process as more of a design and planning tool rather than manifesting itself in the finished result. The resultant charring and cracking of the concrete due to the firing process is a calculated design intention to imbue materiality and process (Fig. 7), much like the fired concrete interior of Peter Zumthor's Bruder Klaus Field Chapel in Mechernich, Germany.

Fig. 7. Slakate detail (photograph courtesy of author)

Second Iteration

Drawing from the experiences of the previous year, in the second iteration of the course extensive material tests and physical prototyping was carried out early in the design process. A smaller but more focused group of four students were involved in a more directed research trajectory that focused specifically on the bending behavior of thin-sheet plywood and the potential resultant geometries. Two students were tasked with materials research and full-scale testing of material properties and fabrication methodology, while the other two developed the larger geometrical framework based on the assumed material properties. A website was created to share and document any materials research and tests, cultivating a continuous developmental environment. Partially owing to the more ambitious geometries and unpredictable nature of the material, it was soon discovered that this "digital" project was extremely difficult to model and simulate accurately in the virtual realm, leading to the construction of scaled physical models in paper that were surprisingly accurate representations of the final construct's bending and joining behaviors. Ultimately the feedback from the physical models guided the modification of the virtual models and the final fabrication drawings.

Chrom[A]-some[X]

Fig. 8. Chrom[A]-some[X] Installation horizontal configuration (photograph courtesy of author)

Fabricated and assembled over the course of 3 days, Chrom[A]-some[X] is an installation that investigates aggregated unit geometries and the material properties of 3/16" white birch plywood and its bending characteristics when soaked in water for several hours (Fig. 8). As part of the initial research process, different techniques of bending plywood with heat and/or moisture were explored: oven, microwave, heat gun, dryer, clothes iron, boiling water, and finally soaking. Various types and grades of wood were tested as well: plywood, basswood, bendy plywood, etc... Specific experiments into different types of joining and fixing the geometry were carried out; two main joint types, the slot joint and the puzzle joint, were developed as tectonic material joining strategies that utilized the characteristics of the wood and CNC cut geometry (Fig. 9). The zip-ties that were part of the initial bending and setting process were incorporated into the overall system.

Fig. 9. Chrom[A]-some[X] joinery detail (photograph courtesy of author)

Unit geometries were explored that allowed for assembly and aggregation, working with the constraints of sheet size and fast CNC milling. The average unit took 5-7 minutes each to fabricate on the CNC mill, including slots, joints, and holes for tension strings. They were then soaked and bent temporarily using zip-ties, and left overnight to dry. After drying the units were treated with varnish for waterproofing, then tensioned to final geometry with the zip-ties and string, eventually being assembled in sections that were joined into the final installation.

As a process, this investigation into materials taught the students a lot about machining, engineering, and designing for tolerances and material variance, especially with a natural material such as wood and unpredictability in a procedure that is inherently imprecise such as water/heat bending of wood. Finding relative precision points that allowed for dimensional stability was the key to creating stable and accurate geometries, as well as staying consistent in the setup of files and cutting direction relative to material grain. While the manufacturing process was very precise and digital, the prototyping and planning process relied heavily on physical and material studies to help validate and test joints, geometries, and tolerances (Fig. 10).

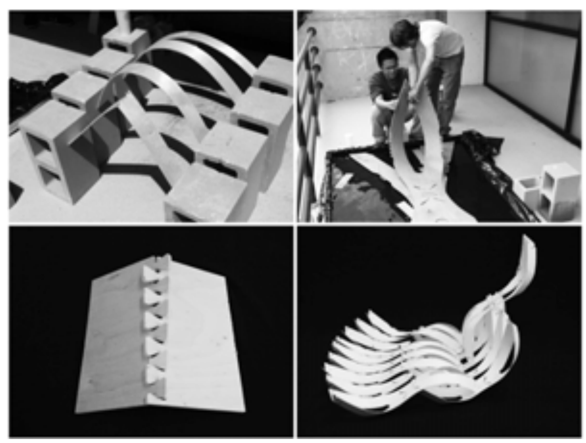


Fig. 10. Material and physical prototypes (photograph courtesy of author)

Comparison and Observations

The first iteration of the course was predominantly concerned with speculation regarding the possibilities that the CNC technology offered, evident in the varied approaches adopted by the students. While in specific situations and in more localized conditions the precision of the digital to physical fabrication process can be relied on to a certain extent, it is shown that complex and dimensionally interdependent assemblies require increased allocation for material irregularities and tolerances. While dealing with the issues that surfaced was a valuable learning experience in and of itself, a relatively small amount of physical prototyping earlier in the process could have potentially avoided some of the more predictable problems.

Fig. 11. Chrom[A]-some[X] Installation vertical configuration (photograph courtesy of author)

The second iteration was much more focused in terms of having a cohesive research trajectory early on, which in turn allowed time to engage in material testing and physical prototyping at a much earlier stage. This helped students understand the material characteristics absent in the digital model, and identifying the unknown parameters that needed to be resolved. Strategically the relevant issues were much more easily isolated and researched, each piece of the puzzle adding to a progressively complete understanding of the big picture. For example, the issues of joinery were initially explored in relative isolation, both digitally and physically and across a variety of different materials and scales. Understanding the bending behavior of the plywood required both materials testing in full scale and in a substitute material at smaller scale. Finding and sourcing the specific type of plywood conducive to the type of water bending applied was a research process in its own right, down to the supplier and direction of grain. Compartmentalizing these questions and slowly but gradually answering them through research and prototyping gave the students the confidence that the overall construct was a solvable problem (Fig. 11).

In the same way we encourage the testing of architectural projects and ideas through the production of drawings and models in the studio environment, the issues of materiality and tolerances are best learned through experience and engaging with the processes in a hands-on manner.

Pedagogically structuring the course to engage the material properties and produce physical prototypes early on proved to be the most beneficial. Isolating unknown issues into a series of simpler, shorter, and answerable questions as part of a longer, more pervasive inquiry helps students attack problems incrementally while avoiding the paralysis that often occurs when simultaneously faced with multiple unknown parameters. From an educational standpoint, ultimately the core advantage that digital fabrication technologies offers is not the precision but the ability to swiftly iterate, test, and verify with a certain guarantee of replicability. This empowers students to prototype and develop projects with a vastly expedient design-to-realization feedback loop, enabling the accumulation of necessary experience to deal with the issues of indeterminacy and tolerance, bridging the gap between digital and physical realities.

Notes

[1] Cache, Bernard. "Towards a Fully Associative Architecture" in *Architecture in the Digital Age: Design and Manufacturing,* Ed. Kolarevic, Branko. Taylor & Francis: New York, NY. 2003. p 144.

[2] Kolarevic, Branko. *Manufacturing Material Effects: Rethinking Design and making in Architecture* Routledge: New York, NY. 2008. p 120.

[3] Kieran, Stephen and Timberlake, James. *Refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction* McGraw-Hill: New York, NY. 2003. p 23.

Pedagogical Synergies:
Integrating Digital into Design

Lee-Su Huang

University of Florida School of Architecture

Introduction

Architects tend to draw what they can build, and build what they can draw.[1]
- William J. Mitchell

The topic of how to introduce digital representation techniques and programs into the beginning design curriculum is an ongoing and evolving debate. Arguments can be made for compartmentalizing both analog and digital representation courses, thus freeing them from the constraints of the studio curriculum and affording greater freedom towards the exploration of the respective mediums. However, as the primary means of architectural exploration, these skills also benefit greatly from being contextualized within the design studio, such that the gradual mastery of technique while embedded within the design process leads to generative design thinking which utilizes drawings as architectural process and not mere representation.

The pedagogical integration of these courses will be examined using one recurring studio project and the corresponding "Introduction to Digital Architecture" course situated in the second year of the design curriculum. The "Door Window Stair" project is a 7-week project occupying the first half of the semester, which runs parallel with the introduction of digital representational techniques as a support course. This is essentially an intense crash course on all the primary digital concepts and techniques an architecture student is required to learn in order to succeed as a beginning designer. As a "jack of all trades, master of none" survey course of digital techniques, the intent is to cultivate a comprehensive conceptual understanding of digital workflows that is embedded within the design thinking process, while providing students with the basic tools of the trade and adaptability to new tools in the future.

Skills-based vs Objective-based

As a course that requires considerable time and effort commitment throughout the semester, the only feasible method to deliver the course hinges on actively seeking out synergies with the studio design curriculum, constructing very precisely targeted assignments that align with studio explorations. Thus a balanced mixture of skills-based tutorials and objective-based or project-based assignments begin to form the structure of the course. The skills-based tutorials provide a broader foundational overview of the software in question, and attempts to also impart a conceptual understanding of the software's operational logics. The objective-based assignments then allow the students to apply some of these skills towards their studio work, while emphasizing specific workflows that have proven to be successful representational techniques or generative towards developing their designs.

Over time, the course has gradually evolved and incorporated an increasing percentage of project-based assignments into the curriculum. The obvious advantage of having shared learning outcomes is the additional time gained to critique and refine the drawings from the different viewpoints of technique and design communication versus design intent. Additionally, changes have been made to the programs and workflows taught to better suit the design studio brief. For example, originally FormZ was taught as the main 3D modeling program; this was substituted for Sketchup which has much more intuitive interface and has operational parallels with the studio pedagogy running in parallel. Later in the semester students are taught Rhinoceros as a more robust modeling platform, but Sketchup still remains a prominent part of the students' repertoire, especially in the early developing stages of a design project.

While both courses benefit greatly from the pedagogical overlap in learning outcomes, at certain points it is constructive to be freed from the constraints of the other, in order to emphasize their own particular agendas. This rises from the fact that some of the skills being taught require pushing the boundaries of the medium, which may not always precisely align with the intent of the studio. In other cases it is productive for the digital course to pre-empt what the studio will investigate, and lay the foundational skills prior to engaging it in a design context. This opens up the possibility for students to explore the limits of the digital medium without worrying about the studio design outcome, and can oftentimes provide a venue for parallel investigations that can peripherally benefit the studio projects.

Pedagogical Structure

The following is a brief description of each week's course content and pedagogical focus in chronological order, as well as any observations regarding the assignments and studio synergies. The course is administered in the format of weekly lectures and two 2-hour lab sessions, along with lab assignments. This makes for a total of 5-6 contact hours per week, in addition to the required time to complete weekly assignments and semester projects.

The Door Window Stair Studio Project

Positioned within the design curriculum as the first project of the third semester, the "Door Window Stair" (DWS) is a 7-week project that uses a "Cultural Artifact" as the initial point of departure. These artifacts, which according to studio professors' preferences may range from paintings, music, literature, choreography, and film, are analyzed and diagrammed as a set of abstract figures or mapping exercises. These diagrammatic representations are then used to generate ideas and a narrative that serves to sequence and structure the developing project as a series of spatial elements. Issues explored include spatial and material hierarchy, scale, thresholds, joints, layers and assemblies. The DWS project culminates in large scale (⅜"=1' or ¼"=1') models that are highly tectonic spatial constructs built from MDF, basswood and acrylic with dimensions reaching 16" x 16" x 24". Most projects consist of a heavier solid armature constructed out of MDF or wood, with a series of spatial moments embedded loosely within. These moments are defined systematically by the circulation, lightweight planar and linear basswood elements, and sometimes acrylic assemblies (Fig. 1).

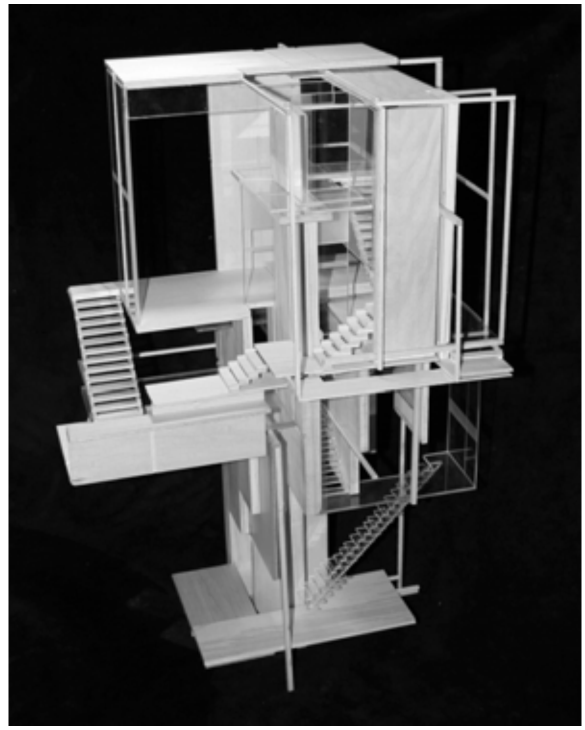


Fig. 1. Door Window Stair Model. Image credits: Erin Lee

Week 01-02 AutoCAD

Their first assignment is a digital counterpart to their first experience with the drafting board. They are asked to replicate, using AutoCAD in strictly 2D, a section drawing of Richard Meier's Douglas House. The students are intentionally given a bitmap image of the section that is somewhat ambiguous in both resolution and lineweight. This requires students to research and understand the project spatially before they can attempt to reinterpret the section drawing to their own understanding. Particular emphasis in this exercise is put on working in layers, unit scale, rationalizing dimensions, plotting lineweights, using groups for repetitive elements, and ultimately a readable drawing with lineweight hierarchy and spatial depth. This process of reinterpretation transforms the rote act of tracing into an exercise that links spatial understanding with the representational technique while practicing the necessary skills required to produce a competent 2D drawing.

Week 03 Sketchup

At this juncture Sketchup is introduced as a more intuitive and beginner-friendly 3D modeling program, with the intention of acclimating students to navigating in virtual 3D space. The "push-pull" mechanic of the program is very intuitive and tactile to beginning students, while the modeling method makes it easy for students to correlate with the linear and planar physical model materials that they are beginning to use in studio to create smaller spatial prototypes. However, at this point the digital curriculum actually preempts the studio curriculum and projects forwards with the first semester project that requires students to construct digitally a prototype DWS project (Fig. 2). Using Sketchup as an exploratory vehicle, students are asked to integrate their spatial prototypes into a cohesive 3D model. This process allows students to conceptualize relationships while being temporarily freed from material constraints, which in turn helps them understand how geometries will intersect and potentially join.

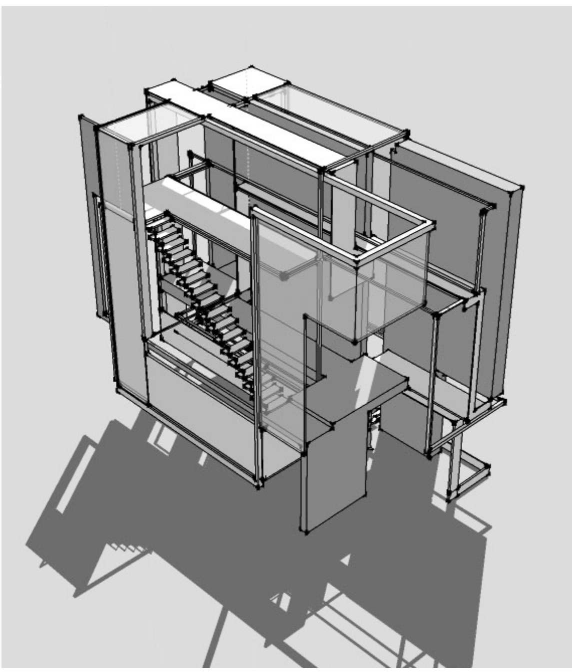


Fig. 2. Semester Project 01: Proto-DWS. Image credits: Joel Corazon

Week 04 Rhinoceros + Brazil

Students are shown how to import their prototype DWS Sketchup models into Rhino for producing abstract renderings with Brazil. They are required to pre-group their geometry into organized layers, as well as basic principles for choosing and curating views of their own design. The specific workflows for creating sectioned diagrams, exploded axonometric, and ghosted axonometric diagrams as representational techniques are shown. This also serves as an early precursor to the latter half of the semester which is focused on Rhino, familiarizing them with the vastly different program environment compared to Sketchup. A lecture is given focusing on both the operational and historical aspects of perspectival and parallel projection methods as well as their common usage scenarios.

Week 05-06 Photoshop

During this point in the semester the studios are generally working on larger physical models as well as developing architectural plans and sections. The first week of Photoshop is dedicated to working with these drawings and adding poche, textures, scale figures, and light/shadow effects to render depth into the 2D drawings. Through these exercises the basic methods and concepts of working with Photoshop are introduced. The second week focuses on perspective views extracted from their 3D models, working with texture, light/shadow, backgrounds, and unifying the atmosphere of the perspectives. In addition, the technique of overlaying the 3D wireframe to convey spatial structure and emphasizing certain design elements through vignetting is introduced (Fig. 3, Fig. 4). At this point some students begin incorporating analog-digital-analog workflows into their design process. For example line diagrams may be scanned and traced, then printed out on watercolor paper for iterative tests with shading. In other cases sectional studies have been carried out that mix both digitally produced and physical medias, using each to their respective strengths.

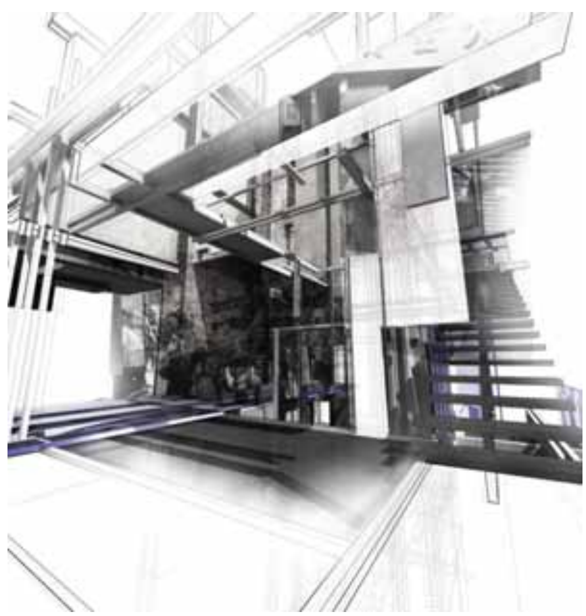


Fig. 3. Layered Perspective Vignette. Image credits: Christina Graydon

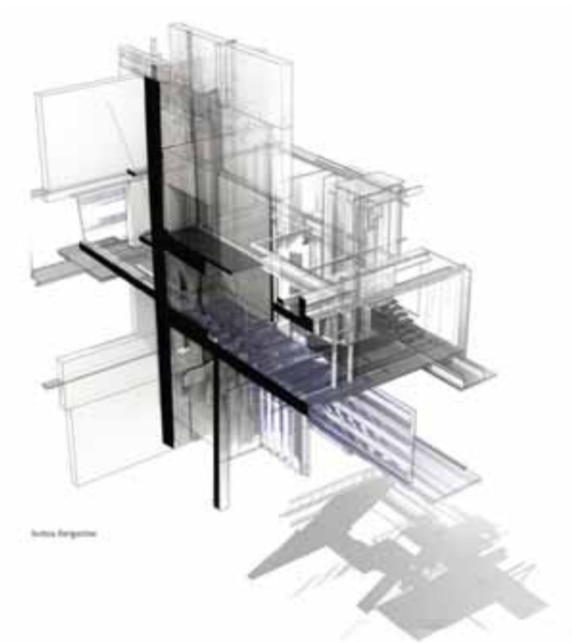


Fig. 4. Section Perspective Vignette. Image credits: Christina Graydon

Week 07 Illustrator

As the counterpart to Photoshop, Illustrator is shown specifically as a method of creating vector diagrams from geometry that can be extracted from Rhino. Students are taught how to group and arrange layers, edit lineweights and linetypes, as well as Livepaint filling in using color

Fig. 5. Exploded Perspective Diagram. Image credits: Adiel Benitez

blocks and gradients. This section empowers students with the ability to conceive and construct three-dimensional diagrams as spatial constructs, as opposed the 2D representational diagrams they have been working with previously (Fig. 5). A series of lectures focusing on the comparative aspects of raster vs vector geometry is delivered to give a conceptual understanding of the underlying differences as well as advantages/disadvantages of both approaches.

Week 08 InDesign

Working towards the second major semester project, students are required to use InDesign to produce their presentation layouts for the DWS project. Since they are required to include a mixture of raster and vector images and drawings, as well as model photos, this is an excellent exercise in managing and balancing the different types of representation and media in a cohesive layout (Fig. 6). Interoperability between the Adobe desktop publishing software is demonstrated, as well as file and link manage-

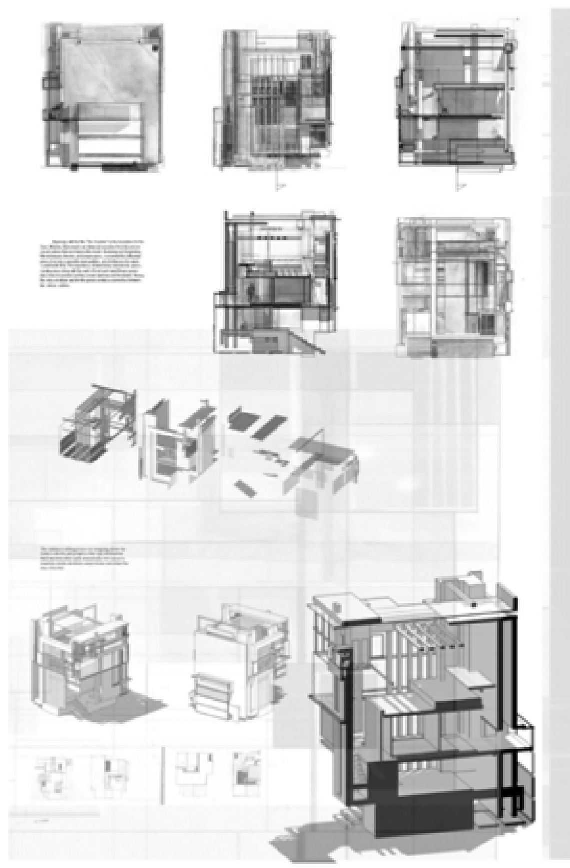


Fig. 6. Semester Project 2: DWS Poster Layout. Image credits: Dana Shores

ment strategies. Particular emphasis is given to the composition and visual balance of the layouts, while still incorporating the necessary architectural drawing elements. This phase is assisted immensely by parallel critiques of the layouts that occur in studio at the same time. Professors are given the flexibility to adjust the required drawing types to better suit and present the student's projects based on the inherent project characteristics.

On Indeterminacy

One of the major fundamental challenges in bridging the gap between analog and digital is the binary and determinate nature of digital methods. The analog line has characteristics that allow it to be fuzzy and indeterminate, awaiting a future reading or adjustment. Much like Louis Kahn's developmental sketches where one line is traced and retraced and adjusted multiple times in search of the optimal geometry as part of the design process, the analog line accommodates this layering and oscillation of potential outcomes (Fig. 7).

In comparison, due to its binary nature the digital line requires a preciseness and determinacy that is usually absent at least in the early formative stages of a design project. As such the digital media is often viewed more as a representative tool rather than a generative tool, with the outcomes conveying a sense of finality and precision in its intent. While working with digitizer tablets and raster editing programs such as Photoshop offer more intuitive alternatives to bridge this gap, these still require numeric inputs and values or percentages. In this sense, time and experience is required to conceptually understand the digital construct as simply one representation of possible outcomes, and the inherent adjustability or ease of modification embodies the indeterminacy that is present in the analog line. Therefore learning how to see indeterminacy in the digital media, and conceptually understand the role of the precise line representing multiple outcomes is a fundamental skill to be learned in order to incorporate digital techniques into the generative design workflow.

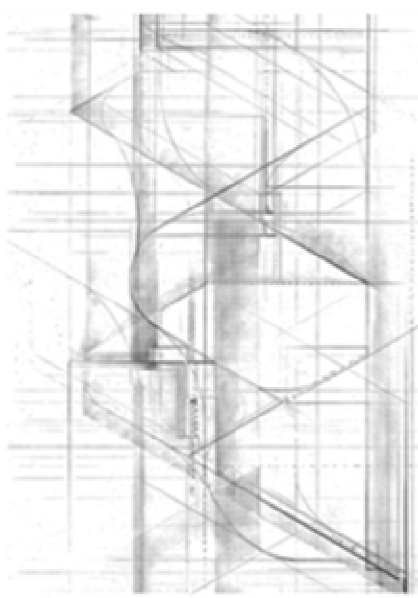


Fig. 7. DWS Concept Sketch. Image credits: Luis Morales

On Seamless Integration

Analog drawing is often taught as an integral part of the studio pedagogy, being the natural method of communication common across visual and design disciplines. The fundamental simplicity of putting pencil to paper and drawing a line to convey an idea resonates intuitively across cultural and linguistic barriers. As the logical extension of such a mindset the craft of drawing and drafting to architectural standards as a means to communicate space is firmly embedded within the studio context. Students are taught the language of space making while manipulating the physical media and reacting to the immediate tactile feedback it provides. This extends to the territory of physical model-making as a means of design exploration as well, as the three-dimensional form of drawing or making space. In her book *Architects Draw* Sue Gussow states: *Drawing is thought extended through the fingertips*.[2] However, what is the implement held by the fingertips, and how does it interface with the medium? Due to their virtual nature the digital programs and techniques in use today forces one to engage the architectural construct once removed from the tangible realm of making. It is this removal of physicality that is simultaneously its advantage and disadvantage; the transience of limitless possibilities in the digital space often gives way to uncertainty and tentativeness, and an end result that lacks finality.

On a broader social level technological advances serve to further embed digital media seamlessly into the daily life of the general public. Processes that used to be complicated and labyrinthe are now simplified and streamlined; take for example the act of creating a website. Ten years ago this would have been an relatively expensive undertaking requiring considerable technical knowledge, or the hiring of specialists. Nowadays there are multiple options available as services that are cheap and efficient, where all the technology that was an entry barrier has been absorbed and streamlined, distilled back to the simple desire to create.

As we examine the impact these advances have on the architectural industry and profession, the focus of the discussion turns to the issue of interface. The method in which we interface with the media we manipulate strongly affects the outcome, as well as its integration into our design workflows. From a pedagogical standpoint we often see digital media separated into its own compartment, where even in terms of course delivery the class is often physically removed to the computer lab. The conceptual and physical removal that is required to work in digital media is the first and most influential barrier to integration. The "paperless studio" as pioneered pedagogically in the mid 1990s during Bernard Tschumi's tenure as dean at Columbia GSAPP represents an evolutionary step towards this integration. Even the simple step of having a laptop and projector in the studios can have a substantial impact on the fluidity and ease in which these techniques can be shown and integrated as readily as their analog counterparts. As display/projection technologies advance, and touch/gesture interfaces improve to a point where we can interface with the technology in a studio environment, we will truly see seamless integration of digital into design.

Notes

[1] Mitchell, William J. "Roll Over Euclid: How Frank Gehry Designs and Builds," in *Frank Gehry, Architect*, J. Fiona Ragheb, ed., The Solomon R. Guggenheim Foundation: New York, 2001. p 354.

[2] Gussow, Sue Ferguson. *Architects Draw*. Princeton Architectural Press: New York, 2008. p 19.

Pattern Thinking

Meg Jackson and Michael Gonzales

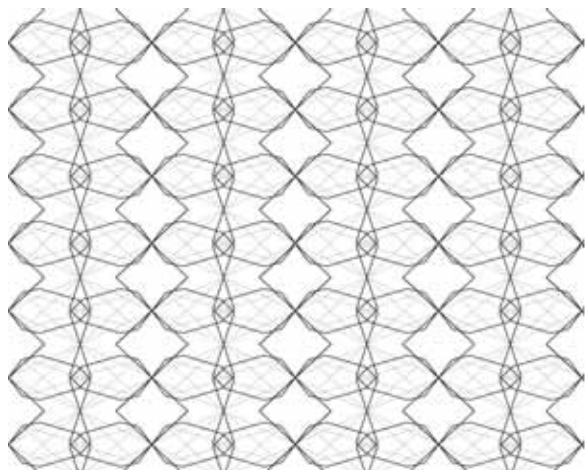
University of Houston

Patterning is a fundamental creative act in architectural design. While traditionally understood as a function of ornament, patterning has seen a reemergence in practice and pedagogy fueled by methods of advanced computation, fabrication practices and the field of Parametrics. The function of pattern has shifted from its historical and traditional role as ornament to the primary gesture of building. This paper investigates patterning as a strategy for making and as a vehicle to introduce beginning design students to not only traditional design processes, but also parametric thinking, digital fabrication and generative techniques.

As Sanford Kwinter writes in The Architecture of Patterns, "Pattern is the means through which the world at once communicates and materially interacts with itself. Pattern is at once the empirical and the abstract. No other notion or mathematical object embraces the two domains at once."[1] Expanding on this notion, our research investigates the pattern for its potential to act as a catalyst for thought and making.

The authors teach foundation level studios in Architecture, Interior Architecture and Industrial Design as well as digital media intro courses. During the past several years, the pattern has been the primary device used to introduce design fundamentals of order, grid, hierarchy, composition, craft, material, texture, relief, tectonics, modularity, component assemblies, and surface. This paper focuses on a series of intensive and short-duration investigations focused on patterning undertaken during the past several years.

Patterning has traditionally been introduced as the expression of materiality, texture, and space applied to textile and surface design. The development of a new foundation curriculum has allowed us to revisit patterning as a generative design strategy for ornamentation, skin, and structure. This essay expands on the use of patterning as a method for developing graphic, haptic, and spatial strategies while exploring the potential to serve as a generative design tool. Students are introduced to a diversity of tools and techniques while simultaneously engaging in the contemporary discourse of patterns in architecture.

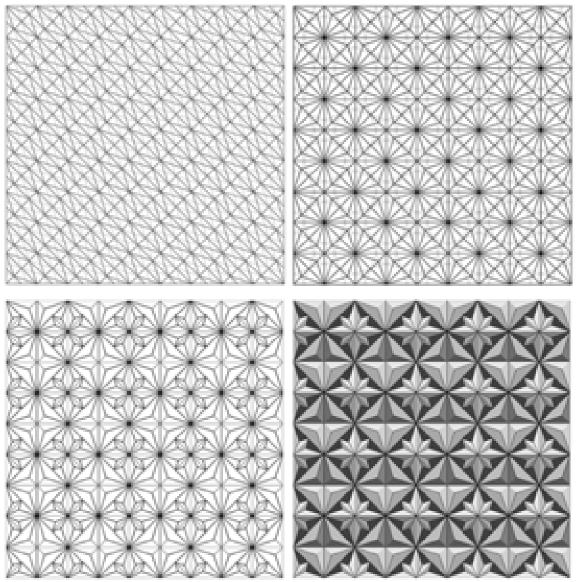


1_ Pattern created from intersecting grids. *P. Marcine*

Order, Organization and Logic

Using analogue techniques, the pattern is introduced as a graphic and surface strategy through the act of layering ordering systems. Using elements of points, lines, and grids, students analyze geometric fields to develop and construct simple rule-sets and logics to inform the aggregation of complex component surfaces. (1 + 2) These preliminary, iterative design exercises ask students to analyze and interpret existing geometric systems to develop simple rule-sets and logics to design a series of grids and fields.

The systems approach to design expands on the Bauhaus tradition of order, hierarchy, and the grid as construction system. The pattern is generated by the intersection of complex grids and its investigation introduces concepts of tectonics, modularity, assembly, texture, and the manipulation of surface, pattern, and field. The initial exercise in each series is hand-drafted. However, in later exercises, students develop an understanding of digital workflow with the production of digital documentation of the analog drawings. Students are also introduced to diagramming and color theory through the act of analyzing the ordering systems. (3)

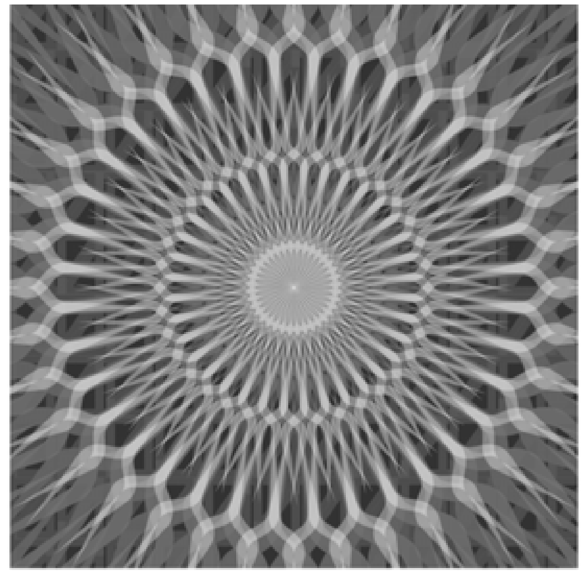


2_ Pattern Generation: from grid network to final pattern to tone relief study. *E. Cheung*

In this case all of the patterns are derived from iterative line exercises. Christopher Alexander states, “A generating system is not a view of a single thing. It is a kit of parts, with rules about the way these parts may be combined.”[2] This layering process, guided by principles of grid organization, is important because the students control the pattern design within the logic of the grid’s constraints. While allowing for critical thinking in the design process remains our primary

goal, beginning design students benefit from constraints which eliminate arbitrariness and allow for calibrated designs. In addition, the exercise of controlling the constraints to generate patterns introduces our students to analog computational strategies.

The rigorous order of patterns and the ability to generate them through a concrete system make them very effective as a method of teaching systems to beginning design students. In addition, since axes, grids, and geometry are the fundamentals of efficient construction techniques, patterns generated from the intersection of grids have the potential to be the organizing principle for building components. These initial design exercises emphasize the design possibilities of patterns generated from a base grid.[3]



3_ Pattern generated from typography. *E. Cheung*

Variance and Complexity

Pattern generation follows a process of precise ordering systems. However, both organizational and operational, patterns have the ability to be highly calibrated yet flexible. Patterns are built by strategically layering and controlling primitives, therefore they have both rigorous order and parametric potential. Patterns also have an enormous capacity for variance within a strict system of constraints.

The capacity of patterns is present in “their redundant qualities, their flexibility, and their combinatory logic”[4] Even within the simple rule-based systems, there is a diversity of patterns derived from the same organization. Further complexity is achieved through repetitive layering of simple geometries.

Patterns are an effective device to introduce a diversity of tools and techniques to beginning design students because they provide necessary constraints while at the same time their flexibility provides a potential for individual exploration. It is important to engage students in their own line of inquiry. Problem solving exercises with multiple solutions are intensive critical thinking experiences which should outweigh the ease of evaluation of more task-based, single-solution exercises. Success is measured by the individual’s conceptual complexity, level of understanding and agility in exploration.

Repetition: Performance and Relationships

An advanced understanding of architectural patterns, one in which they merge multiple discrete interests, is particularly well suited to combine the competing formal, functional, and representational demands placed on design today. In both abstract and aesthetic manifestations, the repetition found in pattern does not optimize or essentialize - its redundancy is a measure of its potential to absorb and respond to information, material behavior, and forces. It can incorporate multiple building systems or adapt to new requirements over time without sacrificing the performance or aesthetic agenda of any one.[5]

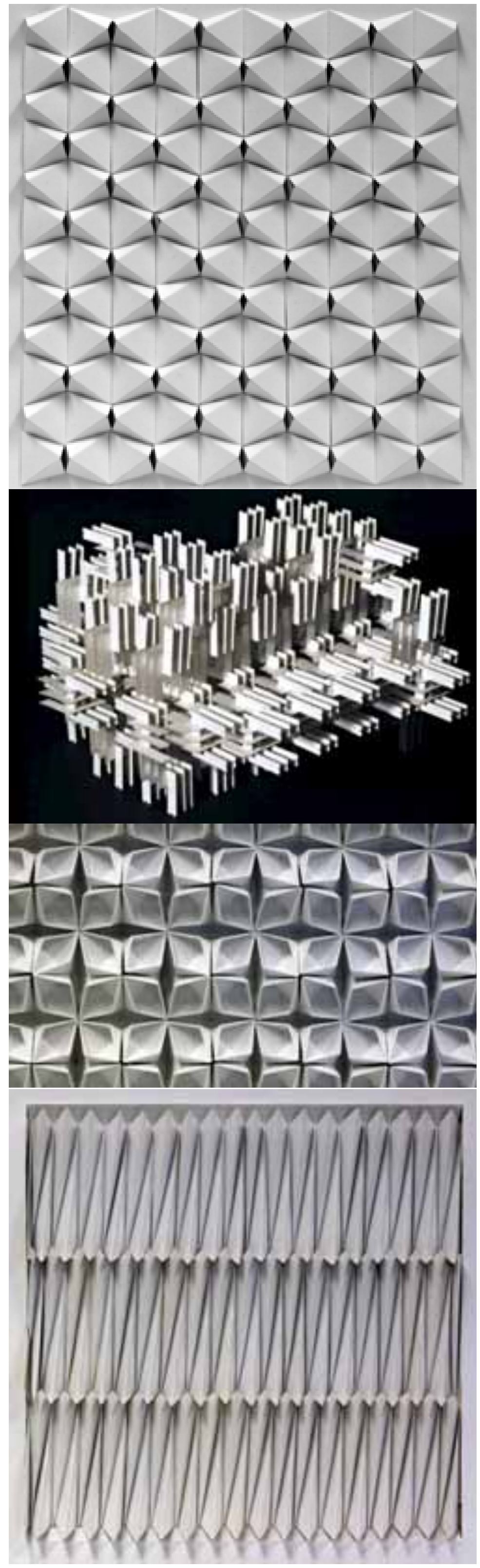
After generating vector patterns, the students analyze the two dimensional systems and project them into a spatial relief. (4-8) While certainly a study in surface and texture, the three dimensional patterning anticipates future tectonic and structural relationships. This two-to –three-dimensional translation is made possible because of the repetitive and hierarchical organization of the generated patterns.

These system-based explorations reveal the power of modulation as a space-making operation. Material investigation taught through a series of rigorous, modular, spatial assemblies introduces beginning design students to pre-parametric problem solving. Various tactics focus on material dynamics, tectonics, and the making of surface. Final installations, made by hand, even as a scale model, reveal the architectural implication of surface, as well as the ability of pattern systems to define and make space. For students, this project serves as an introduction to the aggregation and tactile manipulation of two-dimensional materials as a full-scale approach to making space.

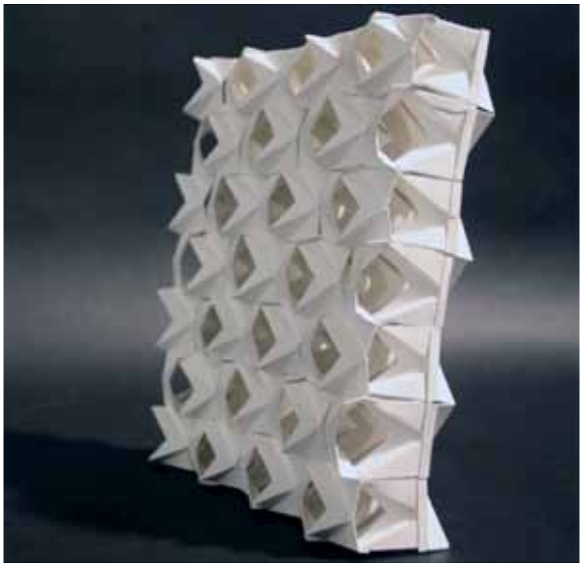
Medium

While the early curriculum privileges manual techniques of making, it is equally important to integrate digital skills. In the pattern generating exercises above, basic digital [vector-based] explorations (*Rhino, AutoCad, Illustrator*) were paralleled with analog production addressing the need for a balance between fundamental foundation education and the engagement of emerging methods.

A system-based approach anticipates the need for beginning design students to connect with digital methods of making.



4-7_ Handmade Bristol paper reliefs translated from vector patterns.
student work

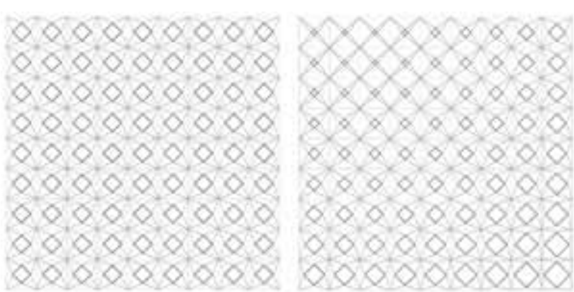


8_ Handmade Bristol paper. *student work*

Extending the concept of material systems by embedding their material characteristics, geometric behavior, manufacturing constraints and assembly logics within an integral computational model promotes an understanding of form, material, structure and behavior not as separate elements, but rather as complex interrelations.[6]

Subsequent material assembly exercises, using a similar method of layering systems, introduce pattern as a method of learning 2D and 3D parametric software (*Rhino and Grasshopper*) as well as processes of digital fabrication. However, working within the Rhino interface, students generated their patterns with the same method of construction, based on the grid. While the layering process was consciously repetitive, more complex patterns were explored by changing the geometry of the base grid.

Coding (Grasshopper) is introduced by controlling parameters; first to inform graphic qualities in two dimensions (9) and later to analyze and control the performance of the system and its components in three dimensional patterning.



9_ Pattern and Affected Pattern. *E. Esparza*

Students were first introduced to Grasshopper by repeating the same layering technique to generate patterns. (Repetition is built into the design process with each exercise building on further techniques. The same system of grid-based patterning is explored by hand drafting, computer drafting, Rhino modeling, and through Grasshopper definitions.)

Later iterations of the Grasshopper definitions allowed the students to dynamically control the parameters of their pattern and calibrate its geometry based on its performative properties and light modulation. Subsequent definitions used attractor points to control the pattern's response to the sun's light and temporal conditions. (10-12)

Using parametric software, the students translate and explore their two dimensional patterns as three dimensional component based systems.

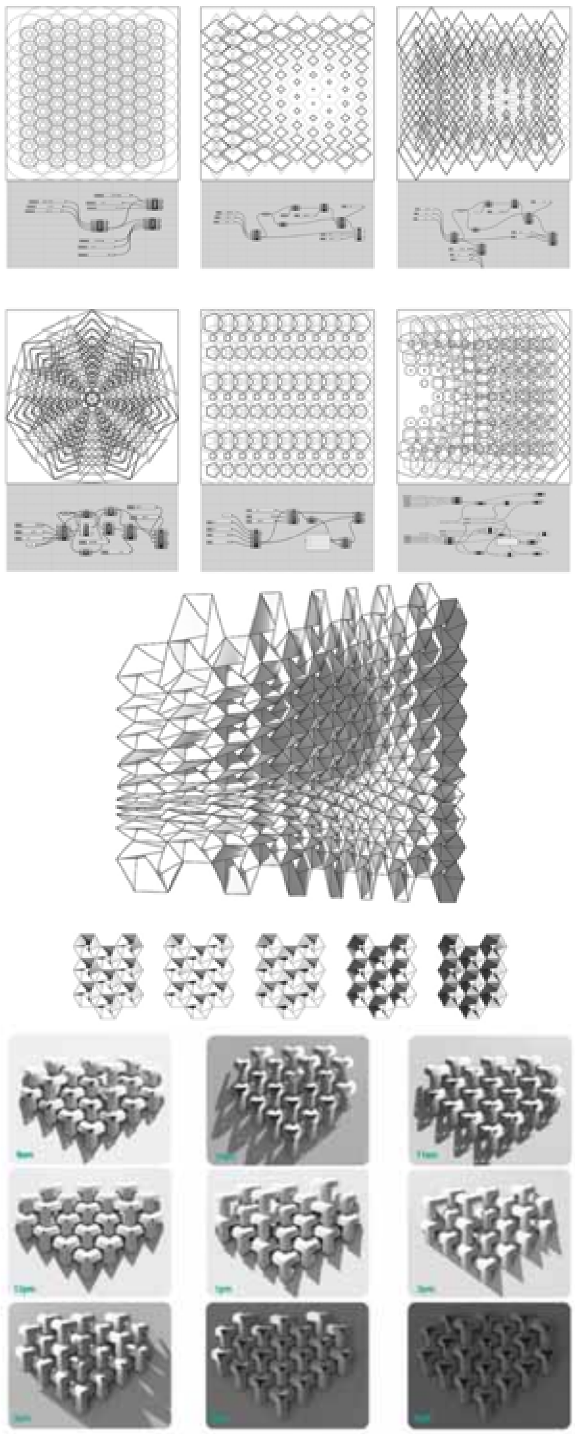
Scale: Methods of Making

When used to introduce digital fabrication techniques, a pattern's ability to exist at multiple scales is important. The pattern is a surface but it is also made up of interrelated components. (13)

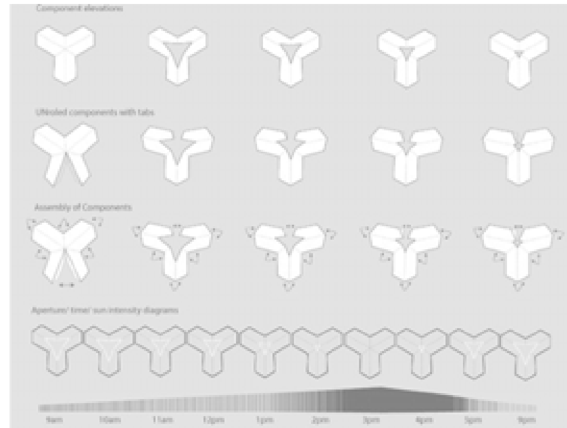
To make objects with complex holistic properties, it is necessary to invent generating systems…The designer becomes a designer of generating systems-each capable of generating many objects- rather than a designer of individual objects.[7]

Patterns are generative systems which are capable of being further generative at multiple scales. The geometries and potentials of both surface and component are compelling fabrication investigations.

The laser cutter is introduced in three iterative exercises – the waffle grid, the aperture relief, and the assembled component. (14) Methods of digital work flows and basic file set-up for digital fabrication are taught in a lab setting however it is important that the assignments are unique so the students immediately begin self- directed troubleshooting. Our introduction to the laser cutter tool is consciously repetitive with the analog studies. We have found that the students who have already completed analog versions of the assembly component demand more of the new tool (the laser cutter) and they almost immediately understand its potential.

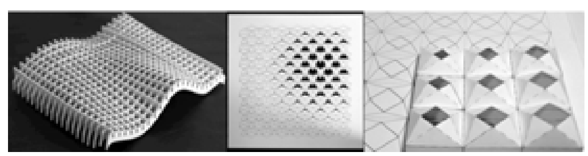


10-12_ Parametric pattern studies. *student work*



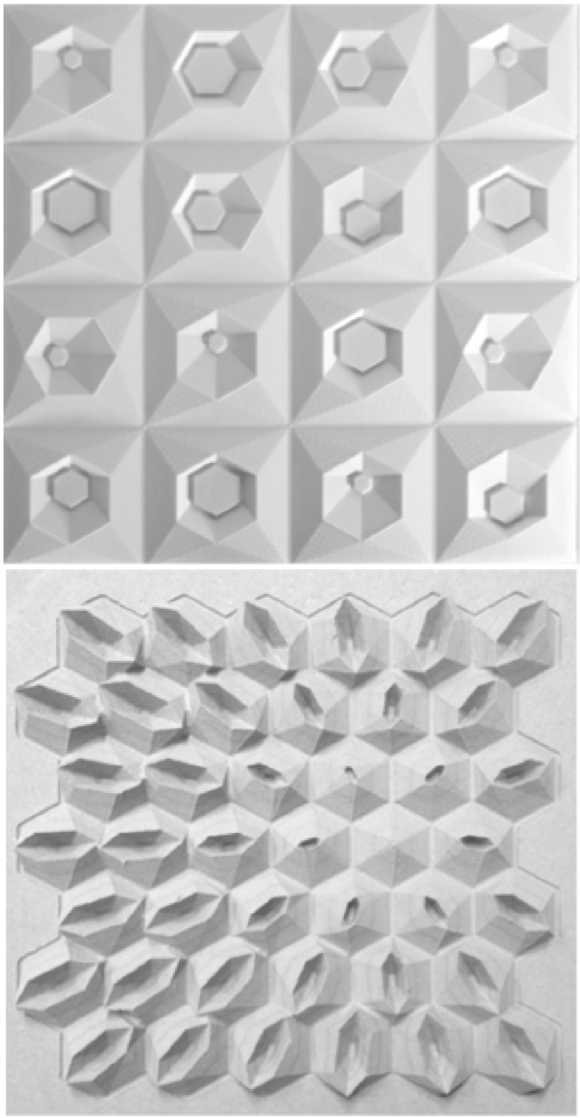
13_ Component system analysis. *Munjer Hashim*

If possible, we believe that introducing digital tools and techniques after students have successfully completed analog methods of making lead to more understanding as well as more productive and efficient use of the digital processes. Students are also able to more easily understand the concept of the tool or technique and make a more conscious choice of a tool or method of making. It is often taken for granted that students know how to make, however we have found that too often our students lack the skills for traditional methods of engaging and manipulating materials. Physical making changes the pace of the design process without disrupting its fluidity and, therefore, allows for an intentionality of ideas.



14_ Related Laser Cutter Exercises. student work

Despite our own interest in digital tools, introducing the students to traditional techniques remains seminal, particularly since they will soon engage with the prevailing omnipresence of digital fabrication. Engaging materials with their hands, foundation-level design students form an emotional connection with their ideas, as well as a sense of authorship. While this may seem like an obvious statement, because of this, it is important how and in what order you introduce advanced techniques of making. Our digital vocabularies seminars include a significant amount of analog exercises done in parallel to the introduction of digital methods.

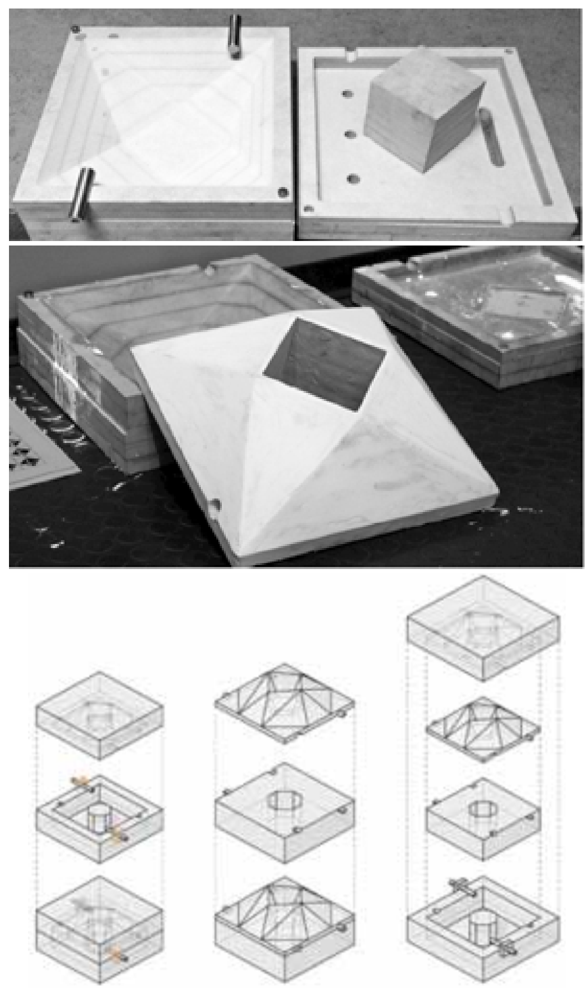


15-16_CNC (Corian, Plywood) *student work*

In addition to the laser cutter, the students are introduced to the 3D Printer, CNC Mill and to the basics of casting. The project is both cumulative and consciously repetitive. Each iteration is a slightly more advanced version of the previous exercise. Repetition builds both confidence in and mastery of the skills, as well as provides an opportunity for self-directed inquiry into the potential of the techniques and tools. (15-16)

Final iterations of the student's patterns were studied at the scale of the component. (19-22)

19_ Milled component mold process. *student work*

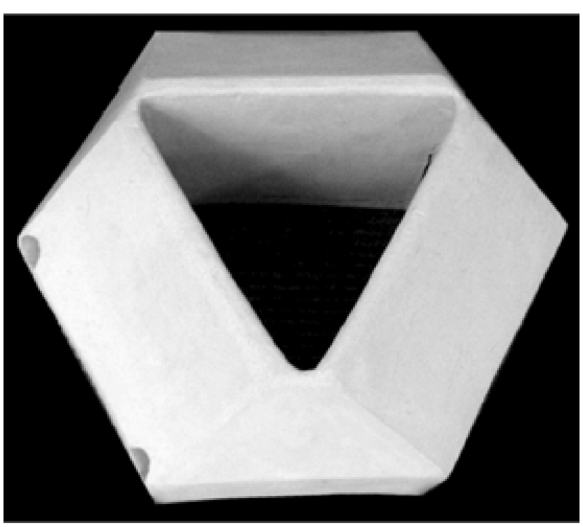


20-22_ Milled component mold process. *student work*

It is important to engage with the traditional and emerging ways of making and material expression in a foundation curriculum. The intellectual ability to transfer a complex, even abstract, idea into a design statement or concept is obligatory. These are specific skills that can be translated across multiple disciplines. The education of a designer must focus on applied and theoretical methods of making as well as aid in developing an emotional intelligence for design.

The hybrid of both critical thinker and conscious maker is most ideal; therefore, whenever possible, design students need to be exposed to real scales and actual construction materials and techniques. Architectural students need to be intimately connected to materiality and gravity and the sensorial physical phenomena of the discipline. Privileging craft within a process of making is essential and only made more so by the advance of digital techniques. It is because making is now increasingly mediated thru digital means that it is urgent for students to engage with physical making and tactile materials both in analog and digital ways. An appreciation for manual traditions makes a student demand more of new tools. Despite the often time consuming and complex traditional techniques, physical making remains a compelling tool for designers.

One should assume that an architectural idea should not be an abstract thought but a material consequence – a material effect. The production of that material effect is the essence of architecture. Therefore, design is understood not a representation of ideas but the physical consequence of them.[8] (23)



23_ Component. *Austin Wilburn*

It is for these reasons, that our students were to work at the scale of the component and to use physical materials to realize the consequences of their patterns. Working with patterns, allows for a continuum of process and concept despite a radical change in scale and medium.

The application of digital technologies and fabrication methods continuously impacts architectural practice. Innovative material research will lead to new design possibilities in architecture and will also allow a more direct interaction between design and production. The resulting building components and methods of building construction have the potential to reinvent architecture and the role of the architect. (24-25)

Conclusion

These case studies illustrate a process of design research that translates ideas into spatial, tectonic, and formal strategies while seamlessly integrating various methods of making, tools and techniques. Thus, beginning design students understood the act of design and the process of making as a dynamic shifting field, rather than as an autonomous act.

The argument for the potential of patterns in architecture is outlined in *The Architecture of Patterns.* "… [Patterns] operate simultaneously on abstract and physical registers. Functioning as both process and image, graphic and code, they are able to foreground the sensual while shaping matter and behavior by stealth."[9] The systems approach directly engages with contemporary practice and design methodologies through the use of parametric software and digital fabrication techniques. The students can apply the same methods of pattern-making to the process of digital fabrication as a means to generate texture, material, and assembly strategies.

Advanced patterns… combine a variety of materials, performance requirements, environmental factors, sensibilities, elastic geometries, optical effects, and kinetic forces, Because they do not discriminate between scales, materials, and applications, they create connections between these aspects of architecture in a manner that is at once direct and seductive.[10]

Patterns are relevant to contemporary design thinking, but they are also an accessible and concrete entry point for beginning design students. It is precisely the pliability of patterns – their "…ability…to distort, absorb, amplify, and fluctuate…"[11] that make patterns valuable as generative teaching tools.

The pattern, as a tool for making, has proven to be an effective strategy for teaching fundamental design processes in several contexts. Both the process of making the pattern and the potential of patterning as a generative device are applicable to introducing both traditional and emerging principles of design. The simplicity of patterns allows beginning design students to develop complex and intricate results based on simple rule-based systems. Geometric relationships and repetition make patterns easily accessible to beginning design students. Within their grid networks, patterns offer the possibility of variance and complexity which can be further exploited with the use of parametric tools. Since patterns rely on a grid organization and can be designed in multiple scales, they anticipate further architectural applications. By understanding pattern not just as ornament but by privileging it as a design process, it can be used as a multi-scalar tool for exploring form, space, and material.

Our research explores the potential of the pattern as a method of making, learning and teaching. We will continue to evolve our current applications of pattern to analyze its opportunities, potentials and short-comings. In our subsequent research, we have looked at patterns beyond their ability to be a surface technique and instead for their potential as a spatial tool. However, by introducing patterning as an initial inquiry, we propose that the logic inherent in pattern-based systems and its potential for translation to digital processes should inform and redefine how we introduce concepts of spatial design to beginning design students.

Notes

[1]Kwinter, Sanford. "Pan-Patternism," in *The Architecture of Patterns*, W.W. Norton & Co.: New York, NY. 2010. P 8-10.

[2]Alexander, Christopher. "Systems Generating Systems," in *Computational Design Thinking,* John Wiley & Sons: Chichester, UK. 2011. P. 58.

[3]Muckenheim, Mark and Juliane Demel. Inspiration: Contemporary Design Method in Architecture, BIS Publishers: Amsterdam, 2012. P. 53-55.

[4]Andersen, Paul and David L. Salomon. The Architecture of Patterns, W.W. Norton & Co.: New York, NY. 2010. P 35.

[5] Ibid, 92.

[6]Menges, Achim. "Integral Formation and Materialization," in *Computational Design Thinking,* John Wiley & Sons: Chichester, UK. 2011. P. 202.

[7]Menges, Achim and Sean Ahlquist. *Computational Design Thinking,* John Wiley & Sons: Chichester, UK. 2011. P 66.

[8]Attributed to Jeffery Kipnis in Anthing Discussion 3, *Anything*, ed. Cynthia C. Davidson. The Anyone Corp.: New York, NY. 2001. P 129.

[9]Andersen, Paul and David L. Salomon. The Architecture of Patterns, W.W. Norton & Co.: New York, NY. 2010. P 14.

[10] Ibid. 92.

[11] Ibid. 33.

Material Assemblies:

Alternative Mediums for Active Assimilation

Patrick Martin, Andrew Doyle

Marywood University

Preface

Building Assemblies (Arch313) - the systems course referenced in this paper - was developed by Joseph Gluba, Patrick Martin, and Andrew Doyle at Marywood University's School of Architecture. This course is concerned with the typical and atypical relationships between design intent, assemblies, subassemblies, details, and materials as they pertain to operational space. Content is addressed through the following course components: readings, online practice quizzes, in class quizzes, digital/analog modelling exercises, and detail section drawings.

The relative weight of individual course components will not be addressed in this document.

Introduction

At moments within any architectural endeavor there exists, to greater or lesser extents, a perceived conflict regarding that which is desired and that which is possible – drawing attention to the material systems one must inevitably consult in order to transform ideas into "coherent" architecture.[1] Understanding this, professionals can optimize the innately conflicted design process by leveraging the reciprocal nature of its embattled agents. Students, however, are frequently encumbered by the notion that material systems are: selected from a fixed inventory, contingent upon a predetermined experiential effect, and therefore, unfit to receive the same degree of critical thought used for governing "high-concepts." This belief stems from another misconception that identifies design as an entirely linear, top-down, undertaking where systems integration is seen as a necessary, but comparatively unsophisticated, chore. With that said, and as indicated by the abovementioned description of professional design practices, capable students will eventually embrace a partnership with the constraints of "reality" (architecture as organized material aggregation), and shift their view of systems integration from that of routine hindrance to that of unique opportunity (i.e. leveraging the conflict). But due to the treatment of most architectural curricula, illustrated by the intellectual and literal separation of systems courses from orthodox studios, this way of thinking is highly counterintuitive and perhaps understood later than need be.

While the academic studio offers an intellectual framework for design investigation at large, its inability to *comprehensively* address both design ideas and the challenges of constructability necessitates courses that cover more nuanced technical information. With this structuring, students are expected to apply content delivered in a systems course to the work they actively develop in design studios. Unfortunately, many of these supplementary courses do not effectively serve the studios they are thought to enhance because of a fundamental difference in the type (and level) of student engagement.

Characterized by a lecture-based, *passive* learning environment, traditional systems courses rely on a student's fear of failure and capacity for memorizing[2] "...a pre-defined set of concepts, rules, and procedures."[3] Recent studies in the field of cognitive science have illustrated the ineffectuality of these methods.[4] As such, *Building Assemblies* aims to facilitate *active* learning. By implementing a student-centered format that combines the simulated "handling" of three-dimensional (3D) digital models within a game-like atmosphere, we hope to both increase educational value and cultivate a learning environment that is pedagogically consistent with that of the design studio.

Student-Centered Learning

Traditional (passive) means of engagement fail to stimulate the full range of cognitive, meta-cognitive, and motivational tools individuals naturally have at their disposal.[5] Under such circumstances, the likelihood that students will reach meaningful understandings decreases, while the potential for students to develop "fragmented knowledge" and exhibit "unthinking acceptance" increases.[6] Over time this can hinder a student's ability to: think critically, problem solve, communicate, and collaborate – skills which are generally important, but particularly vital to the successful practice of architectural design.[7]

Drawing upon the principles of constructivist learning theory, *Building Assemblies* means to facilitate active knowledge construction through student experience and inquiry.[8] By asking students to review course content outside of class, we exchange what would normally be time spent in the traditional lecture for time spent on context-based "game-like" exercises, questions, and critical discussions. Though research has confirmed that this level of interactivity lends itself to greater information retention, the effectiveness of the course still hinges upon student preparedness. To preempt this dependency, we incentivize the group by adding an "extra credit" component to assigned readings. This device helps sustain the (inter)active learning environment by boosting overall motivation - a psychological feature that is essential to productive learning strategies.[9]

Motivation is defined as "the condition of being eager to act or work."[10] It is determined (in large part) by one's perceived ability to address a given objective. However, there is also a component of motivation linked to anticipated reward, or pleasure. The inspired learner is more likely to have a productive educational experience, moreover the true benefit of a motivated condition is its potential to foster an independent learning pursuit that continues well after formal education ends.[11] In actuality much still rests on the leadership capabilities of the instructor.[12] Try as we have to keep the course enlivened and productive, we are still developing and its pedagogical framework.

Three-Dimensional (3d) Learning

In addressing the effectiveness of applied learning theories within architectural systems courses, we must also address the representational techniques used to communicate course information. In his seminal work, *Perspective as Symbolic Form*, Erwin Panofsky identifies the perception of perspective as an experience of space, suggesting a connection between representational techniques and "*weltanschauung,"* or world view.[13] This observation emphasizes the inappropriate use of unfamiliar and ostensibly cryptic orthographic drawings to describe three-dimensional building assemblies. In other words, beginning design students who have yet to master two-dimensional drawing notation are subjected to a graphic language barrier, neglecting their innate understanding of three dimensional space. Forcing students to extrapolate information from unclear external sources in this way can lead to incomplete or inaccurate internal representations, adversely affecting performance.[14]

Recognizing the potential for this difficulty within our own systems course, we opted to shift away from the primacy of two-dimensional representation. Leveraging the "visual intuition" of students, the course is designed around a series of interactive digital modeling exercises. Each week students are provided with a digital inventory of building components and the fundamental systems that guide them: assemblies, subassemblies, details, and materials. Upon receipt of these (unconstructed) digital model students must correctly assemble and label their constituent parts by both referring to required texts and engaging the instructor. In this way the exercise serves as a catalyst for independent exploration and active discourse to an extent that may not be possible through lecture-based instruction. This application of digital technology follows a historical trend in the development of architectural learning tools. Just as the advent of paper making technology allowed for the reconceptualization of a Euclidean based architecture, digital methods may serve a similar developmental function.[15]

The digital modeling exercise described above is, by definition, a "simulation." Generally speaking, simulations are abstract computational models representing a simplified reality in which learners can both interact with the environment and test outcomes based on predictable behavior.[16] This ability to visualize complex building assemblies without the use of physical examples allows for students and instructors to effectively cover a wider breadth of information in a shorter period of time. According to Bern Dibner's *Moving the Obelisks,* there exists a historical precedent supporting the use of simulation to facilitate understanding. In the late sixteenth century, Pope Sixtus V commissioned architect and engineer, Domenico Fontana, to reposition the obelisk that now rests in St. Peter's square.[17]

Fontana's use of a functional scale model, simulating the complexities of the transportation, appealed to the spatial intuition of Sixtus V while the normative presentations of Fontana's contemporaries were refused.[18]

Although little quantitative research exists concerning the use of digital simulations in building systems courses, recent testing of computer aided simulations in the medical field provide insight as to their educational effectiveness. Fundamental learning objectives in anatomy courses, for example, are comparable to those of a building systems course.[19] According to studies conducted across several California universities, students using 3D simulations of anatomical systems displayed an increase in student satisfaction when compared to control groups studying with 2D images; similar methods applied at Linköping University in Sweden also indicate a correlation between student satisfaction and overall learning improvement.[20] It can be argued, in accordance with constructivist learning theory, that the level of engagement necessitated by 3D simulations alone can have a positive effect on knowledge acquisition as a means of active assimilation.[21]

Educational Games

Although digital modeling simulations promote interactivity between the student and instructor, the isolated exercise often precludes interpersonal discourse between students – still encompassing elements of cognitive constructivism but lacking the complementary effectiveness of "social constructivism."[22] This terminology describes a social process wherein knowledge is acquired through discussion with others, similar to adaptations of the Socratic Method used in many architecture studios.[23] As indicated previously, the simulations employed within our course are interactive models representative of real-world situations. With the addition of specific features such as "fun, risk, and competition," [24] the simulations become game-like. These characteristics, previously absent from the course, were integrated into our existing structure as a means to connect self-directed (active) learning and peer-based social learning processes. It is appropriate then, to describe the resulting environment as one supportive of academic "play" – a word that merits contextual justification due to its often ambiguous and rhetorical use.

To clarify the distinction between conventional notions of play as an unregulated cognitive act, and our use of the word as a catalyst for productivity, we will address the rudiments of play as phenomenon. In *Homo Ludens,* cultural anthropologist Johan Huizinga describes play as an integral aspect of cultural development, including the arts, philosophy, and warfare within its scope of influence.[25] As described by preeminent play-theorist Brian Sutton-Smith, play between individuals, becomes a form of "meta-communication," caused by an engagement of the mind (also observed in play between animals).[26] If play manifests itself beyond the bounds of the physical, and "precedes language"[27] as Sutton-Smith suggests, it is certainly beneficial to the process of learning and relevant within the context of academia. Performance, then, (with respect to *Building Assemblies*) becomes contingent upon a game's ability to leverage its motivational properties.[28]

It is worth noting that the use of ambiguous terminology such as "game" and "play" is explicitly avoided within our course. Using these terms in the classroom may cause students to trivialize course content. These precautions also serve to reinforce the illusion of choice with regard to participation in the "game" itself – as stated in *Homo Ludens,* "Play to order is no longer play: it could at best be but a forcible imitation of it."[29]

The game-like elements incorporated in our systems course run parallel to the course grading structure; bonus points associated with assignments serve as a scoring mechanism corresponding with an overall class "ranking." In this way, each assignment represents a contest between the students. This method of external motivation through "reward" relies on a student's inclination towards playful competition, a social impulse considered by Huizinga to be "older than culture itself."[30]

Although the effectiveness of "learning through perseverance"[31] within a social context has been substantiated, motivation resulting from competition is not exclusively "social."[32] Combining the experiential interactivity of digital simulations with goal-oriented game mechanics allows for an active learning environment in which students can compete against a predictable system during and outside of class. This exercise is designed to promote interest in course material for longer periods of time, resulting in greater content retention.[33]

Conclusion

Much of the criticism that targets active learning theories is derived from an inability to substantiate the findings of applied research. For example: there is a significant lack of research regarding the *long-term* content retention of student participants. The majority of results indicated by *short term* studies are inconclusive – favoring neither active nor passive learning methods. Additionally, in an effort to limit variables that may compromise findings (instructor competency, learning environment, etc.), studies seldom reflect a “real” adoption and employment of active and/or passive learning strategies.[34]

For these reasons, and the fact that studies have not been conducted within the context of an architectural systems course, we consider much of the research discussed in this document to be anecdotal.

Notes

1 Reiser, Jesse, and Nanako Umemoto. *Atlas of Novel Tectonics.* New York: Princeton Architectural Press, 2006. 58.

2 Marlies Baeten et al., “Student-centered teaching methods:: Can they optimize students' approaches to learning in professional higher education?” Studies in Educational Evaluation 39, no. 1 (March, 3013): 15.

3 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011. 21.

4 Marlies Baeten et al., “Student-centered teaching methods:: Can they optimize students' approaches to learning in professional higher education?” Studies in Educational Evaluation 39, no. 1 (March, 3013): 14-21.

5 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011. 19.

6 Marlies Baeten et al., “Student-centered teaching methods:: Can they optimize students' approaches to learning in professional higher education?” Studies in Educational Evaluation 39, no. 1 (March, 3013): 21.

7 DiCarlo, Stephen. “Teaching Alveolar Ventilation with Simple, Inexpensive Models.” *Advances in Physiology Education* 32, no. 3 (September, 2008): 185-191.

8 Gu, Ning, and Xiangyu Wan. Computational Design Methods and Technologies: Applications in Cad, Cam, and Cae Education. Hershey, PA: Information Science Reference, 2012. 140.

9 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011. 21.

10 1 Merriam Webster Online. Accessed February 10, 2014. http://www.merriam-webster.com/dictionary/motivation.

11 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011. 84.

12 Ibid.

13 Erwin Panofsky, Perspective as Symbolic Form.(New York: Zone Books, 1997), 13.

14 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011,18.

15 Gu, Ning, and Xiangyu Wan. Computational Design Methods and Technologies: Applications in Cad, Cam, and Cae Education. Hershey, PA: Information Science Reference, 2012, 140.

16 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011, 24.

17 Dibner, Bern. *Moving the Obelisks*. Cambridge, Mass.: M.I.T. Press, 1970, 24.

18 Ibid.

19 Alexander Keedy et al., “Comparison of Traditional Methods with 3d Computer Models in the Instruction of Hepatobiliary Anatomy.” *Anatomical Sciences Education* 4, no. 2 (March/April, 2011): 85.

20 Petersson, Helge et al., “Web-Based Interactive 3d Visualization as a Tool for Improved Anatomy Learning.” *Anatomical Sciences Education* 2, no. 2 (March/April, 2009): 66.,

Alexander Keedy et al., “Comparison of Traditional Methods with 3d Computer Models in the Instruction of Hepatobiliary Anatomy.” *Anatomical Sciences Education* 4, no. 2 (March/April, 2011): 84.

21 DiCarlo, Stephen. “Teaching Alveolar Ventilation with Simple, Inexpensive Models.” *Advances in Physiology Education* 32, no. 3 (September, 2008): 185.

22 Gu, Ning, and Xiangyu Wan. Computational Design Methods and Technologies: Applications in Cad, Cam, and Cae Education. Hershey, PA: Information Science Reference, 2012, 141.

23 Ibid.

24 Nikolić, Dragana “Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3.” PhD diss., The Pennsylvania State University, 2011, 25.

25 Walz, Steffen P. Toward a Ludic Architecture: The Space of Play and Games. Pittsburgh, Pa.: ETC Press, 2010, 33.,

Sutton-Smith, Brian. The Ambiguity of Play. Cambridge, Ma.: Harvard University Press, 2001, 6-7.

26 Sutton-Smith, Brian. The Ambiguity of Play. Cambridge, Ma.: Harvard University Press, 2001, 6-7.

27 Ibid.

28 Walz, Steffen P. *Toward a Ludic Architecture: The Space of Play and Games*. Pittsburgh, Pa.: ETC Press,

2010, 4.

[29]Huizinga, Johan. *Homo Ludens: A Study of the Play-Element in Culture*. International Library of Sociology. London: Routledge and Kegan Paul, 1980, 7.

[30] Huizinga, Johan. *Homo Ludens: A Study of the Play-Element in Culture*. International Library of Sociology. London: Routledge and Kegan Paul, 1980, 173.

[31] Nikolić, Dragana "Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3." PhD diss., The Pennsylvania State University, 2011, 46.

[32] Mcclarty, Katie et al., *A Literature Review of Gaming in Education*. New Jersey: Pearson Publishing, 2012. http://researchnetwork.pearson.com/wp-content/uploads/Lit_Review_of_Gaming_in_Education.pdf, 15.

[33] Nikolić, Dragana "Evaluating a Simulation Game in Construction Engineering Education: The Virtual Construction Simulator 3." PhD diss., The Pennsylvania State University, 2011, 46.

[34] Alexander Keedy et al., "Comparison of Traditional Methods with 3d Computer Models in the Instruction of Hepatobiliary Anatomy." *Anatomical Sciences Education* 4, no. 2 (March/April, 2011): 89.

Light Resistance:
Correlating Spatial Consequences with Formal Maneuvers

Victoria McReynolds

Texas Tech University

Introduction

Light is a natural physical phenomenon the complexity of which reveals the structure of human consciousness....The more complex and nuanced the stimulation, the more fully the brain comes to life. Shape, edge, texture, color, shadow, highlight, playing with and against one another, effectively enable the brain to make the most subtle distinctions, thereby imbuing human experience with a richness and complexity that defines it.[1]

Light is an underutilized tool in the lesson of form making. Spatial consequences of design decisions are unavoidably evident as students test, refine, and demonstrate light behavior. Performance based process negates architectural preconception by marginalizing aesthetic judgement. Light becomes an active agent in space making when correlating aperture, threshold, vessel with pressure, dissipation, reflection. Regardless of size, light continuously operates at a one to one relationship integral with material dictation while capable of transcending scales. Light exercises in beginning design are best used to leverage the relationship between immaterial space and material form making.

This paper considers the material properties of light as a productive subject matter and argues the necessity of optic-based exercises in foundation design studios. *See Seeing* is a semester long project for second-year architecture students encompassing optical analysis, optical devices, and building design that forges spatial consequences with material formulation. Example projects by three students demonstrates architectural sequencing created in dialog with light's resistance. The *Optical Devices* exercise capitalize on potential for spatial complexity in our physical environment by challenging students to propose sequences demonstrating light's capacity for redirection, capture and extraction.

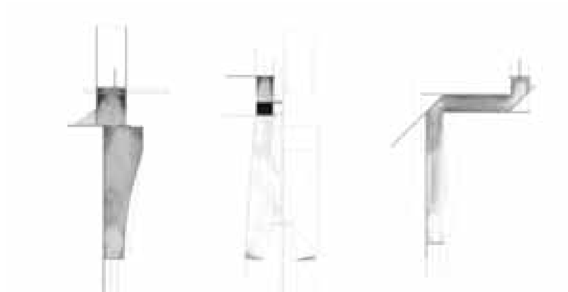


Fig. 1: Optical Device Drawing: Technical and Atmosphere. Student work by Christy Purcella.

Optics stimulates curiosity and atmospheric wonder in people. However, with the advent of digital electronics choreographing spatial limitations factor less in product design. Convenience, mobility and size drive an industry of small seamless devices. Circuits, voltage and algorithms unfettered by spatial arrangements are the forces determining digital performance. Spatial complexity is simplified as a result of formal freedom. Empirical engagement of economically efficient and homogeneously vast built environments amounts to little spatial intelligence depriving opportunities to internalize cause and effect relationships. Appropriating optical instruments, such as cameras, telescopes, binoculars, film recorders, as precedent for material and atmospheric teachings opens untapped creativity in students for spatial inventional.

The success of *See Seeing* hinges on the student's ability to shape light and control resistance by establishing a correlation between material and spatial constraints. Physical modeling is the vehicle for testing and demonstrating light events that are further documented through photography and drawing. Performance rather than aesthetics drives the critical dialog with students allowing each individual to develop their own identity. Mastering light's behavior of reflection, dissipation, force and transmission is an orchestration between materiality, spatial limitation, orientation and duration. Through optical components of aperture, threshold, and vessel basic architecture principles of size, program, and context can be introduced and successfully integrated without sacrificing nuance and complexity.

Optical Analysis 01: Replacing Sight by Light

Each student is responsible for selecting an optical instrument from which to begin the semester. Only two constraints guide their decision: the optical instrument must rely on analog performance and there must be a minimum of two lenses. A fantastic range of instruments have made their way into studio varying from cameras, projects, video recorders, binoculars, and a telescope. Each one inspiring stories of amazement and use such as the Brownie Target Six-16, Brownie Hawkeye, and Polaroid “Big Shot” famously known as one of Andy Warhol’s favorite cameras.

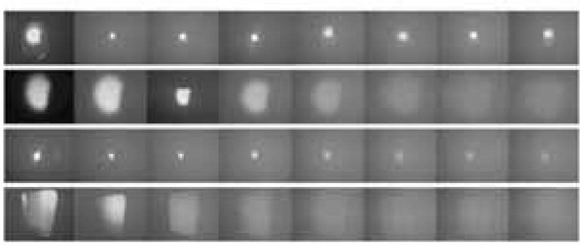


Fig. 2: Optical Instrument Analysis 01: Replacing Sight by Light. Evidence strips work by Harrison Marek.

We begin by looking at the optical instrument performance, not as it relates to the design of one’s eye but as a channel for moving light. This is accomplished by projecting light through all optical paths and photo documenting the resulting image referred to as the “evidence strip” (Fig. 2). Exploring limits and range are significant as the student pushes light through their instrument in order to find exceptional light moments when varying the distance between the light source and their instrument and the distance between the instrument and projected image.

Optical Analysis 02: Optics Language

Dissecting the device is the primary means for learning the optic language of aperture, lens, reflection, refraction, and vessel geometry. A series of measured technical drawings through the optical paths provide a scaled understanding of the spatial and material proportions. Diagrams (Fig. 3, upper series) analyzing three conditions of internal controls (spatial & material), external constraints from the instrument to the eye, and external constraints from the instrument to the viewed object are derived from these drawings.

Optical Analysis 03: Characteristic Diagram

Characteristic Diagram (Fig. 3, lower series) illustrates the conclusion of analysis and catalyst beginning for making. The diagram is intended to capture a unique quality of performance or arrangement observed in the original instrument. Essentially answering the question what makes the optical instrument unique.

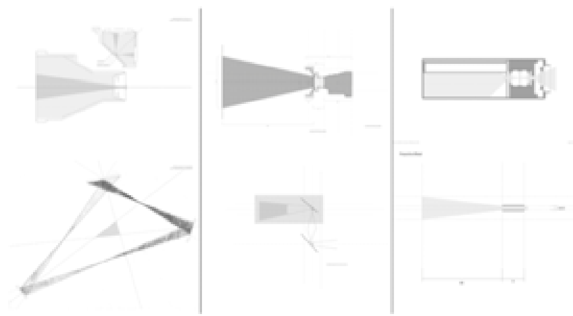


Fig. 3: Optical Instrument analysis diagram and characteristic diagrams. Student work from left to right: William Pellacani, Christy Purcella, Christopher Pope.

Optical Device Drawing: Technical and Atmosphere

Drawing is utilized as a means to combine the technical and atmosphere conditions of their device (Fig. 1). Technical drawing exercise requires the student to address the material conditions and boundaries of the device they propose. Atmosphere drawing exercise requires the student to document the light and shadow behavior acting with in their device.

The learning object is to reinforce the correlation between their design decisions and the resulting spatial conditions of the device light behavior.

Optical Device Modeling: Creating the Condition

This phase of the project builds upon the characteristic diagram and asks students to realize light in their device through three conditions: redirect, capture, and extract (Fig. 4). Each relationship is developed as a design conversations of apertures, thresholds, and vessels. Emphasis is placed on developing complexity by iterative modeling and refined architectural language of enclosure and connections.

Project 01: Infinite Loop of Light

This project's Characteristic Diagram "Regeneration of Dissipation" organized apertures to two variations: at the center and at the ends. Apertures located at the ends both redirected and released light as it traveled from one vessel to the other. While apertures located in the center provided a perpendicular opening to the direct light path designed. Thresholds further articulate the edge of each aperture by extending a surface for the diffused light to project across. Materials with various translucencies also play a role in controlling the quality of light.

Fig. 4: Optical Devices demonstrating light performance according to concept. Student work from left to right: Project 01 - William Pellacani, Project 02 - Christy Purcella, Project 03 - Christopher Pope.

Project 02: Parallel Registration

"Parallel Registration" is a project that materialized light as two paths transitioning from separate explicit vessel enclosures towards one shared implicit vessel. One path shaped light along a single corridor introducing a staging of three thresholds. The other path stretched light across a long corridor introducing thresholds as an act of redirecting light. Parallel Registration exaggerated the characteristic diagram (Fig. 3) in order to convey complexity and play along the light path.

Project 03: Proportion Bleed

"Proportional Bleed" is a project that maintained mathematical proportions within the device to test light and design while adjusting the orientation and position of the characteristic diagram in relation to the perimeter. The original instrument relationship of a small vertical aperture to a large projected plane served as the base unit from which the student developed the device.

Conclusion

The intent in this series of light studies is that students directly engage the technical and poetic phenomena of immaterial as a reality rather than abstract notion. In structuring exercises that remain focused on light performance rather than light sensation shaping materials become the critical medium from which to arrive at a holistic intention. Consequences of material design choices are relentless evident in the immaterial outcome.

Acknowledgements

Students whose work illustrates the ideas in this paper are Harrison Marek, William Pellacani, Christy Purcella, and Christopher Pope.

Notes

[1] Lebbeus Woods, April 20, 2012 (2:49 p.m.) "Measuring Light", *Lebbeus Woods Blog*, http://lebbeuswoods.wordpress.com/2012/04/30/measuring-light/

On the Value of Craft
in Contemporary Architectural Education

Melissa Ng

University of Waterloo

In a recent encounter with a graduate student using a CNC router to carve wood, I realized that without a basic understanding of material, the potential of digital fabrication tools remains largely untapped. The student was routing out table legs from a slab of walnut, however, the wood was oriented with the grain across the width of the leg as opposed to along its length. As a result, the leg—unbeknownst to the student—would be subject to shear failure due to short grain. As 3D modelling, computer programming, and digital fabrication continue to replace more traditional design/build curriculums, the problematic gap between the study of architecture and material reality continues to increase.

The digital-era architecture curriculum distances students from manual labour and meaningful tactile interactions with material and material processes by way of virtualization and automation. Virtualization and automation, however, cannot replace the time-honoured lessons that come from craft traditions.

Pritzker Prize-winning architect Peter Zumthor expresses his view on contemporary architectural education in a recent interview published in the New York Times: “We should force universities to train carpenters and woodworkers and leather workers [...] Architects [have] lost contact with the real business of building”[1]. Zumthor’s emphatic message reminds us that architecture exists in the physical realm: that the materials architects specify have physical properties, laws, and limits; that students stand to learn much about the nature of material and construction through well-established craft traditions.

It is important to note that the lack of material understanding in architectural education is not new, and certainly not the result of advances in digital technology. In an anecdote from 1903, Adolf Loos describes a saddle maker’s design experiment: aspiring to create a modern product, a saddle maker enlists the help of a University Professor and his students to create designs for a modern saddle. There are thirty submissions, including some designs by the University Professor himself. Upon reviewing the submissions, the saddle maker remarks to the professor, “My dear sir! If I had known as little as you do about riding, horses, leather and labour, I too would have your imagination”[2]. Similar to Zumthor, Loos argues for a more sensible approach to design; one where material understanding is met with a sensitivity to function, and a knowledge of the technical skills and capabilities of the labour force. The sensible approach to design that Loos calls for is already highly developed in craft traditions like woodworking.

Even among woodworkers, the challenge of instilling the importance of tradition has existed since the Industrial Revolution. Ernest Joyce, author and esteemed cabinetmaker, writes, “To those pundits, therefore, who may claim that the teaching of hand skills is no longer relevant in this day and age it can be pointed out that anyone who has been shown to force a piece of wood against a mechanised saw will have learnt very little, but if he has had to saw that piece of wood by hand he will be more likely to know that much more about it, he will have a greater respect for it and will understand in greater depth the problems that will have to be faced in its manipulation”[3]. Joyce’s argument, which was a reaction to his contemporaries’ unquestioning embrace of power tools, is even more relevant today as digital fabrication tools occupy an ever increasing role in design schools. Similar to power tools, digital fabrication tools separate the maker from directly engaging the material at hand. Without prior fabrication experience, students using these tools risk becoming mere spectators of the making process. Joyce argues that the direct sensual feedback one receives when a material is worked by hand, allows a maker to better understand a material’s inherent properties and to be mindful of its limitations. Fine craftsmanship is not the result of the maker alone, it is the result of a careful relationship between the maker and the material. Tactile experiences can help forge this relationship and must compliment the increasingly virtual paradigm of formal architectural education if true innovation is to be achieved.

Fig. 1. Discovering the form: Carving a chair backrest with knives.

Learning by Woodworking

Over the past two-and-half years, the focus of my studies as a graduate student has been the relationship between maker and material, with an emphasis craft traditions. I spent the majority of my time in my school's workshop, hoping to gain insight into materials and construction. Upon entering the graduate program, my partner and I had reclaimed some twenty twelve-foot-long eastern white pine boards and we were stubborn to build a harvest table with our reclaimed material. However, we would soon find out that due to an unacceptable risk of damage inflicted by nails and other hidden imperfections, we were prohibited from using any power tools to dress our reclaimed wood. Without the aid of power tools, we chose to build the table by hand. I knew nothing about traditional woodworking when I first picked up a hand-plane, but I was soon inspired by the richness of the craft: the quality of a hand-planed finish, the spirit of craftsmanship, and the nature of material. I was amazed by the wealth of knowledge contained within craftwork; I was amazed by the tools themselves and what they could reveal about the wisdom of our ancestors. Although I was intrigued by Ernest Joyce's words when I first read them, it was only after I had started to engage traditional methods of woodworking, that I understood the pedagogic potential of hand tools and manual work.

Fig. 2. Finished Chair, by Melissa Ng

When planing a wood board by hand, the body experiences direct sensual feedback: wood tears out when planed against the grain, a continuous shaving indicates the flatness of the board, and the scent of freshly cut fibres signal the genus of wood. The process of manually marking out each cut with a carpenter's square refines one's understanding of construction tolerances. Carving knives allow for a form to be gradually discovered in the making process (See Fig.1, Fig.2). The 'binding' of a handsaw can often reveal the high moisture content in unseasoned wood.

I learned that when it comes to finishing a piece of furniture, the hand-planed finish is unrivalled. George Nakashima, a highly revered mid-century Master Woodworker and architect, comments on the hand-planed finish in *The Soul of a Tree*. He writes: "For the best work, the [blade] is sharpened after each stroke, not because it is dull, but because the finest finish demands it"[4]. Nakashima writes without exaggeration: after a few minutes of using a recently honed blade, I can feel a tangible difference on the surface of my own projects. Interestingly, I found that even a dull plane blade can often leave a rather smooth finish when compared to sandpaper. Sanding abrades the surface of wood and tears wood fibres. Repeated sanding fills in the damaged wood pores with dust created in the process. By working with ever-finer grits of sandpaper, a smooth surface can eventually be achieved with the caveat that light cannot penetrate the torn, dust-filled fibres. This has the unintended consequence of making the wood surface look and feel dull or worn down. Sandpaper finer than 600-grit is required to achieve a quality that even begins to look like a planed finish. [5] Hand-planing (or any woodworking tool with a trenchant steel blade), shears wood fibres cleanly and leaves a crisp edge. Light is able to penetrate the wood surface and reflects back to reveal the three-dimensional grain structure (see Fig. 3).

How wood is processed affects the quality of the finish it can receive. The finishing process itself is one of the most underestimated stages of any built work. Achieving a fine finish can sometimes take as long as the entire making process leading up to the finishing stage. When finishing wood in humid environments, a single coat of pure tung oil (arguably one of the finest oils for wood) can take several weeks to fully cure. Even though architects are generally not involved in the physical building process, understanding the nature of various finishes, for example, can lead to informed decisions when it comes to specifying materials and finishes that make a big difference in the quality and cost of a project. This foresight can be developed in architecture students through building and working with material.

Fig. 3. Hand-planed butternut wood with five coats of pure tung oil finish

The transformative experience of working material is aptly described by Nakashima. He writes, "[the] hands develop in a special way with intense and concentrated use. The flesh becomes stronger and heavier in certain areas, better fitted to grasp and use the tools"[6]. With practice, hand tools become extensions of the body, and allow an extraordinary amount of subtle tactile information to pass through the body. Craft traditions, such as woodworking, embody more than five thousand years of subtle tactile wisdom that can be accessed by using tools that have evolved from those traditions.

Because many craft traditions are still practiced, I can continue to learn from them. I am amazed when I learn about our ancestors' understanding of material, as revealed by 'primitive' tools and technologies. For instance, the yarikanna or Japanese spear plane—a thousand year old technology and predecessor to the hand plane—can cut the cell walls of a piece of wood so cleanly that no water is able to penetrate the wood's pores and thus, the wood is able to naturally resist mould.[7] In an age where sustainable construction is becoming increasingly important, we can learn a great deal about responsible and intelligent use of material from our ancestors. The knowledge of material properties, uses, and solutions, is survived by craft traditions and deserves vigorous renewal in architecture.

The Value of Craftwork

For me, building a harvest table—a year-long process—was physically, mentally, and emotionally demanding. While other students were learning how to use laser cutters, CNC routers, and 3D printers, I was learning about wood, building science, and the cultural history of woodworking, papermaking, and pottery. While my classmates were learning about computational design, I was learning about traditional joinery and how to design for the movement of wood. I spent hundreds of hours learning how to sharpen steel blades and how to properly use a handsaw—all while building a table, making paper, and throwing pottery (See Fig.4). At a time when architecture is increasingly explored and represented digitally, my graduate research into traditional woodworking placed me at odds with the interests of many of my peers and professors. In many ways, the entire endeavour was shadowed with doubt.

Reflecting on my experience of the past few years, I am sure now—beyond a doubt—that working material with my hands has positively reshaped my understanding of architecture and design. Knowing that there are unique limitations and potentials to every material, I now consider material properties contextually, from a functional and experiential perspective. Having constructed several full-scale, fully-functional details with real materials subject to real forces, I am now better able to visualize construction assemblies and the forces acting on those assemblies. We have all heard the dictum 'architecture is in the details', but how often do we consider that joints and joinery support architecture? They are structural, experiential, and can be artful. My experience has revealed to me the importance of considering the availability and cost of materials, and the skill level of labourers. I am mindful of how a built work will endure through time and how a built work will affect others.

Reflecting on that New York Times interview with Peter Zumthor, I cannot help but to agree with him in that prospective architects need to engage with real materials and real construction practices. This advice deserves the serious attention of design educators. There are fundamental lessons about architecture that come from woodworking, leatherworking, and other forms of craftwork: lessons that are compromised when virtual and automated tools replace direct, tactile experiences. Although I do not believe that beginning design students should work solely by hand, I do believe that students can greatly benefit by developing a wider skill set from continued exposure to handwork and craft traditions.

I was fortunate in my graduate studies that the rigour of my material exploration was not compromised by the pressures of time. I spent nearly three years making a table, four chairs, ninety-four earthenware pots, and a lamp. I was privileged to have patient professors that understood the importance of tradition; I was given the opportunity to pay concentrated attention, and the chance to slow down. I was provided with an adequate workspace, encouragement, and solitude. Most importantly, I was given the chance to listen to my inner voice and—much like the master/apprentice tradition—I had to find my own way.

Fig. 4. Graduate thesis work, by Melissa Ng

Notes

1 Michael Kimmelman. "The Ascension of Peter Zumthor." *The New York Times* (New York, NY), Mar. 11, 2011.

2 Janet Stewart, *Fashioning Vienna: Adolf Loos's Cultural Criticism*. (London: Routledge, 2000), 119.

3 Ernest Joyce, *Encyclopedia of Furniture Making.* (New York: Drake Publishers, 1976), 11.

4 Nakashima, *The Soul of a Tree: A Woodworker's Reflections* (Tokyo: Kodansha International, 1981), 128.

5 Scott Wynn, *Woodworker's Guide to Handplanes.* (East Petersburg, PA: Fox Chapel Publishing, 2010), 8.

6 Nakashima, *The Soul of a Tree*, 113.

7 S. Azby Brown, *The Genius of Japanese Carpentry: An Account of a Temple's Construction.* (Tokyo: Kodansha International, 1989), 76.

You Ain't Seen Nothing Yet:

Architectural Precedent Studies Enhanced by Physical Site Visits

Deborah Oakley

University of Nevada, Las Vegas

Introduction

The use of precedent studies in architectural education is a longstanding tradition, with valuable lessons gained in studying excellent examples from both past and present. Constructed effectively, they become a systematic study of a building in its many aspects, including sociocultural dynamics, contextual influences, hierarchical and organizational strategies, plan layout, horizontal and vertical circulation patters, material assembly, structural and environmental systems integration, and more.

One of the risks, though (even with in-depth studies), is that students may develop a mistaken notion that a *real* understanding of the building has been obtained, that they actually *know* the project, when in fact the only interaction has been with a *representation* of it. However "real" a virtual reality model may be, there is still no substitute for actually putting one's hands on the actual material texture of a building, or of physically moving through its spaces and experiencing the sensations of light and sound therein. Similar to the difficulty in trying to explain the taste of chocolate to someone who has never tasted it, without physically interacting with physical materiality it is difficult if not impossible to obtain a true sense for a building.

This paper describes a studio learning experience where the faculty sought to extend the notion of precedent studies. By combining diagrammatic analysis with physical visits to the projects under study, the objective was to have students better understand the direct connection between representations of buildings and the actual buildings themselves. The use of on-site visits to buildings, whether local or abroad, of course forms another longstanding tradition in architectural education; but here we were explicit about connecting research with physical experience in an effort to create a more thorough understanding.

"*This* is My Precedent"

Beginning students of design do not *a priori* grasp either the mechanics or the implications of conducting a thorough case-study investigation of a project. With the Internet serving up an endless supply of architectural imagery, the fledgling student may easily conclude that a few photographs will satisfy the requirement to "include a precedent study in your research." But executed superficially without further examination, they are little more than inspirational images; simply window dressing on a presentation.

The following hypothetical dialog typifies the type of exchange a beginning student might have during a design critique where specific guidelines were not provided on the research:

Student: (Pointing to a printed picture pinned on the wall before immediately proceeding to discuss her design.) "And so this is my precedent, and what I did in my design was…."

Design Critic: "Hold on just a second before you go on… let me just ask you first what is it that's important about that project relative to your design?"

S: "I like the form and how it engages the city."

C: "Can you explain that more?"

S: "Well, I feel it really expresses an idea of movement and I like the playfulness of the shape."

C: "I see. And do you know where it's located?"

S: "Umm, I think it's in Pittsburgh."

(Student in the background: "No, remember, it's Philadelphia!")

S: "Oh yeah, that's right…Philadelphia. I knew it was somewhere in Pennsylvania. I'm not from that region of the country so I wasn't sure."

C: "Okay, that's fine, so maybe next time you'll be sure to check those basic facts. And what are the primary materials?"

S: "Umm, I think it's brick. Or maybe it's concrete. I'm not really sure."

C: "Alright, so you need to find out what it's constructed from as well. So tell me, then, what you do know about the project."

S: "Umm, well, it's a theater!" (says the student with a nervous smile)

C: "Well, that's good. Since your design project is a small theater, it's a good thing that you're looking at the correct building typology. But have you looked at the organizational strategies or the primary circulation routes through the building? How about it's relationship to the city grid? Have you found any facts about the square footage of the major spaces? Have you looked at the building systems and how they and the structure are integrated with the architectural concept? I don't see any other diagrams other than the one photo pinned up."

S: "Umm, no, I haven't."

C: "Then how is this a precedent for your own work?"

S: "Well, I found it on the web and I though it would be a good starting point for my design."

C: "And what web site was that?"

S: (Now feeling increasingly defensive and fidgety) "Mmm, I think it was ArchDaily, or maybe it was Architecture Week…I don't quite remember."

C: (Feeling slightly annoyed at how little the student knows about the project being referenced) "Okay, I'm not trying to make you uncomfortable. I'm just trying to understand what you're learning from this project. What I get so far is that this theater that you're not sure the location of, what the organizational strategy is, how large the primary spaces are, what materials it's made of, and what the systems are…this is your precedent study."

S: "Umm, yes. Our studio professor told us to research precedents."

C: "Well, I'm afraid that what you have here is an inspirational image and that's about it. Without actually dissecting the building and studying it in detail, and learning it's lessons, it's not a precedent study! All right, we've spent enough time on that, let's talk about your design concept."

S: (With a sigh of relief coming out of hot water). "Okay, yes! That would be good!"

And so it is that if not given explicit directions on what to study, the beginning student will not necessarily undertake the requisite detailed investigation of a project. In order to have any true effectiveness then, the first step is to clearly define the expected outcomes of the analytic study of the precedent project.

The Precedence of Precedents

Arguably the most widely cited contemporary text on the subject of precedents, Clark and Pause's *Precedents in Architecture*, has been a classic in the field for nearly thirty years. Occupying the shelf of many an architect and student of the field, it has become a de-facto reference. Now in Its fourth edition, the book includes the work of 38 distinguished architects and some 118 projects abstractly diagramed in terms of multiple criteria.[1]

While the book excels at diagramming the projects, it intentionally makes no attempt to reproduce them photographically; instead, it is left to the reader to further research. It is thus a valuable tool for a deeper understanding of these projects analytically, but considered on its own requires further augmentation for a fuller understanding of the various structures.

There have been at least two ongoing studio experiments to generate organized computer databases of architectural case studies. One has been conducted in the United States by Akin[2], and one in Belgium by Heylighen and Verstijen[3]. Both of these employ a systematic approach drawn from extensive research in Case-Based Reasoning (CBR) in the field of computer science, and extended to Case-Based Design (CBD) in architecture.

Akin describes an architectural case as "the codification of all of the information necessary to describe a precedent, which can be used in solving new architectural problems. Akin argues that "After all, the entire studio approach is based on learning from experience and CBD tools could provide students with relevant experience that they have not (yet) had by themselves."

The outcomes of the experiments by both Akin and that of Heylighen and Verstijen are both positive and mixed. They are positive in that the students appeared to be engaged by the computer tools; however, in the case of Akin's research, among the conclusions is that "The active use of a case to generate complete and complex solutions is not supported by our data." Heylighen and Verstijen express a slightly more positive spin that the "overall quality of the design as related by the studio staff as well as its concept, reuse, form, function and creativity as rated by an external judge turn out to be positively related to the frequency of using the CBD tool."

Despite the apparent success of these experiments, however, (and in the case of Akin's work this covered a time span of a decade of development), such tools are still not at all widely employed in design education. It is further of interest to note that none of these authors appear to have produced further articles along the lines of this research in the subsequent decade since their publication in the early 2000s.

Bridging Theory and Reality: The Precedent Study-Site Visit Exercise

As noted above, we contend that however important analytic exercises may be to studying an architectural precedent, and however thorough they may be executed, and however deeply developed a computerized database of cases can be created, there is still a vital component missing from this endeavor. Absent that other staple activity of architectural education, the physical site visit, precedent studies remain somewhat abstract.

We thus structured the primary studio learning experience around both facets of in-depth precedent studies combined with physical visits to the precedent projects themselves.

The building typology elected for the main semester design project was a small public library. It was felt that this was a structure that all of the students should have spent time in by this point of their lives, and was a manageable as well as engaging program for an entry-level design studio. In addition, since we are a school based in Las Vegas, the nearest major city with a similar climate is Phoenix, Arizona, home to a number of award-winning public libraries constructed in the past twenty years.

Another consideration was that many students in our program have little travel experience, and most have never been to the metropolitan Phoenix area despite its close proximity (about a five hour drive). The field trip was therefore an experience that would potentially benefit them on many levels, both sociocultural as well as academic. In the end, approximately two-thirds of the students from two studio sections were able to participate in the field trip aspect of the exercise.

Five libraries were chosen to study. Four of the projects were small branch libraries roughly equal to the program size of the studio design project. The fifth library was the Phoenix Central library, designed by Will Bruder in the early 1990s. Though vastly larger than the studio project, this building itself was precedent setting and became one of the major catalytic forces for a contemporary Renaissance of public architecture in the Phoenix metropolitan area. Being well documented we therefore felt it appropriate to include this in our list of research projects. (Fig. 1)

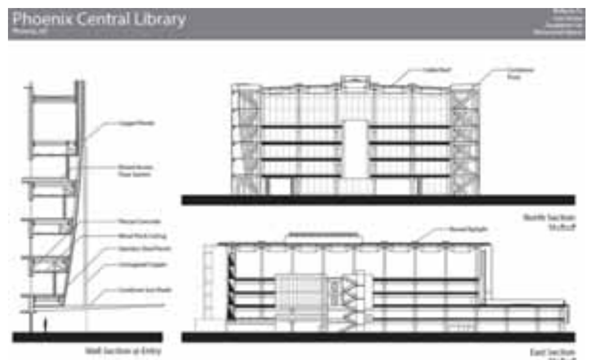


Fig. 1. Orthographic section drawing of the Phoenix Public Library generated by students.

The other four projects were the Desert Broom and South Mountain Community Libraries in Phoenix, and the Arabian and Appaloosa libraries in Scottsdale, Arizona, a city immediately to the east of Phoenix. The first thee of these projects were designed by the Phoenix firm Richärd+Bauer, and the last by DWL Architects, who also had collaborated with Will Bruder on the Phoenix Central Library.

Students were broken down into teams of three or four individuals for the study, which consisted of several phases. The first phase was one of research. In addition to their own independent research, the student teams were supplied access to articles published on the projects and partial sets of the actual construction documents generously provided by the design architects where available. The Phoenix Public Library was very well documented so no additional materials were acquired or needed.

With these materials, the students conducted the second phase of preparing both traditional orthographic drawings (site, floor plan, section, elevation and wall details), as well as virtual 3D models of the building parti and massing and exploded axon drawings (Fig. 2), circulation, structural and mechanical systems (Fig. 3). A two page written description was also required from each of the project teams to accompany the final printed documentation.

In the third and final in-house phase, each individual team then digitally presented their research and documentation to the rest of the class using PowerPoint, and we discussed their research at length. Thus all students were able to become somewhat familiar with each of the different projects, with each student team becoming the "experts" for one specific project.

Arriving in Phoenix well prepared with a deep exposure to the projects either from their own research or garnered from their classmate's presentations, the fourth phase was the field trip itself. Each of the five libraries were visited during this trip, as well as a few other highlights that we were able to squeeze in such as a final day tour of Wright's Taliesin West.

The head librarians of the various projects were justifiably enthused about their projects and happily agreed to provide tours of the back-of-house activities at the libraries. For the Phoenix Public Library, the head of facilities who had been involved from the conception of the library in the early '90s generously came in on a Saturday morning before the building opened to give a detailed guided tour. (Fig. 4)

Included in this experience was an office visit with James Richärd of Richärd+Bauer (Fig. 5) and a guided tour of the Appaloosa library with Jeremy Jones of DWL, so students were able to have a great discussion and ask pointed questions about the project designs and the architects' working methods. We are grateful to both of

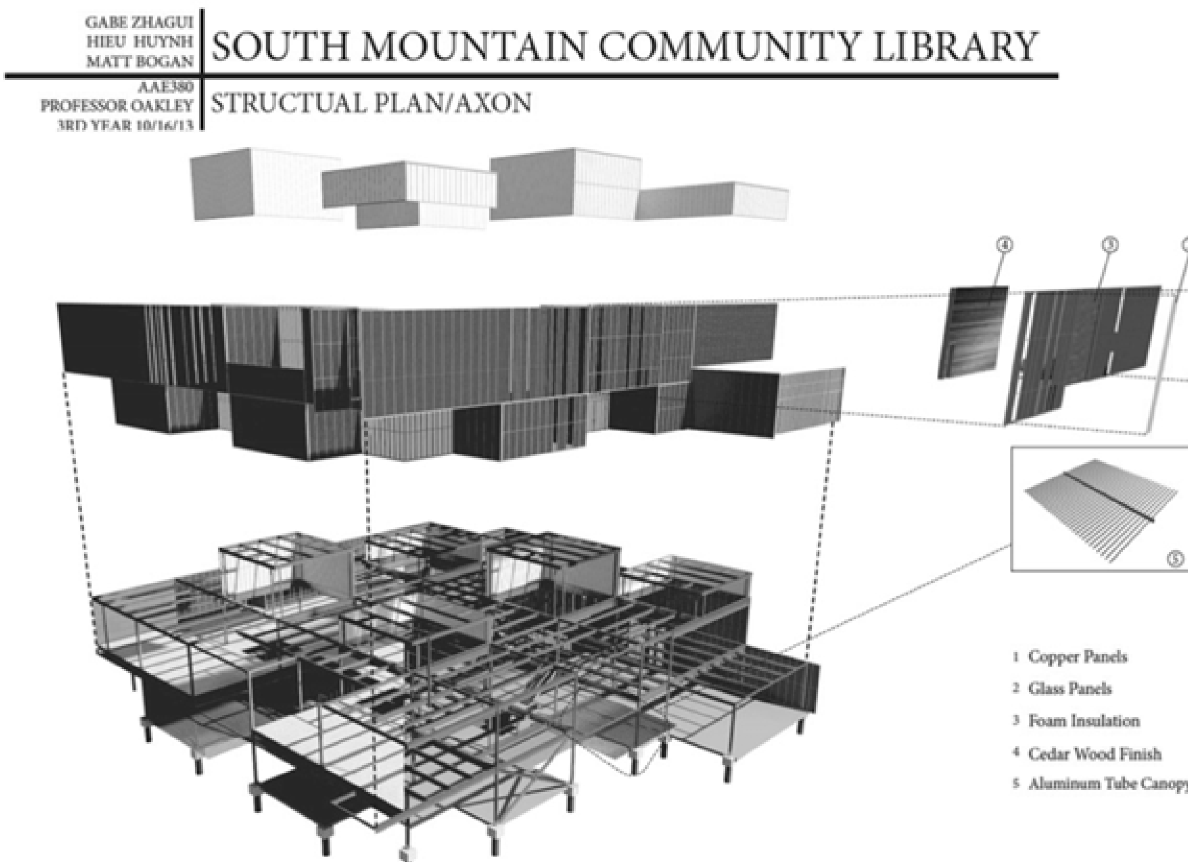


Fig. 2. Exploded axon structural assembly diagram for the South Mountain Community Library, generated by students based on construction documents.

these practitioners for taking time out of their busy schedules to meet with our students.

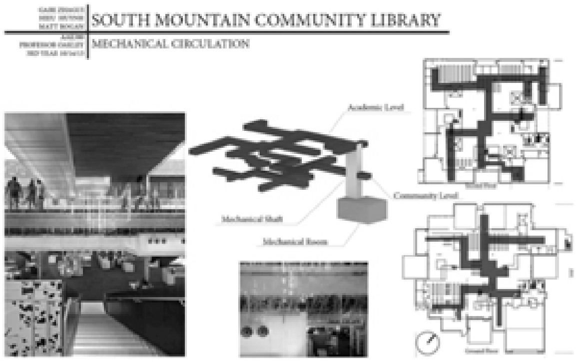


Fig. 3. Mechanical systems diagram for the South Mountain Community Library, generated by students based on published documents.

Fig. 4. A behind-the-scenes tour of one of the mechanical rooms at the Phoenix Central Library.

Fig. 5. Students and faculty meeting at the office of Phoenix-based architect James Richärd.

Discussion and Future Research

It was encouraging to witness that the first-hand experience of the projects definitely appeared to augment and transform the student's understanding beyond their previous research. Though providing only anecdotal evidence, typical comments expressed at the various project sites were along the lines of "Wow, it's so much *smaller* than I thought it was from the photographs!" or "The color is so much different than what I had envisioned," or "Now I finally understand what that diagram was illustrating!"

Additional anecdotal evidence from student comments comparing the previous year (when a less formalized and closely linked precedent study was undertaken) versus the structured exercise described here, indicate that the directed study has yielded a more positive outcome. Students truly seem to have found this a significant learning experience that positively shaped their conceptual and experiential understanding. This ultimately informed the students' own design of the library studio project that followed the combined study-travel experience.

Where this exercise should be extended further is an additional effort to close the circle of learning and take the learning experience to the next level. Additional time should be given to revisit the documents produced prior to the field trip to make corrections and amendments to the precedent diagrams after the projects have been visited. It may be desirable to also collect a record of the student experiences in a diary or blog format that provide a more formalized documentation.

In the end this was a valuable exercise that bears repeating for future classes, and we look forward the next offering of the studio with a new class of eager students.

Notes

[1] Roger H. Clark, and Michael Pause, *Precedents in Architecture: Analytic Diagrams, Formative Ideas, and Partis.* 4th Edition. (Hoboken, NJ: John Wiley and Sons, Inc., 2012).

[2] Ömer Akin, "Case-based instruction strategies in architecture," *Design Studies,* 23, no. 4 (2002): 407-431, 10.1016/S0142-694X(01)00046-1 (accessed January 15, 2014).

[3] A. Heylighen, and I.M. Verstijen, "Close Encounters of the Architectural Kind," *Design Studies*, 24, no. 4 (2003): 313-327, 10.1016/S0142-694X(02)00040-6 (accessed January 15, 2014).

Soft Drawing

Andrew Santa Lucia, Lisa Smith

Illinois Institute of Technology, School of the Art Institute of Chicago

The imagination works with eyes open. It alters and is altered by what is seen. The problem is that if we admit this, then the relation between ideas and things turns mutable and inconstant. Such destabilization is bound to affect our understanding of architectural drawing, which occupies the most uncertain, negotiable position of all, along the main thoroughfare between ideas and things. For this same reason, drawing may be proposed as the principal locus of conjecture in architecture...for what is potent in them rather than what is latent.[1]
- Robin Evans

Soft Drawing is the type of communication that relies on bias, intuition and motivation in design processes; mobilizes different mediums, techniques and genres of representation; and champion's imaginative realities. In addition to hard drawing (plans, sections, elevations, schematics, details, etc.), soft drawing can and should be an essential part of the beginning architecture student's education because of its place in mediation of ideas regarding population, performance and future propositions. These three foci create a space for the beginning architecture student to interject their always-already emergent understanding of the world precisely through soft drawings.

As a re-originated trend in architectural education and practice, soft drawings seek to enhance the communicative ability of traditional mediums of representation for both specialized and non-specialized audiences. Soft drawings have been around much longer and may cross genres from simply annotational and descriptive to autonomous and narrativistic, employing techniques from graphic novels, comics, animation, painting and other non-architectural visual fields. These drawings challenge the hegemony of hard drawing in architecture, since they are at least equally effective and at best better in communicating design ideas. In the scope of beginning architectural education, hard and soft drawing should play equal parts in the development of an attitude and discipline towards architecture.

This article will describe three foci of soft drawing that are represented in contemporary architecture. The introduction of these three areas early on in an architectural education can help students grapple with fundamental architectural questions like building, form, program and shape with a perverse rigor and nuanced experimentation. Each section will define the motivated drawing type and distill an argument for it through popular and/or iconic examples. These three foci are: (1) Population drawings—a powerful tool to understand architectural projects by representing people's use of space; (2) Performance drawings—an effective way to describe effects of building performance, materiality and context; and (3) propositional drawing—a projective means of suggesting new worlds and futures.

Populations

Population is an important way to understand the relationship between architecture and people. By adding signs of life to a drawing, the impact of architecture on natural behaviors and real scenarios can be portrayed and critiqued. This type of drawing is useful for both imagining behavioral possibilities and representing existing situations in built or unbuilt works. These drawings are often the basis for representations used to convince a client or a critic of the project's use, viability, and desirability, in terms of its users.

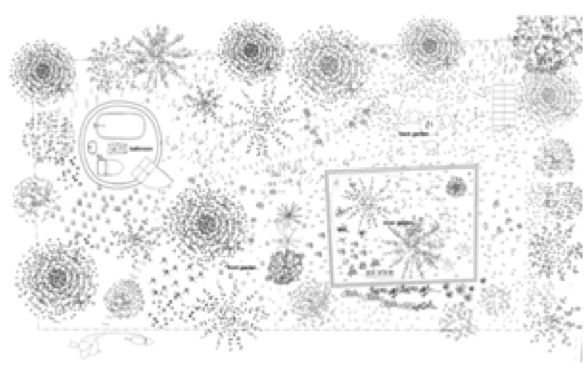


Fig. 1. Plan and Elevation of T project by junya.ishigami+associates. (2013).

In this project, Junya Ishigami proposes a house in London that is more garden than structure (fig. 1). A living unit is reduced to its minimal requirements without sacrificing privacy and comfort. Ishigami proposes a series of inner and outer gardens as the true luxury of the house. He uses soft drawing to obscure the light lines of the architecture in the organic and dense forms of trees, grasses, shrubs, and garden paths. Without seeing the landscape loosely drawn, the viewer can never understand the luxury of the garden for its wild, non-gridded atmosphere. According to Ishigami, he uses drawing not only to represent architecture, but to represent a feeling:

My drawings express a feeling for architecture. The experience of walking through a building is a totality of fragments. When designing, I always imagine a space. I want my drawings to offer viewers the entire architectural experience. I don't like computer renderings or systematic perspective drawings because they represent just one piece of the overall picture.[2]

In a series of axonometric maps and posters developed by ODLCO for the Museum of Contemporary Art Chicago, soft drawings are used to provide visitors with a simultaneous view of all parts of the building and the organization itself (fig. 2). Using an existing BIM model developed to aid preparers in the installation of complex artwork, ODLCO developed sectional axonometric projections to expose interior spaces. Interior colors, people, artworks, objects, and nature were hand-drawn to illustrate the program of each space, painting a picture of the daily operations of the organization.

Fig. 2. Excerpts of ODLCO's Summer Cutaway Map and Winter Cutaway Poster for the Museum of Contemporary Art Chicago. (2013).

Populated soft drawing is used here to represent existing information in a form that is delightful to a general audience. Though the information—the role of the museum curators, the location of the loading dock, or the importance of the museum archive—is not especially visual, when illustrated in space, the system of the museum becomes legible. Though this technique is used here on an existing building and program, it could be adapted to express narratives in unbuilt works or test concepts in developing projects.

Performances

Performance of projects are related most directly to building technology, materiality, context, environment, climate, time, form, shape, building systems and more object-oriented issues. By choosing an aforementioned disciplinary focus, performative soft drawings can activate conversations regarding these issues visually, sometimes through one vantage point rather than two or more e.g. a sections that depict skins systems as mediating climates or a diagrammatic series of stills describing formal manipulation. Blending didactic tools such as text and seriality, performative soft drawings cross boundaries of pure orthographic, perspectival, rendered and animated genres of representation. Through the lens of performance, architects and designers can more generally describe the effects particular building aspects engender through their relationships with any number of other pertinent design issues.

Fig. 3: Peter Cook and Archigram, The Metamorphosis of an English Town. England. 1970.

In this iconic example from Archigram's Peter Cook, the performative elements of architecture and urbanism are portrayed as a metamorphosis. (fig. 3) Issues of context, building systems, skin, materiality, shapes, programs and cultural changes are shown in this strip. The first row introduces the premise of the english town and the new technological developments affecting it. The drawing is predominantly a series of elevational strips with handwritten and stylized text that describe a particular narrative of development above the elevations. Cook's use of snarky criticism unfolds his position that the type of metamorphosis that the English town went through was 'cheek-by-jowl'. [3]

This type of performative soft drawing employs conventional elevation drawing with the use of didactic text meant to lead the reader through a narrative. Moreover, this is also propositional as it communicates the transparent intentions that Archigram had, most evidently the evolution of architectural form and culture through the technological developments occurring at the time. By distilling this motivation through elevational drawing and accompanied by a widely accessible story makes this presentation act more like a singular didactic tool than a supplement to Archigram's futurism - this drawing doesn't depict futurism, it is futuristic in its performance.

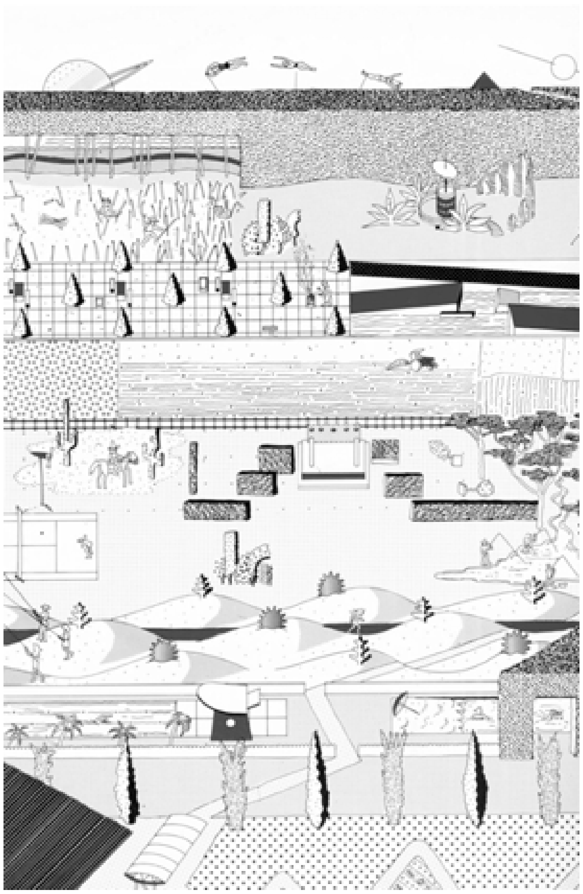


Fig 4. OMA/Rem Koolhaas, Parc de La Villette, Paris, France. 1982.

OMA's Parc de la Villette 1980s competition entry displays an incredible aptitude towards performance. (fig. 4) By using the genre of Japanese landscape painting - an expressively flattened, elongated and condensed method - Koolhaas is able to distill his argument of compartmentalization. The three sections to the drawing act very much like floor plates in a section, more specifically the Downtown Athletic club skyscraper. In Delirious New York, Koolhaas says that,

Such an architecture is an aleatory form of "planning" life itself: In the fantastic juxtaposition of its activities, each of the Club's floors is a separate installment of an infinitely unpredictable intrigue that extols the complete surrender to the definitive instability of life in the Metropolis.[4]

By inhabiting a different genre of representation, Koolhaas was able to expose his project as a horizontal skyscraper, experienced program to program, but not vertically. This genre of landscape painting embodied an integral part of that argument and helped push his programmatic agenda, softly.

A necessary criterion for performative soft drawings should be that they perform for their viewers. Architecture's relationship between itself and other criteria should be expressed explicitly and transparently. In that way, there shouldn't be misunderstanding about what architecture does in any given circumstance. By exposing the exchanges between programs, forms, users, systems and materials, soft drawing gives architects a new avenue to imbue vivid interaction and narrative into their work, showing how it performs under particular scenarios.

Propositions

Propositions are projective by nature and discuss architecture not how it is, but how it may be related to a new future. Propositional soft drawing can inhabit utopian, complicit and/or dystopian future scenarios, using a number of different genres of communication, including videos and animations. The basis of proposition is either acceptance or denial of said proposal, so inserting a viewer into a position to do either elevates drawing from simple representation. Proposing differs from representing in that it seeks a relationship and position from an audience.

MOS architect's designed Instant Untitled, a pavilion for the 2010 Venice Biennale. Their video entitled *Not Negative*, is an example of a soft video that uses their actual pavilion as a backdrop to discuss the future scenarios where bubbles take over the world as the preferred architectural form. (fig. 5) In *Not Negative*, their introduction tells the tale that,

Nobody knows exactly when it all went wrong. But after IT ended, everyone just decided to live outside...The old buildings became fun to visit, but they were ruins form another subjectivity. People just couldn't relate...Everyone just preferred to be under the bubbles, amongst the air waves. The decision wasn't completely rational. And *global warming wasn't the reason for IT, but it helped justify their subsequent decisions.*[5]

Fig. 5: MOS Architects. Not Negative video of Instant Untitled. Venice Biennale. Italy. 2010.

The rest of the video shows scenes of actual people interacting with tethered bubbles in a plaza. As a form of future projection, this video works extremely well as a didactic device and a call to arms rallied around an architectural proposition. MOS does not try to represent their project as it is, but how it might be with the help of video cameras, editing software and a dystopian narrative of how 'IT' took over, played out through very real interactions at the 2010 Venice Biennale.

Fig. 6: And/Or Us Architecture Collaborative. Wally World. A House for Roger Waters Competition Entry. Chicago.2013.

And/Or Us architecture collaborative's Wally World portrays a new architectural world on and about the album cover of Pink Floyd's The Wall. This competition entry for A House for Roger Waters uses normative tropes and situations to elevate the vision of the project into a story about a story. On the packaging label of the album cover, And/Or Us wrote,

The compartmentalization of daily life has been commoditized to strip down the last humanity left. This walled world is embedded with endless adjacencies of cultures and societies. It is scaleless, porous, and dense. The future is always an image of the past and the containers in which we live only incubate our desires for fresh authenticity. How we move forward precisely will be defined by how we break through.[6]

References from life are folded into the actual project by encapsulating babies, cars, planes, waterfalls and Villa Savoye, into it's compartments, as well as into the situation the album cover find's itself in - in a room where the record is taken out of its album jacket to expose its alternate history by the famous hand's of Le Corbusier. Wally World attempts to thrive in its genre as and album cover and photograph.

The enhanced reality provided by a vision of the future makes propositional *soft drawing* an essential strategy. Imbuing narratives of conceivable or ridiculous realities allows users to identify with particular tropes and define their position through the scenario being proposed. In this manner, propositional soft drawings make viewers offers they can't refuse to acknowledge.

Softness Today

We become what we behold. We shape our tools, and thereafter our tools shape us.
-Marshal McLuhan[7]

Soft drawings are not tools as much as they are foils to push work through towards a new understanding of architecture. Soft drawings can be utilized by students to better depict predictable/unpredictable human behaviors; geographical and urban contexts; natural phenomena; and their effects on architecture physically through time, space and place. These modes of soft drawing look to elevate representation from position of supplement to an integral part of project content as it can be a versatile starting or end point in conveying design thinking.

On the other hand, traditional formats of architectural representation do not fit comfortably into the new mediums they are being disseminated in—via the internet, projectors, mobile devices and screens. Beginning design students exist in a seemingly post-digital world where the exact difference between what is real and represented is a matter of opinion and/or medium *e.g. social network versus community.* Soft drawings are adaptable and can comfortably fit those mediums, utilizing animation, interactivity, large format printing, animation and video.

The way architects express their ideas is changing and architectural education should more directly relate to the individual attitudes of future architects, since they will usher in new eras of work. In a hope to tap into the intuitive knowledge of the beginning architecture student, while at the same time delivering a method of drawing that is rigorous, soft drawings will become more than just nuanced expressions of current trends in representation and inhabit a much more raw and foundational part of beginning architectural education.

Notes

1 Evans, Robin. Translations from Drawing to Building. MIT Press. Cambridge. 1997. 154

2 Nuijsink, Cathelijne. *"Natural Highs: Junya Ishigami Blends Building and Landscapes,"* in Frame Magazine, March/April 2012. 86

3 Cook, Peter. Archigram. Princeton Architectural Press, New Jersey. 1999

4 Koolhaas, Rem. Delirious New York: A Retroactive Manifesto for Manhattan. Oxford University Press, Oxford.1978. 157

5 MOS Architects. *"Not Negative"*, video of Instant Untitled. Venice Biennale, Italy. 2010

6 And/Or Us Architecture Collaborative. *"Wally World"*. A House for Roger Waters Competition Entry. Chicago. 2013

7 McLuhan, Marshall. Understanding Media : The Extensions of Man. New York. 1964

Building Drawings:
Connection of Material and Line

Maria Simon, NCARB

University of Hawaii at Manoa

introduction

There are many concepts, skills and tools that need to be taught to basic design students. Some of the most common tools; drawing, digital media, model making, and building fabrication function as the means to describe design ideas. I seek opportunities to explore a unified design process within the intersection of these tools to enrich a beginning design students' learning outcomes. By integrating drawing, modeling and building into a joined design process students can physically learn how representational tools dialog with and serve a material purpose. I focus on the meaning of a line as a theoretic framework for a project, *Building Drawings* that I run with first year students in a Design Communications class. The project leads students through a drawing to building process knitting the two tools together through the process of developing meaning and evolution of a line.

Fig. 1. Still life drawing, every day objects.

Conceptual Framework

Design is a process of looking toward the potential of the future and of reflecting on what has happened in the past. Teaching a clear, journey based design process to first year students allows them to cultivate a taste for lingering and relishing in the design process as an opportunity for self and design discovery. The embodied knowledge gained from a practiced design process frees the student to approach future design challenges with the confidence of a known process regardless of future context or media. A design could be crafted by hand or could be digitally scripted and the outcome will carry the same design intention so long as the author has a clear understanding of *how* they choose to work with a tool. The challenge to the beginning design student, and all designers is to develop a process of representing architecture through a graphic methodology that has a conscious acknowledgement of material responsibility. (Material is understood as the primary currency of architecture.) One possibility is to view this connection of drawing and building through the lens of a line's meaning in architecture.

In architectural drawings the roles of reason and emotion are reversed. Creativity is an experience, not an abstract idea that a mind and body incessantly analyze. -Frascari, "Eleven Exercises," 27.

The importance and meaning of a line is often lost on first year architecture students. They tend to see lines as an element of assembly that builds toward a larger composition. While that is an important concept to grasp, it does not adequately represent the comprehensive nature of a line's purpose in the context of architecture. In technical drawing (which I refer to as drawing or design drawing) lines are embedded with a task of translation. They are not simply a mark on a page, a compositional element or a gesture in a sketch. Design drawing lines carry the burden of being a representational tool indicating the careful delineation of space. They demarcate the boundary between figure and ground, the change between public and private. Lines depict where a specific material is placed along with describing its orientation to gravity. A line is the beginning of a narrative that allows its reader to inhabit represented space through an imagined experience.

Architectural drawings are images that serve as tools for architects to imagine the construction of their buildings as part of the continuous flow of their design practices. They reveal the imagination of construction through a complex unfolding process rather than representing the frozen mimetic depiction of the absent building.
-Zhu, "The cultural context of design and the corporeal dynamism of drawing as the foundations for imagination of construction." 82.

There is a hierarchy of drawing categories with associated line types. How the lines are used and what their intention is, is specific to each category. The line of a figure ground diagram has a different responsibility from that of a perspective drawing, from that of a line in a design drawing. Each is specific because each intention is specific. Design drawings are intended to be built or to describe an idea of built space. In a drawing, lines transcribe the placement and purpose of a specific material. The collective assembly of lines imbues a spatial identity and projected architectural experience. This paper is specifically referring to the lines of a design drawing.

When a student is first learning line making, the task is often taught through analog methods. This engages the head, hand and drawing in a dialog that is connected and influenced by the body. A student fully learns to linger on a line and meditate in its making and meaning when the process is slowed down by hand drawing. Students must consciously maintain attention and focus on the craft of each line in order to achieve a clear and well-crafted drawing, a practice that through memory pays dividends later in their design careers. I see the cultivation of a relationship between the body and drawing as a fundamental part of basic design. Due to the slow and deliberate nature of drawing that already engages the body in a process of understanding, I challenge that students should also start learning how to embed a material understanding into their lines. The physical process of drawing can be conceptually and physically aligned with building. Both practices can be approached from a similar methodology. Drawing is an act of building through the assembly of lines articulating material. Building is a three dimensional expression of drawing assembling material in a composition that defines space. Building drawings, drawing building. In this context, drawing can be taught as a mindful act of material assembly through line making.

If the architectural drawings are tools in a process of disclosure, this process is grounded on both the cultural context of design and the corporeal act of drawing.
-Zhu, "The cultural context of design and the corporeal dynamism of drawing as the foundations for imagination of construction." 83.

The specificity of a line's purpose should be reflected in the careful selection of material that shapes space. I challenge the term "materiality" because it lacks specificity and architectural identity. "Materiality" describes material as homogenous, one material without distinction from another. When we accept "materiality" we are reducing spatial experiences to banal, with disregard to human sensory experience. When we draw "materiality" we miss using the clear terminology we need to fully transcribe the spatial experience we are seeking.

The drawing has two roles [for me]: it first facilitates the gradual imaginary construction of the full entity in the imagination, and secondly, drawings become instructions for the builders and craftsmen in order to materialize the idea.
- Pallasmaa, Juhani,"An Architectural Confession"

Juhani Pallasmaa eloquently describes the duality of ideas behind a drawing; projected inhabitation of a drawing through imagination, and the actual material reference. If we are careless with our specificity of material then how can we embrace the power and richness of a projected architectural experience? In essence, when we refer to "materiality" in drawing we are describing un-buildable mass of that separates figure from ground, a diagram, which is inherently seen as a solid or void but without material specificity. While an undeniably important graphic, a figure-ground diagram has a simple and specific non-material task. I seek to link the idea that a drawing and building (thus material) are inherently connected, removing the idea of non-descript "materiality" from the architectural discourse at the beginning design level.

To help students understand the meaning of a line and the embodied material energy associated with it, I ran a design project *Building Drawings* with a Design Communications class at the University of Hawaii. The project lead students through a deliberate design process that established a bond between drawing and building. My pedagogical goal was to use the idea of line creation as a framework to expose students to a few basic concepts; first to position drawing as a link between mind, body, hand and material. Second was to take advantage of the time and craft of hand drawing to build an association of assembling drawings to assembling buildings. I also wanted to take advantage of the opportunity to teach the meaning of a line as a heavily layered element in design drawing. Last was to expose students to a design process that would create a clear methodology for them to reference regardless of tool.

Project

Building Drawings was based on the structure of a project run by Pamela Hurley and Michael Chisamore at the University of Memphis, "Architecture and Narrative". I chose to model the initial phase of this project after theirs due to their successful integration of literary reference, writing, and drawing exercises. Their project also placed a heavy emphasis on developing each element simultaneously as a design process, allowing writing and drawing to be in a constant dialog with one another as they evolved. The *Building Drawings* project sequence was set up to expand on that process by creating a structure to methodically explore the idea of embedded spatial and material ethos within the act of drawing architecture.

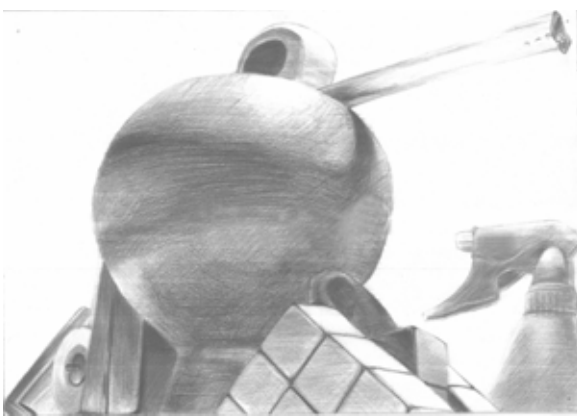


Fig. 2. Still life drawing, every day objects

Building Drawings started as a still life drawing exercise, students drew dramatically lit everyday objects at close range. The drama of the initial scene helped students to later occupy their drawings to apply a larger spatial narrative for the project (fig 1 and 2). Concurrent to developing their drawings they were reading excerpts of *Invisible Cities* by Italo Calvino which served as a precedent for the students to model the vivid description of space and detail on in their own written descriptions of their mini cities. Based on and referencing specific spaces in their drawings they were asked to write narratives describing a dream sequence of what it would be like to inhabit and walk through their imagined environments. The narratives serve the function of changing the scale of the drawings, allowing coffee mugs to be amphitheaters and shoes to be science laboratories while also creating a framework for further design elaboration.

Once the students had developed a sense of spatial experience, they were asked to create a set of orthographic drawings of their mini cities. The orthographic drawings architecturally describe the spatial sequence and proportion derived from their drawing and narrative. This exercise also encouraged students to craft design drawings that capture as much passion as their still life drawings, a difficult task at any level. As student added more detail to their designs, they are always referencing and updating their narratives as a conceptual framework for their drawings. The drawing phase of the project engaged the students in a representational loop involving drawing, imagination and body reinforcing concepts that they had learned earlier in the semester.

Upon completion of their drawing set, the students were asked to select one of their most descriptive section drawings to develop further (fig. 3). The sections were scanned into the computer so that the students could digitally collage an imagined atmosphere, based on their narrative, into their city's environment. The collage/drawing hybrids were printed on brown craft paper to allow students to brighten and tone back their drawings through layered analog processes using colored pencil and paint. The process of bringing analog to digital and then back to analog was intentionally set up to break down the boundaries of those tools as exclusive from one another.

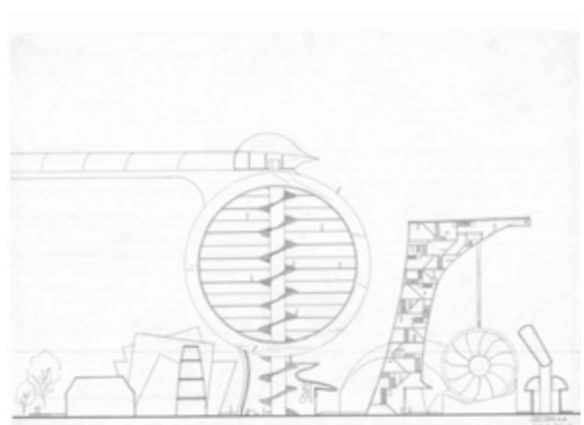


Fig. 3. Final section drawing.

The final phase of the project was set up to empower students to discover their own line's meaning through translating and extruding them into three dimensional manifestations, which I call 2.5 D drawing. Through this process they were literally turning the drawn space into the direct extraction of space through modeling (fig 4 and 5). This action highlights the relationship of a line to its material intention.

The conceptual framework behind this project was to explore the link between drawing and building placing the design process in the center as a seamless loop allowing one design technique to be spurred off of another. In critique of the project's first iteration, the building component and material ethos was not as developed as it needed to be to reach its pedagogical goals. In future iterations, a stronger material translation needs to be developed. When this project is run in 2014, the design sequence will be elaborated on to employ a full scale, material specific building component. I believe by introducing a series of frames into the project, the extrusion of a line to 2.5 D, to building material can allow for a focused exploration of building without becoming a semester long (or longer) building project. I intend to present these revisions at the 2014 conference in Chicago.

... drawing is bound to be only two-dimensional lines on paper, whereas the imaginative image exists in its full materiality, plasticity and weight.
-Pallasmaa, Juhani,"An Architectural Confession"

Fig. 4. 2.5 D example.

Conclusions

As this project continues to develop, be tested and retested by both my students, and myself I hope to discover deeper correlations between drawing and building. I expect that this project has the potential to frame the design process as a loop or web so that whether or not the project starts with a building detail or if it is started with a dramatic still life drawing, the learning relationship and work produced could be similar.

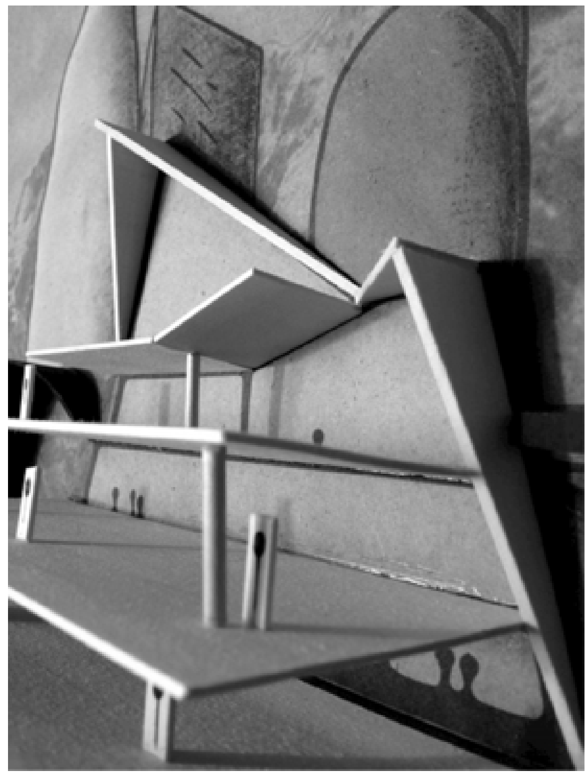


Fig. 5. 2.5 D example.

I see this project as being able to expose students to comprehensive and integrated design ideas early in their academic careers. The meaning of a line and its relationship to construction is often not fully explained or understood until later in their academic careers. The understanding often comes from a comprehensive studio that requires a student to create traditional detail drawings. While I do not believe this project replaces the knowledge gained through architectural detailing, I do think it helps to establish a foundation for the relationship between drawing and material. I also believe that it provides a conceptual grounding for the poetry of material allocation in a drawing vs. approaching material from a purely technical perspective through detailing.

Learning the value of mindful line work should be at the center of basic design pedagogy. Through the direct relationships of drawing and building, students cultivate a conceptual tie between material assembly and drawing assembly through process. *Building Drawings* requires students to engage material, head and hand in a learning relationship where they embed ideas into their projects while simultaneously gaining knowledge from the project by fabricating it. As an architect it is rare to draw without the intention to evoke a spatial experience. Through building drawings, basic design students are able to translate the link between line and material through a systematic design process.

Not only does drawing involve the ability to decide how to achieve a certain end, but also the ability to reflect upon it and determine the achievement of a beatific life, a vita beata, a merging in a single embodiment of three complementary arts: the art of drawing well, living well and building well.
- Frascari, Eleven Exercises, 7.

Notes

[1]Frascari, Marco. Eleven Exercises in the Art of Architectural Drawing: slow food for the architects imagination. New York:Routledge, 2011.

[2]Cook, Peter. Drawing: the motive force of architecture. West Sussex: Wiley, 2008.

[3]El-Bizri, Nader, "Imagination and Architectural Representations." In From Models to Drawings edited by Marco Frascari, Jonathan Hale and Bradley Starkey, 34-42. New York: Routledge, 2007.

[4]Zhu, Qi, "The cultural context of design and the corporeal dynamism of drawing as the foundations for imagination of construction." In From Models to Drawings edited by Marco Frascari, Jonathan Hale and Bradley Starkey, 79-87. New York: Routledge, 2007.

[5]Kunze, Donald, "Concealment, delay and topology in the creation of wondrous drawing." In From Models to Drawings edited by Marco Frascari, Jonathan Hale and Bradley Starkey, 137-145. New York: Routledge, 2007.

[6]Hurley, Pamela and Michael Chisamore, "Architecture and *Narrative*: *Designing with Invisible Cities."* Paper presented at the Design Communications Association Conference, Still Water, Oklahoma, October 22-24, 2012.

[7]*Pallasmaa, Juhani,"An Architectural Confession" Paper presented in association with Studies in Silence exhibition in Honolulu, Hawaii January 31-February 28, 2014.*

Critical Inquiries | Critical Overlaps:

Finding Design Opportunities and Leveraging Material Explorations Toward Mutually Beneficial Outcomes

Gregory Spaw

University of Tennessee

Critical Inquiries

As academics, how can we facilitate beginning students in seeking out opportunities for speculative / tangible design while broadening their purview in current material discourse and digital / analog processes of making?

Over the last four years, I have had the opportunity to offer a course that aspires to address one possible approach to the stated question. The seminar / workshop entitled, Re(formation), gets its moniker from Architecture's current state of flux:

Hampered by liability and prone to passing the buck, architects—ever more marginalized—need to re-establish their place in society. Young practices less burdened by professional dogma and streamlined in technological synchronization, are in a position to serve as the advance guard at the cusp of Architecture's re(formation).

With this framing in mind, the class is structured in two distinct phases. The first is a research component, asking each student to give a Pecha Kucha style presentation (20 slides x 20 seconds) on an emerging design firm, fabrication technique, and installation artist. Through this process, beginning design students are able to take in a broad survey of practices, techniques, and work they are generally not familiar with in an extremely short time frame. In parallel, tutorials conveying relevant software and hardware are administered to introduce and further the collective capabilities of the class. The cluster of knowledge that emerges among the students serves to further class discussion and push the students' own aspirations.

Incorporating this new found frame of reference, the next phase of the course asks small teams (3 -4 students) to develop their own installations using either a material or fabrication technique as a starting point. While quite foreign to beginning design students, this process facilitates critical discussions allowing constraints to be found by uncovering certain material logics; the feasibility of certain techniques; as well as the ever-looming criteria of cost, time, and availability. Inherently critical during the entirety of the endeavor is the creation and testing of physical artifacts. This engagement allows for iterative feedback loops between digital and analog methods of design and representation. As a final step, students are asked to create a set of instructional drawings that reiterate their understanding of component assemblies. Experimentation, ingenuity, and practicality are all equally prized. In total, the class calls for realization through first-hand design, fabrication, and deployment.

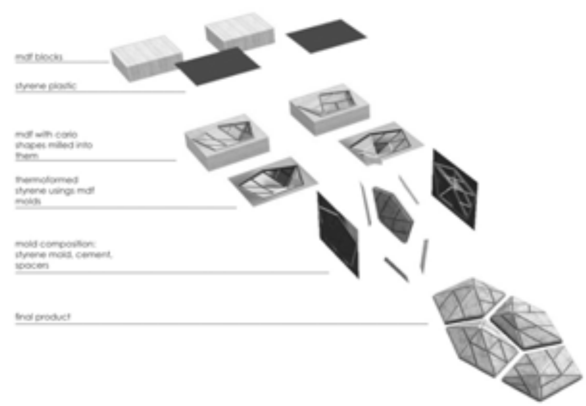


Fig. 1. Diagram of Materials and Process. Image: Jordan Bailey, Samuel Bouck, Michael Nelson, & Kyter Steffes

Over the past four years I have been continually impressed with how students leverage both unique approaches and workflows in order to generate a thought-provoking set of final constructs year after year. Projects have ranged in scale and scope. An outline of a few of the more intriguing studies include: a series of hollow rotationally molded thin concrete shells (Fig. 1-3), a folded-unit based Tyvek shading system employing depth and variable apertures to modulate light, and a suspended structure of sheet aluminum milled and pierced by T8 florescent bulbs.

Fig. 2. Testing Rotational Mold. Image: Author

Fig. 3. Hollow Concrete Unit Prototype. Image: Author

Last year's course, in contrast to previous iterations asked the students to respond to a particular set of given criteria. A local business that had issues of excessive noise, flawed circulation, and inadequate seating for its patrons agreed to serve as a hypothetical test bed for the beginning design students to engage (Fig. 4). Taking cues from the novel Suttree by Cormac McCarthy, the establishment's namesake, all of the groups explored the theme of the river through their selected material manifestations and corresponding processes. While there were several successful projects, one team of beginning design students found a particularly successful ending. Through their vision, commitment, and clever resourcefulness they were able to push this speculative endeavor to a clearly articulated reality.

Using the novel as a generator, this team created their own set of design criteria—the creation of a clean and timeless design, utilizing an organic language without straying into literal interpretation. With this in mind, several important conversations relating to material selection took place. As a first step, the students selected wood as a locally sourced material that easily related to the establishments' existing environment. Once this was decided, it was suggested that the students do some preliminary research into fabrication processes that might work well with the chosen material while meeting the stated and self-imposed criteria. Soon thereafter, steam bending was brought to the table as an interesting and viable trajectory to pursue.

Fig. 4. Existing Condition of Suttree's High Gravity Tavern. Image: Author

With the students only having a cursory knowledge of their chosen method of production they were pushed to quickly build a prototype steam bender. Using readily available scrap plywood their response was a 6"x6"x30" chamber that employed a ConAir clothes steamer as a heat source. This impromptu resourcefulness allowed the team to quickly produce small material tests using different species and proportional cross sections. Quite often the students perceived some of the most useful testing initially as failures. As a facilitator, these moments provided key opportunities to ask critical questions and / or point them in the direction of relevant precedents. After a series of particularly trying tests, the team was asked to step back from direct testing and provide an overall vision for the installation and how it would address the broader concerns posed in the brief. From this new tack, the students produced a series of rough sketches / diagrams that addressed many criteria broadly but in tern raised questions related to feasibility of construction. At this point they were referred to the remarkable precedent work of the furniture designer, Matthias Pliessing. Using his work as a point of reference, the team was able to look at his process and make informed decisions about how their own project should proceed.

Applying knowledge gained during the previously held computational workshops the students were able to translate their initial sketches into the computer by drawing a series of flowing guidelines that interfaced with the as built conditions and created continuity from the front of the space to the rear. These guide lines in conjunction with relevant cross sections, dictated key moments and served as the underlying basis for the formation of a non-uniform continuously curved surface that was meant to serve several programmatic functions while paying reference to the Tennessee River of McCarthy's prose.

Diverging from Pliessing's approach, the team created contours from the digital model at a typical interval of eight inches. The resulting lines were offset to serve as structural ribs. With wood already having been tested via the prototype steamer, the students quickly settled on three-quarter-inch plywood for this component due to its multi-directional strength and ease in mechanical fastening. Having previously used the school's three axis CNC router during the first phase of the re(formation) seminar, the group concluded its use was a logical extension in accurately translating the digital model into the realm of physical testing.

Fig. 5. Inspecting the Mk II Steam Bender. Image: Nicholas Burger

Needing something for the ribs to tie into, the group mocked up a ten-foot wall section using typical framing and drywall techniques. With this as a superstructure, the team set to work creating an updated steam bender out of three-inch PVC tube, that allowed for longer strips of wood to be heated to higher temperatures. At the same time, after researching ideal hardwoods for use in steam bending, the students settled on White Oak due to the grain structure and appearance. The team reached out to local sawmills and found an operation where they were able to source select-grade plain sawn green oak. After planning, joining, and ripping the boards into quarter-inch by one-inch strips the students where ready to fire up their Mk II steam chamber (Fig. 5). The newly acquired wood proved to be far more malleable than their initial tests.

With the plywood ribs held in place and a fully functional steam bender at their disposal, the team was able to start testing the qualities of their selected material and fabrication technique in earnest. After being steamed for twenty minutes the individual strips of White Oak were pulled from the tube and quickly attached across the established contours (Fig. 6). Beyond being visually compelling, the interpolated slated surface also served as lateral bracing. Due to their diligence, the students still had a month to incorporate / address many of the jury's interim suggestions / concerns regarding the project.

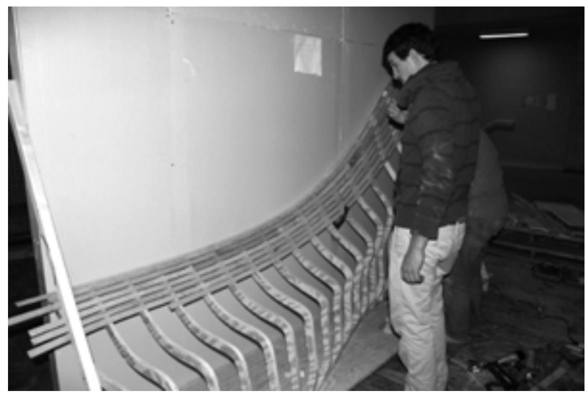


Fig. 6. Mock-up in Progress. Image: Nicholas Burger

Critical Overlaps

At the final review the 1:1 scale mock-ups were presented to the owner of Suttree's as different design approaches to the given brief. The molded felt tiles that took advantage of the existing ceiling grid and the compression molded granulated cork wall panels were both well received. However it was the steam bent project, largely due to the mock-up (Fig. 7), that elicited the most interest. In fact the piece was so well received that it didn't take long for the owner to inquire about the possibility of the project being commissioned. The student team was very excited by the possibility of their proposal being implemented. I served as an intermediary between them, the administration, and the business with the goal of finding an agreement between the parties. A preliminary consensus was reached in which the students would design and build the project for credit as part of an independent study. This allowed the group to have access to the college's facilities and for me to function as an advisor for the project. In turn the business would cover material expenses and provide scholarships for the beginning design student's tuition. With this in place the team met with the owner to discuss scope and additional practical concerns related to the project. Soon

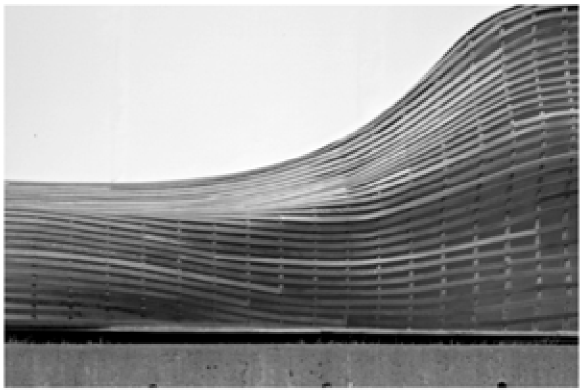


Fig. 7. Competed Steam Bent Mock-up. Image: Author

thereafter an estimate was generated and accepted.

The team had roughly a month by the time the financial agreement was settled to work through the further development of the fifty-foot seating installation. This allowed the as-built drawings to be double-checked and for incorporation of the newly established design criteria. Including development of an alternative technique of construction that allowed for offsite assembly, such that the establishment was minimally impacted during business hours. Revisions to the structural capacity took place as well. This phase of development provided many opportunities for critical discussions and required the students to once again create mock-

Fig. 8. Section in Progress. Image: Nicholas Burger

ups, both digitally and physically, for testing and feedback to occur. In order for all aspects of the project to be accounted for, the students were required to digitally model all aspects of the design. This added clarity to their understanding of problems and aided the team in finding solutions. The overall geometry was refined through the use of iterative design and mastering of workflows including the use of some parametric tools.

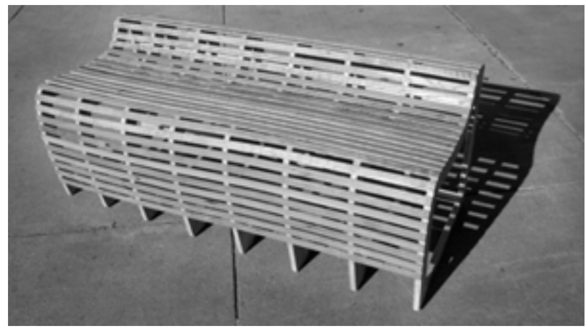


Fig. 9. Section of Final Assembly. Image: Author

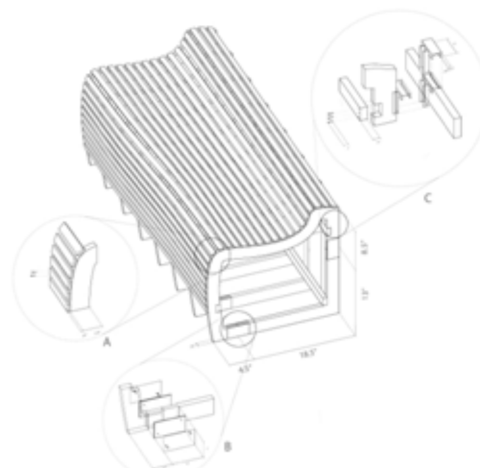


Fig. 10. Connection Details. Image: Kyle Jenkins

Final approval from the client was given after the spring semester, allowing for little more than two weeks for fabrication and installation. With materials acquired, including newly sourced quarter sawn White Oak and the construction of an Mk III steam bender that eased an existing bottleneck in production, the students entered into the final phase of the project at full speed (Fig. 8-10). Due to the extensive physical testing that had already occurred, the production of the installation, while a considerable effort, was realized without any unforeseen contingencies. As prescribed, the piece was transported and installed in a six-hour window before the establishment opened (Fig. 11-12).

Quite remarkably, the realized project served to generate a scenario where beneficial outcomes were present for all parties concerned. The beginning design students acquired new digital and analog proficiencies. While working with a client, they kept the project within budget, delivered it on time, and in-turn received funding toward the expense of their self-generated independent study. The College of Architecture and Design was able to reach out to the community and tout a well-received piece of design completed by its students. The business was able to engage / support the students' education and in-turn received a highly executed design that would be nearly impossible to commission through other means. Finally, I was able to facilitate the continued refinement of the students' first commissioned project from its inception to final execution. With this experience as a precedent, I am intrigued by future critical overlaps of interest in teaching, research, and practice.

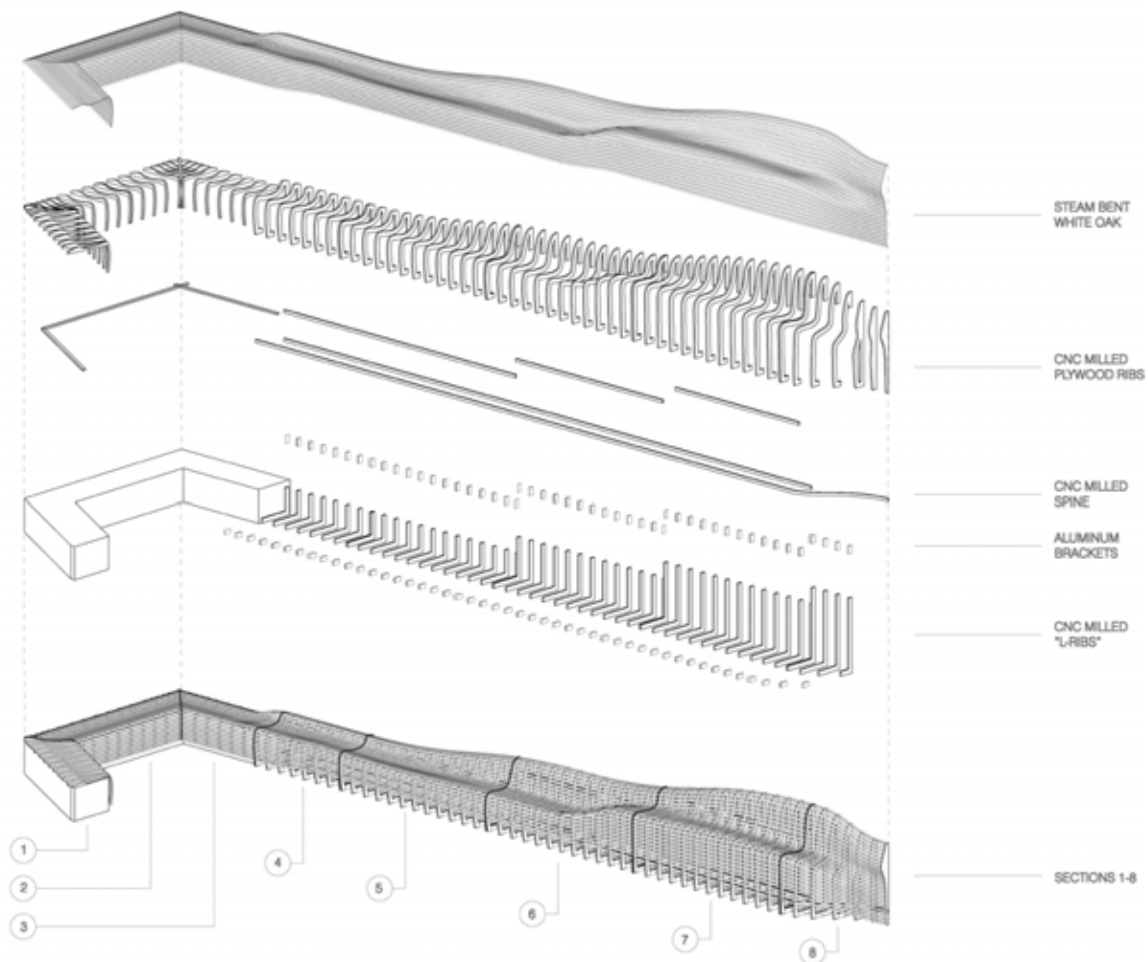


Fig. 11. Exploded Axon Showing Bench Components. Image: Jared Wilkins

Fig. 12. Final Installation of Bench. Project Credits: Ali Alsaleh, Nicholas Burger, Jacob Heaton, Kyle Jenkins, Jared Wilkins

Building Birdhouses:
Introducing Environmental Ethics through Short Design Exercises

Carey Clouse

University of Massachusetts at Amherst

Introduction

As an introductory assignment for a design studio in the Spring Semester of 2013, twelve students were tasked with the challenge of designing and building a dwelling space for urban birds. This assignment was the first phase of a semester-long timber competition studio, and the project provided students with useful insight into the physical properties of this material. Their task was to investigate wood products---to test, push, innovate and expand their conceptions of this material---by designing and building architectural birdhouses.

During the course of the short assignment, students learned the basic principles and requirements of nest design, developed playful and creative design schemes, mocked-up and then built those designs, and finally deployed their birdhouses in urban areas. At the end of the studio, these design ideas and projects were displayed in an exhibit on urban bird habitat, before being released into the urban environment. Throughout this design process students challenged their own values and beliefs; forming a deeper understanding of environmental stewardship, the complicated relationship between humans and the so-called natural world, and social attitudes around habitat loss and creation.[1]

This paper shares the organization and outcomes of this one-week assignment, as well as the methods, challenges and pedagogical opportunities that such a model presents. While this effort can be understood as an exploration of materiality and making in the context of an architecture studio, the project had an unexpected outcome, largely inspired by the informal conversations this topic seeded. The work of designing for birds---many species of which have been displaced by humans in urban areas---charged the studio with an atmosphere of moral (or normative) uncertainty and concomitant self-reflection. In this first studio project, students grappled with their own feelings of culpability and also their notions of agency, forming, in the process, a stronger personal environmental ethic.

Making

Unlike most studio-based design|build courses, the birdhouse design|build project presented students with a tangible, hands-on opportunity to engage with the issues of urban functioning, *through a single week-long assignment*. Short-term design|build can be a major undertaking for both teacher and student, but this miniature project scope allowed for a host of manageable outcomes: the introduction to new tools and design techniques, a beautifully-crafted product,

Fig. 1. Students present their initial design schemes in studio.

and meaningful conversation around both environmental stewardship and alternatives to conservation of natural areas.

As a pedagogical tool, this assignment introduced students to model making and craft at the scale of the small full-scale mockup. The assignment can be taught in conjunction with a model-making workshop, an introduction to the woodshop or digital fabrication tools, or the investigation into a material resource. As this was a timber competition studio, this time was used to tour a local wood fabrication shop, and the assignment required students to work with wood products in new ways. While just a week long, it served as a high-success first project that helped to release a summer of pent-up design energy before digging into site analysis, precedents and other programmatic research. Finally, this project helped to frame several of the larger goals of the design studio, introducing students to the materiality of wood, concepts of housing and displacement in urban areas, and the studio's larger sustainability agenda. (Figure 1)

Connection to Architecture

Nidification efforts,[2] whether by animals or humans, offer striking parallels to the constraints and opportunities found in human habitation. However, as an introductory design assignment, urban bird habitat also presents a program so simplified that material and tectonic inquiry can move to the forefront. When pressed to design for a bird, rather than another human, students found that they were suddenly freed from traditional expectations around tectonics and material use. Rather than developing forms using conventional construction methods, the students experimented with weaving, folding, dipped wax constructions and intricately carved elements. Their creations became examples of what Raymond Holden suggests is "far from being what human beings would call domestic architecture,"

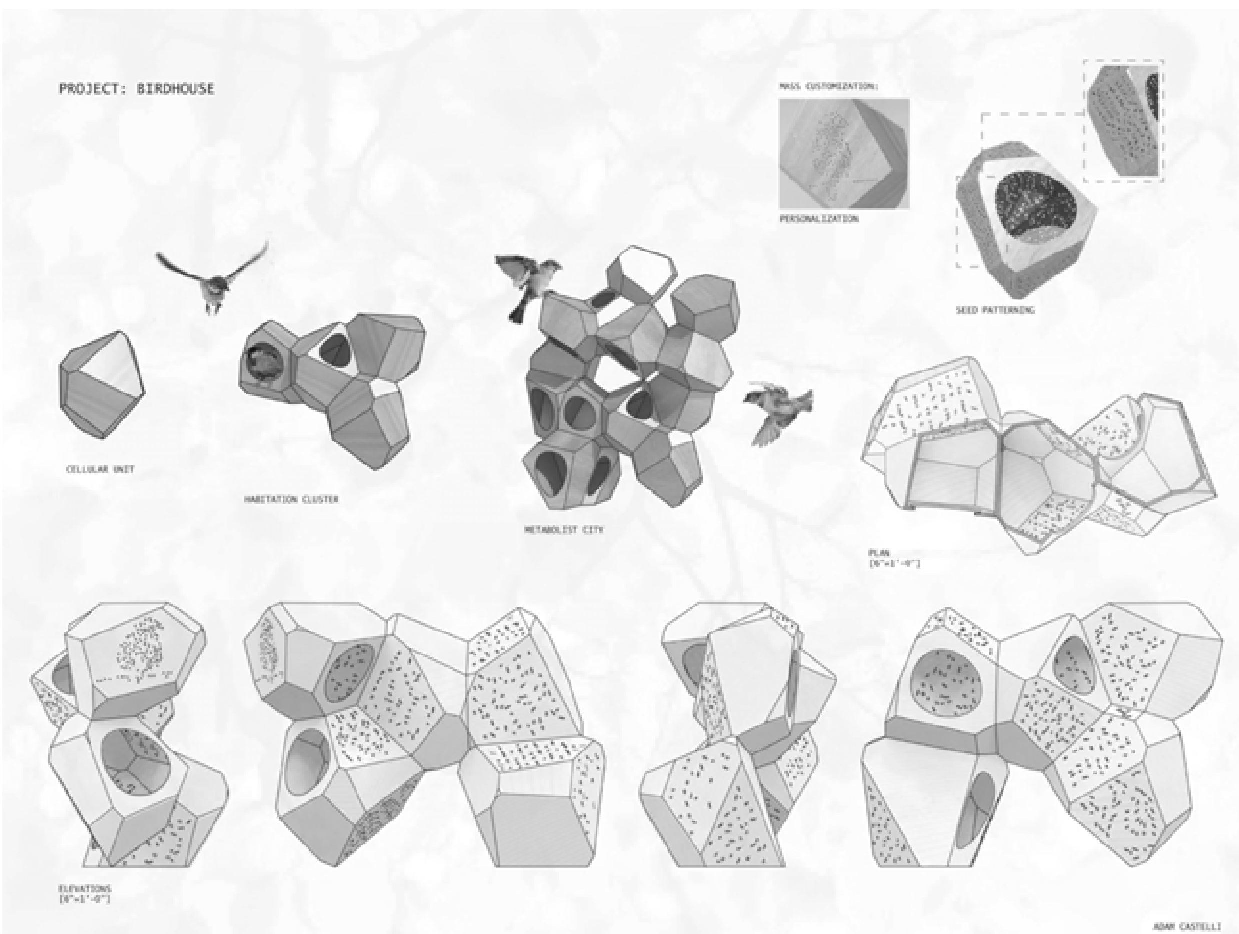


Fig. 2. Tessellating birdhouse units click into place with magnetic planar walls.

and "rather a part and extension of the bird's body, performing a bodily function which the feathered flying machine itself cannot perform."[3]

This spatial and formal exploration was freed from the social, cultural, and natural-world archetypes of birdhouse construction, effectively addressing powerful architectural objectives. Birdhouse design also served as an outlet for pared-down form making, a fast entre into space, form, and tectonic language. Moving beyond their own prior conceptions of birdhouses and their client's ornithological needs, the students developed a clear architectural agenda for their work. Their projects demonstrated both a tectonic method and a material response, vessels that might serve as the genesis for an even larger building project.

For example, some of the student projects that specifically went beyond the birdhouse archetype included construction methods that mirrored those favored by the bird clients, or forms that drew inspiration from the patterns found in nature. A modular housing strategy introduced by one student borrowed geometries from crystal formations found in nature, and then used those repetitive planes to suggest a three-dimensional tessellation that would allow for the units to fit together in an accretive building strategy. (Figure 1) Another student employed similar geometric planes, but came to this shape by an entirely different method. She sought a "natural" construction strategy that would allow for small leftover scraps of wood or paper to be connected without fasteners or glue. To do this, she reverse-engineered a friction-locking joint that then dictated the form and geometry of the larger vessel.

Craft

During the course of the week-long exercise, students investigated nest building from the perspective of the inhabitants and the hosts; then built their design. After exploring formal and spatial ideas in fast iterative models, students eventually would need to build a full-scale model. Their task was to learn more about wood as a material, and to hone their craft skills by using that product in the final mockup. The physicality of this assignment became a central concern to students, as it was both a limiting factor and principal idea generator.

In building these birdhouses at scale, the assignment allowed designers to put their own solutions to test in the real world. Because they would ultimately be deployed in a public urban area, the houses needed to be built to reflect both formal and functional concerns. Even over the short duration of the semester, this approach effectively tested ideas of function, scale, and tectonics by deploying the birdhouses into the urban environment in places where they could be monitored over time.

Several birdhouses were built specifically with this testing in mind. One student created matching units; one constructed out of wood and the other constructed out of metals. The twin units were hung next to each other in an attempt to see if birds would preference one material over the other. (In the short testing period, no bird life was recorded near those units.) Another student fabricated two cork birdhouses with keyed joints; her goal was to see how the units weathered over time. The units are still hanging intact, nearly one year later. (Figure 3)

Fig. 3. One of the birdhouse units, deployed for testing in an urban backyard.

Moving Forward

As a one-week, introductory studio assignment, this project fulfilled pedagogical and curricular goals by quickly introducing course content within the framework of a low-risk, high-success and broadly accessible design project. However, the project's short time frame limited the depth and rigor of student work, limiting both the number of iterations each student developed and the value of post-assignment testing. One could imagine that the assignment could be taken even further to include a reflection period, in which students would observe and journal. They could then learn from watching both birds and humans engage with the work, documenting adaptations, accretions, and apparent successes or failures.

Developing an Environmental Ethic

The birdhouse project presented these architecture students with a tangible, hands-on opportunity to engage with the issues of urban habitat depletion and interspecies interaction. While helping students to hone their design and construction skills at a very small scale, they also explored the theory that would frame and support their larger studio experience. This conversation included considerations of biodiversity, the impact of urban development, the ecological services provided by birds including pollination, fertilization and pest control, and human attitudes towards wildlife in cities. In considering possibilities for urban bird habitat, students started the semester by considering the more global issues of sustainability, resilience, and interactions between humans and the rest of the natural world.

Students were encouraged to link theory to studio through assigned readings that complemented their design projects. In addition to the research resources from Audubon and Cornell that facilitated the development of spatially and materially appropriate housing for the bird species they had selected, students were exposed to writing from naturalists such as Lyanda Lynn Haupt (Crow Planet) and Graeme Gibson (The Bedside Book of Birds).[4] They also read, at the beginning of the week, two architectural theory readings that would help them frame their birdhouses within the studio: Vitruvius' Second Book of Architecture and John Ruskin's The Lamp of Truth. Through a single formal discussion session and many informal conversations, students fervidly debated the larger project themes.

This meta conversation provides an important context for the profession of architecture and is one that needs to be built into design studios in order to prepare students for the likely environmental challenges of the future. This student group learned about the characteristics of wood---while connecting this material to broader ideas about resource scarcity and environmental impact. Students produced physical habitat for birds---while also considering their own engagement with the natural world. In helping students to develop their own environmental ethic, and in providing time during studio to have these larger theoretical conversations, educators can effectively infuse meaning and relevance into form-centered design exercises.

Conclusion

Educators must do the work of framing studio projects: These are the assignments that can link environmental impact, resource scarcity and design engagement to the context of the traditional studio. This week-long birdhouse assignment was knit into the larger studio program, rather than applied as an external project or discussion that ultimately could be disconnected from the long-term work. In doing so, this exercise provided students with new tools for both making and finding meaning. Moreover, the project was able to hold the interest of millennial designers by approaching architectural form from the dual angles of craft and environmental activism.

At the root of this short design assignment was an intention to have students critique their own conceptions of natural and human-made environments. Some of the most poignant discussions that emerged addressed human involvement in natural processes, and the ways in which new forms of habitat can be built into extant urban fabric. In researching, designing, and building architectural birdhouses, students were invited to explore, intellectually and physically, a critical engagement with their environment.

Fig. 4. A student presents a set of birdhouses, with process, at a final review.

Notes

[1] The studio work referenced William Cronon's *Uncommon Ground*, in an effort to recast the polarized perceptions of nature and city. Cronon, William, ed. *Uncommon Ground: Rethinking the Human Place in Nature.* Norton: New York. 1995.

[2] Nest building efforts. Discussed in Chris Chester's *Providence of the Sparrow*. Chester, Chris. *Providence of A Sparrow: Lessons From a Life Gone to the Birds*. Anchor: New York. 2004.

[3] Holden, Raymond P. *The Ways of Nesting Birds*. Review copy, Dodd Mead & Company: New York.1970. 15.

[4] Haupt, Lyanda Lynn. Crow Planet: Essential Wisdom of from the Urban Wilderness. Back Bay Books: New York, 2009.

Gibson, Graeme. The Bedside Book of Birds. Random House: New York. 2007.

Cultivating the Constructive Imagination

Patrick Doan

Virginia Tech

Constructive Inquiry

For those whose interests and responsibilities are to teach and integrate building technology within the education of the architect, how questions of architecture's constructive nature are introduced to beginning design students in architecture can be difficult. The majority of students coming to architecture typically have very limited experience and exposure to construction. Many have never walked a jobsite, swung a hammer, or spent a day in an architect's office. While this initial lack of construction exposure does not define a student's ability to grasp and understand architecture's constructive nature, it does present a challenge to those trying to instill and convey the built realities at play in the realization of works of architecture. As teachers within the studio and lecture / seminar courses, we try to convey the weight and resistance of materials, gravity, wind, rain, heat, cold, and the cultural and natural forces that inform a building's physical and constructive reality. Still, this can be difficult given that the architect's education in the realm of constructive inquiry is typically gathered from and bounded by secondary experiences and sources such as books, drawings, the classroom, and studio. The involvement with the constructive aspects of the work for the architecture student is typically not a direct hands-on engagement in its physical making, but an analogous experience, relying on drawings and models to provide the primary ways in which they approach, explore, test, and demonstrate constructive understanding. For students coming to architecture, these forms of constructive engagement can seem foreign, distant, and abstract, adding to the difficulty of accessing and grasping the connections to the physical richness and implications that is inherent in the relationship between construction and architecture.

Architect Louis Kahn speaks quite poignantly about this quandary:

A young architect came to ask a question. 'I dream of spaces full of wonder. Spaces that rise and envelop flowingly without beginning, without end, of a jointless material white and gold. When I place the first line to capture the dream, the dream becomes less.' This is a good question. I once learned that a good question is greater than the most brilliant answer. This is a question of the unmeasurable and the measurable.[1]

Kahn's words articulate one of the more frustrating and difficult lessons a young architecture student must face early in their education; the reconciliation of their dreams with the constructive realities that are an integral and a necessary part of their work. As teachers, how do we engage and work to cultivate the student's constructive imagination and understanding; to help them overcome their innate desire and tendency to avoid the constructive nature of their work?

Being both an instigator and witness to the struggles of architecture students confronting these questions, the following reflection is offered as a way of retracing the constructed lines of student work through a studio project called the 'cube.'

Learning from Lou

For the architect Louis Kahn, the construction site was ripe with architectural potential. He understood that to approach architecture, the architect had to consider and embrace building materials, assemblies, details, and means and methods. His observations and musings of the crane as an extension of the architect's hand revealed his willingness and desire to allow the construction site to teach the architect and inform architecture.[2] Kahn's thoughts on construction were not just lip service. If we study and listen to his words, we see that the constructive nature of architecture was significant to his architectural position. His well-known dialogue with a brick and its desire to be an arch can be seen as an architect trying to come to terms with and find architecture's boundaries; both its limitations and potentials.

'What do you want Brick?'
And the Brick says to you,
'I like an Arch.'
And if you say to Brick

'Look, arches are expensive, and I can use a concrete lintel over you. What do you think of that?'
'Brick?'
Brick says:
'…I like an arch…'[3]

From Kahn's words, one can visualize in a very direct and animated way, walls of masonry yielding to arched openings that allow for natural light to enter a room. Embedded within his words is also a sequencing of actions, where each move has an architectural consequence to the work. There is always a foreshadowing of things to come. Architectural decisions and consequences were not singular and isolated, but rather had a compounding influence and presence on the work.

Kahn constructed and told stories of architecture. Storytelling was a way that he could draw out architectural questions, consequences, and propositions. His words are dense and at times difficult to access, which (one could speculate) reveals his own struggles of coming to terms with the complexity of architectural thinking and making. He was not using words to supersede or take the place of drawing and building, but rather to assist in activating and guiding his search. Architect and teacher, Marco Frascari, writes about the importance of architecture's storytelling nature:

In architecture, storytelling can be accepted as a procedure that can be used both for teaching and for conceiving of, developing and erecting proper buildings. Architectural stories told face to face, possess a remarkable ability to convey architectural ideas and concepts so that people can readily understand them.[4]

It was in this spirit of Kahn's storytelling that I began to reconsider the student's work that came from the cube project. I realized that two types of tales were emerging: one, a constructive tale of the physical act of making and the other the completed work that was telling the tale of a student's emerging architectural position.

Constructing Tales

…I was soon struck by what seemed at the time the peculiar disadvantage under which architects labour, never working directly with the object of their thought, always working at it through some intervening medium, almost always drawing, while painters and sculptors, who might spend some time on preliminary sketches and maquettes, all ended up working on the thing itself which, naturally, absorbed most of their attention and effort.[5]

Robin Evans articulates quite well this unique relationship architects have with their work. There is an inherent distance that separates the architect from the actual work to be realized. For architecture students this distance can be difficult to overcome which might explain their reluctance in engaging the questions and role construction plays in their work.

To bridge this gap, I gave a group of second year undergraduate architecture students a project called the 'cube.' Within a six week time period, they were asked to design and construct a 16" cube that was to be assembled out of building materials that could be obtained at any building supply store. The only parameters they had to adhere to was that all faces of the cube must be able to support the cube and that no part of it could extend beyond the 16" boundary.

Fig. 1. Cube – Student Work

The cube project was designed to immerse the student into the physical act of making with the primary objective to remove the distance that typically separated the student's relationship of construction and architecture. As they started moving from their drawing table, where they had been developing drawings and models of the cube to the workbench, a change and shift in attitude occurred. The cube was no longer a distant or idealized object, but a real and tangible thing. It became a construction site, where the drawn and modeled propositions made by the student were put to the test. No longer were they working with analogous means, but dealing with the actual building materials and tools to realize their vision. A dialogue developed between the drawing table and the work bench where for many their initial design assumptions and drawings were immediately put into question. The cube became very real and very physical. It exerted a presence and resistance that drew the student deep into the work. Conversations were about the thing itself where material choices, joining, treatment of edges, corners, grain direction, and formwork mattered. Ideas and desires met the cubes constructive realities. More importantly the question of sequence came into play. They had to parse out from their work an understanding of how to construct what they had imagined, drawn, and modeled. Given the size of materials they were using and the equipment required to perform the work in the shop, they could not begin cutting at will. A plan of action had to be developed that formed directly from an understanding of the construction sequence. This meant that with material selection came questions of detailing and joining. The sequencing of the work became a form of constructive storytelling, where each decision had a direct impact and built upon one another. Through the cube the students were constructing a tale of making.

Kahn was aware of this sequential action when he said:

I draw a building from the bottom up because that's the way it's constructed. It depends on gravity. You begin with the way all the weights can be distributed on the land, and then you build up. If you do that, then you draw like and architect.[6]

Many of the students experienced the frustration of construction, especially if it was their first time working in the shop. More importantly they soon understood that even though they may not know or fully understand their next moves, the cube was foreshadowing questions to come. They had to engage it with a different pace and become attuned to the questions and consequences the making of the cube presented. This often meant having to reconsider moves. A part to whole relationship emerged where they saw that a small scale decision could have a larger impact on the whole.

After the Fact

What the cube project offered the student was the opportunity to constructively think through their work in the shop and on the drawing table, where a sensitivity and awareness to making was introduced and engaged directly. The work became an embodiment of architectural thinking that demonstrated a position that each student had taken about making. It was in the completed cube that the second tale was being told. Some cubes were tectonic in nature; a visual orchestration and celebration of assembly.

Fig. 2. Tectonic Tale – Student Work

For these students revealing the cubes constructive nature was necessary. Other students took a more a-tectonic approach, working to conceal joints and the visual clues of its making in favor of surface and continuity.

Fig. 3. (A) Tectonic Tale – Student Work

The architect Sverre Fehn wrote:

A constructive thought is the nerve of an idea, but it is realized through its construction. It dictates a precise dimension and its structure, the selection of material. The nature of a constructive thought precedes the calculated reality, as the thought carries the totality of completion.[7]

What can be taken from Fehn's words is that the beginnings of constructive inquiry can be found within the architect's imagination; cultivated through the unfolding dialogue of hand and mind working to reconcile dreams and desires with physical and constructive realities. Embodied within architecture's constructive nature is the architect's knowledge of making that demonstrates their skill, understanding, sensitivity, and position they take as to how materials and spaces are thoughtfully formed and brought together. The constructive imagination is storytelling, where the immeasurability of visions and dreams coupled with the measurable means of construction form a constructive dance. As the nineteenth century French architecture Viollet-le-Duc wrote,

Architecture and construction must be taught, or practiced simultaneously; Construction is the means, Architecture is the result.[8]

Notes

[1] Louis Kahn, "Form and Design," in *Louis Kahn: Essential Texts*, ed. Robert Twombly (New York: W. W. Norton & Co., 2003), 62-63.

[2] Louis Kahn, "Silence and Light," in *Louis Kahn: Essential Texts*, ed. Robert Twombly (New York: W. W. Norton & Co., 2003), 250.

[3] Louis Kahn, "Materials," in *Between Silence and Light: Spirit in the Architecture of Louis I. Kahn*, ed. John Lobell (Boston: Shambhala Publications, Inc., 1979), 40.

[4] Marco Frascari, "An architectural good life can be built, explained and taught only through storytelling," in *Reading Architecture and Culture: Researching Buildings, Spaces and Documents*, ed. Adam Sharr (New York: Routledge, 2012), 225.

[5] Robin Evans, "Translations from Drawing to Building," in *Translations from Drawing to Building and Other Essays* (Cambridge, Mass: MIT Press, 1997), 156.

[6] Louis Kahn. *What Will Be Has Always Been: The Words of Louis Kahn*, ed. Richard Saul Wurrman (New York: Access Press and Rizzoli, 1986), 176.

[7] Per Olaf Fjeld and Sverre Fehn. *Sverre Fehn: The Thought of Construction*. (New York: Rizzoli, 1983), 40.

[8] M. Eugène-Emmanuel Viollet-le-Duc and George Martin Huss. *Rational Building*. (New York: Macmillan and Co., 1895), 1.

Edges:
An Introduction to Analog + Digital Fabrication

Shelby Elizabeth Doyle, Visiting Assistant Professor of Architecture

Louisiana State University

Introduction

The introduction of digital design and fabrication techniques is an increasingly significant process for contemporary architectural education. The validity of digital techniques has been established and the discussion has shifted to the more meaningful question of how digital tools are situated in a design education. A successful introduction to digital techniques occurs simultaneously with students' introduction to manual techniques. This concurrent strategy prevents the conceptualization of digital tools as additions to or replacements of manual tools. [1]

Accordingly, the constructed polarity between manual and digital is an outdated and unproductive fiction. The two are innately different and should not be compromised through forced synthesis: Hand making results in the direct production of an artifact, drawing, or model, whereas digital making is interstitial to the production of an artifact. [2]

Consequently, digital making or fabrication should not be conflated with digital imaging or representation. Architect and theorist Stan Allen notes in his article *Artificial Ecology* that the practice of architecture has always been in this paradoxical position of being invested in the production of real, concrete matter yet working with tools of abstract representation (drawings, models, computer simulations and so forth). [3] As architecture is invested in the production of 'concrete matter' so must be the introduction of digital techniques, rather than in the production of representation.

This paper discusses a Louisiana State University (LSU) College of Art + Design (CoAD) seminar, taught in the School of Architecture. 'Edges: an Introduction to Analog + Digital Fabrication' that tests the pedagogic potential of teaching digital techniques through the crafting of artifacts. The course is part of an ongoing conversation at LSU CoAD about the position of digital tools and techniques in the undergraduate curriculum.

Course Overview

'Edges: an Introduction to Analog + Digital Fabrication' familiarized students with analog and digital fabrication methods through the investigation of materials, assembly, and tectonics. Rather than preferencing or demanding a specific software or fabrication method the course asked students to develop a process or approach to making, to investigate material limitations, and to design with the specifics of each toolset.

The course had a limited scope: to introduce digital techniques through the fabrication of artifacts. Issues of producing artifacts were intentionally separated from those of architectural design and architectural representation.

A series of weekly design projects explored the translation of digital models into physical artifacts through manual and digital fabrication tools. Each exercise examined a design process and fabrication technique with respect to a specific toolset (software and hardware). Students were encouraged to develop an understanding of best practices for each toolset and to explore their inherent limits. Particular attention was paid to the feedback provided by the translation from a 'perfect' digital model into a physical model with the requisite tolerances between materials and techniques. Students were exposed to material constraints, the strengths and limitations of digital and hand tools, and the combination and tolerance between multiple tools and materials. Techniques explored included: laser-cutting, 3D printing (ZCorp + ABS), casting (resin + plaster), 3D scanning (large + small scale), CNC routing, CNC milling, and combined techniques. Each design exercise required an assortment of digital and analog processes, post-production skills, and in most cases assembly. This was complemented by the wood-shop fabrication of display frames or boxes for each assignment, used to present the work at an end of the semester exhibition. [3]

The final project required students to establish their stance on the relationships between fabrication, craft, digital design, and architecture. This was accomplished through a written manifesto and the fabrication of an analytic object using digital and/or hand methods and demonstrating the assumed position and the resulting design process. As the course did not specifically explore the theoretical foundations of digital design the textual component was the least successful of the assignments and will be reconsidered for future versions of the course.

During final exams week, 'Edges' culminated in a public exhibition of the fabrication projects, designed and curated by the students to. The exhibit was located in the lobby of the LSU Middleton Library, one of the highest trafficked spaces at LSU.

Techne v Metis

The theoretical framework for this course began with, the writings of anthropologist James C. Scott. In *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, Scott writes:

Metis resists simplification into deductive principles, which can successfully be transmitted through book learning, because the environments in which it is exercised are so complex and non-repeatable that formal procedures of rational decision-making are impossible to apply. In a sense, metis lies in that large space between the realm of genius, to which no formula can apply, and the realm of codified knowledge, which can be learned by rote. [4]

Techne is often translated as craftsmanship, craft, or art and *metis* as wisdom or cunning. Scott goes on to describe *metis* as an order of represented knowledge completely different than those of *techne*. As such *techne* 'radically differs from metis in terms of how it is organized, how it is codified and taught, how it is modified and the analytical precision it exhibits. [5]

Techne can be expressed precisely and comprehensively in the form of rigid rules and principles. In contrast, metis encounters the future from the premise of incomplete knowledge. It is this notion of 'incomplete knowledge' that gave an educational foundation to 'Edges'. Or rather, the question: how to teach an approach to 'incomplete knowledge' through conjecture, and speculation.

'Edges' was structured to present design as the exploration of 'incomplete knowledge' and framed design as the practice of active, iterative engagement in material production. This encouraged students to develop an approach to ambiguity and to develop flexible processes for meeting unforeseen, unpredictable, and unknown challenges of the design process. The practice of artifact-based learning forced the development of a design process that demanded active decision-making, establishing alternative priorities, and resolving material realties.

Edges Structure

'Edges' cultivated autodidacticism through fabrication projects, carefully framed and bounded to focus on a sequential introduction to specific aspects of making with digital techniques. This was achieved through strategies to reframe challenges and extrapolate and transform information, and to accept and deal with ambiguity.

Each assignment was one to three sentences in length with the aim to create a simple, concentrated, and restricted entry point into a set of digital techniques. This allowed the complexity of the assignment to reside in the design response rather than the interpretation of the assignment. These exercises aimed to give scale to the computer screen and to challenge the notion that manipulation occurs exclusively within the virtual environment.

Each exercise was paired with the production of a shelf or frame used to display the resulting artifact:

Using the wood shop produce a shelf or frame to display

Fig. 1. Examples of the frames and shelves produced for the exhibition. Student work produced by: Andrew Pharis, Emily Reckenbeil, Monica Perez, Susana Constenla, Tess Baudry, and Cody Drago. (In the PDF names link to portfolios from the semester.)

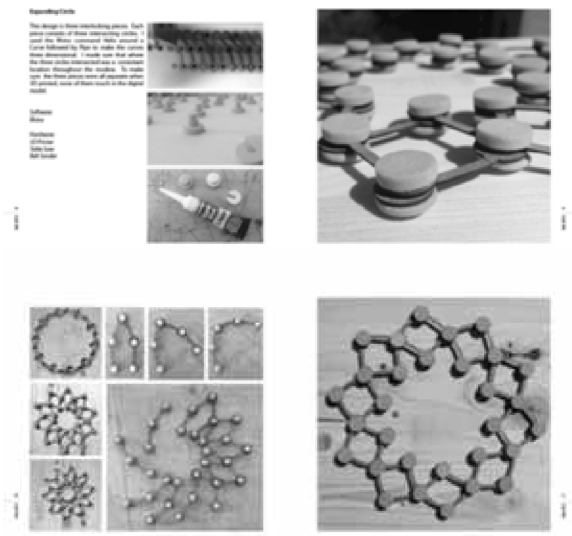


Fig. 2. Examples of a student portfolio page spreads. (Emily Reckenbeil

the laser cut object (optional: and the original object). A well-crafted joint should connect at least two planes. Use scrap or recycled wood.

Additionally, throughout the semester students documented the process of each exercise and provided self-evaluations of the successes and failures of each project. The act of documentation and reflection was established as a vital aspect of the design process, rather than something that occurs ‘after’. These portfolios were assembled in InDesign, printed, bound, and displayed at the final exhibition.

Edges Assignments

The ‘Edges’ assignments are as follows:

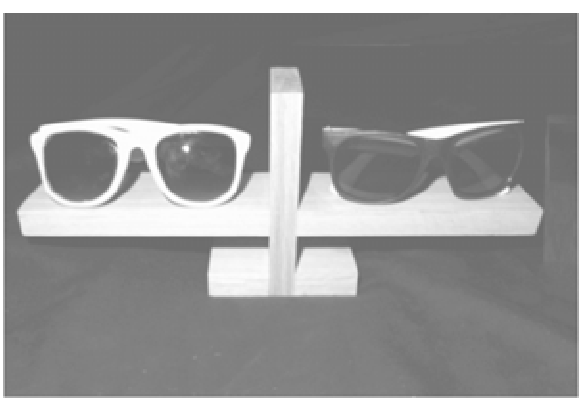


Fig. 3. Laser cut sunglasses on the left, originals to the right. (Cody Drago)

1. Translate a physical object into a digital file to be laser cut and assembled to produce a replica of the original object.

2. Create a 3D object by aggregating a single shape or family of 2D laser cut shapes that hook, snap, or otherwise assemble without glue or other adhesives.

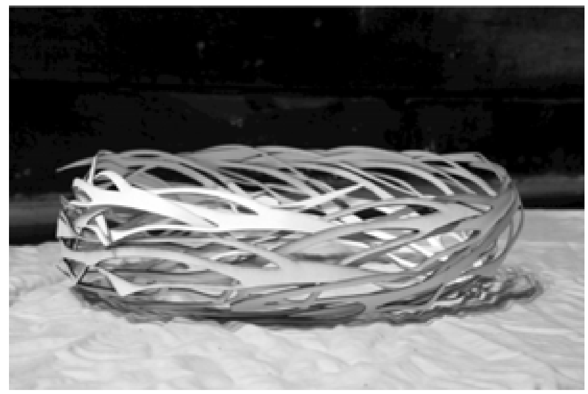


Fig. 4. Assembled laser cut museum board. (Tess Baudry)

3. Design an object in Rhino to be printed using the ZCorp 3D printer in the LSU Design Shop. The project should explore models and geometries that capitalize on the 3D printing technology and would be extremely difficult or impossible to fabricate using other modeling techniques or technologies.

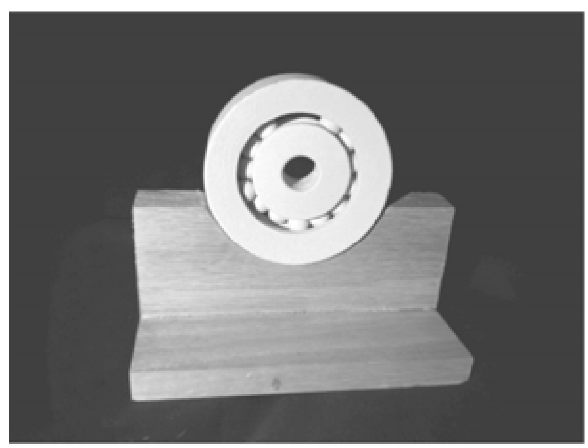


Fig. 5. 3D printed ball bearing in exhibit frame. (Cody Drago)

4. Design a 3D object that combines 3D printing and laser cut parts. This project should explore and test the tolerances between the two technologies and determine which aspects of a project or model are best represented through each technology.

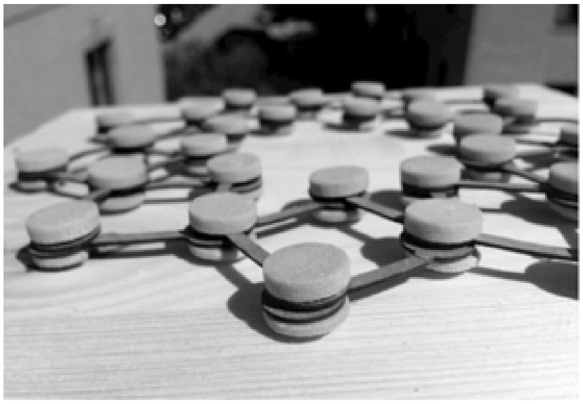


Fig. 6. Reconfigurable framework, a 2D Hoberman Ball. (Emily Reckenbeil)

5. Begin with the 3D scanner available in the CoAD CxC. Scan a small object, approximately the size of a coffee cup. Using the digital model produced by the scan and the technology or technologies of your choice fabricate a replication of the original object. [6]

Fig. 7. Left. Bird sculpture from the LSU Hill Memorial collection. Left. Model produced from 3D scanning and then laser cutting in chipboard. (Tess Baudry)

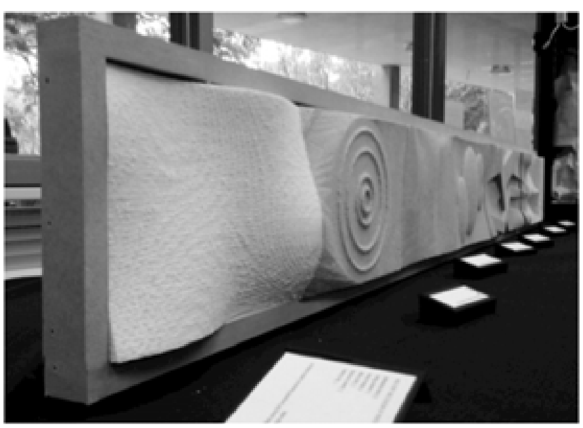


Fig. 8. Assembled CNC routed foam in the exhibition frame. (All students)

6. Cut one sheet of 4' x 8' x 1.5" Rigid Foam Insulation into 12" x 8" pieces. Begin with the edge of the model preceding yours. Cut the sheet into 12" x 8" pieces. Produce a 3D surface in Rhino within a constraint of 10" x 7" x 1.5". Mill the surface, cut out milled portion of the foam to 10" x 7". Combine all models into a single display.

7. Using Rhino design a 3D object, which will be translated into a physical mold to be cast. You are limited to acrylic models filled with casting resin. Consider the shape of the acrylic framework, the size and volume of resin (amount / cost), and the mechanics of pouring (clamping / ventilation / protecting work surfaces).

Fig. 9. An anthill was cast in plaster, 3D scanned, laser cut as a void and then filled with blue resin. Shown here in exhibit frame. (Cody Drago)

8. Purchase one sheet of 4' x 8' Furniture Grade Plywood. Design a chair to be CNC'd and which fits on one sheet on plywood. Consider necessary post-production to complete your design such as: sanding, finishing, joinery, hardware, shop work, hand worked pieces, or upholstery.

Fig. 10. Students modeling their chairs, in the LSU quad below the live oaks. (All students)

9. Use the ABS 3D Printer in the Engineering CxC to 3D Print a model of your design that builds upon the strength and thinness possible with the ABS Printer (recommended 0.0625” (1/16”), experiment with 0.03125” (1/32”) and even 0.025625” (1/64”) to maximize the model volume produced from 1 cubic inch of ABS Print material ($12 per/cu in).

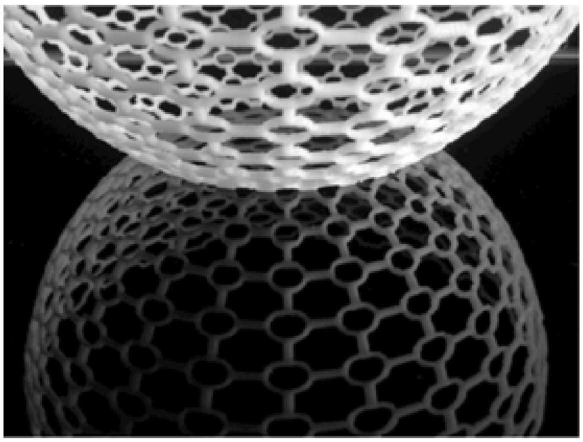


Fig. 11. An ABS 3D printed basket photographed on an Apple MacBook Pro screen. (Susana Constenla)

10. Using the scans created from the archive at the LSU Hill Memorial Library produce a diorama of the 3D scanned objects: apple, termite colony, Escher fish, bird statue, canine skull, and bird skull. Draw upon the aesthetics and arrangements of natural history dioramas and taxidermy displays. The completed display should be housed in a wood and acrylic display case and there should be a narrative attached to the objects’ interaction.

Fig. 12. The assembled diorama box of 3D scanned objects. (All students)

11. Produce one – two + portfolio spreads of writing and/or drawings, which describe your stance on the relationship between fabrication, craft, design, and architecture. Design an analytic object using digital and/or hand technologies, which demonstrates your position.

Fig. 13. Manifesto objects. (All students).

12. Redo the assignment(s) of your choice from Assignment 1-10.

13. Design and document the final exhibition of the coursework including: exhibition drawings, exhibition labels, schedule, and advertisement strategy.

Challenges + Limitations

There are several challenges to teaching digital tools through fabrication that can be mitigated. The first challenge was the speed of technologi-

Fig. 14. Final exhibition of ‘Edges’ work in the lobby of LSU Middleton Library.

cal development. Maintaining a complete collection of relevant and up to date software and hardware is nearly impossible.

Therefore, this course aimed to teach students the underlying principles of modeling and fabrication software rather than capture a moment in technologic time. The specific futures of these technologies are unknown, but will certainly change.

The second challenge was the high cost of digital fabrication, particularly for beginning design students. This course mitigated cost by assigning limited and focused work, encouraging the use of found and recycled materials, and requiring low cost tests prior to more expensive fabrication projects. Future considerations might include, fabrication fees levied at the institutional level to support the purchase, maintenance, and use of necessary technology.

The third challenge was access to resources. As is the case with many schools, physical resources at LSU are located throughout campus. In many cases siloed within departments. Therefore, the course worked closely with several departments and local community members to gather the necessary resources to introduce a broad range of digital tools and techniques. [7]

Conclusions

'Edges' was a seminar course aimed to introduce students to digital techniques through the fabrication of artifacts. It highlighted that the polarity between manual and digital making is unproductive. 'Edges' did not intend, nor offer a framework for integrating these concepts into the architectural studio environment. Rather it attempted to create an educational space to explore and fail in a low-risk environment and to develop a conceptual relationship with a set of tools, as these tools are changing. It is imperative that there is space in a curriculum to explore and to fail outside of the high-pressure venue of studio, where failure is enthusiastically discussed but rarely fully employed by students anxious to produce carefully imaged portfolios.

Contemporary architecture departments are tasked with the introduction of digital techniques

Fig. 15. Final exhibition of 'Edges' work at LSU Middleton Library.

in a design education as the associated digital tools are changing. These techniques (regardless of the specific software or hardware) should be introduced conceptually through the crafting of artifacts, the making of things. Digital and hand techniques should be taught concurrently in seminars and reinforced through the architecture studio.

As the curricular discussion continues it will become necessary to abandon the language of digital and/or manual in favor of a discussion of available techniques categorized instead by function or intent such as 2D imaging, 3D modeling, drafting, or fabrication; a framework that allows for techniques to be taught in pursuit of an artifact (drawing, model, or other) rather than mandated by a specific digital and/or manual technique.

This is a liberating notion; architects are makers and having more tools means being able to make more things. Tools and techniques should be taught in the pursuit of imagining and producing the 'concrete matter' of architecture.

Notes

[1] Hemsath, Timothy. "digital RE thinking: digital literacy in beginning design." Proceedings of the 24th National Conference on the Beginning Design Student, Georgia Institute of Technology, 2008.

[2] Maze, John. "Benignant Beginnings in Digital Fluency: Simple Principles to Merging Digital Media and Early Design Pedagogy". Proceedings of the 22nd National Conference on the Beginning Design Student, Iowa State University, 2006.

[3] Allen, Stan. "Artificial Ecologies." Reading MVRDV. Rotterdam: NAi, Publishers 2003.

[4] ZCorp employs ink-jet technology to apply binder to thin layers of gypsum-based powder. ABS employs acrylonitrile butadiene styrene a thermoformable material to print durable solid objects at high resolution. CNC is an acronym for Computer Numerical Controlled systems where computer produced code provides for automation of machine tools.

[5] Scott, James C. Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed. New Haven: Yale University Press, 1998.

[6] CoAD: College of Art + Design. CxC: Communication Across the Curriculum CxC an LSU resource focused on enhancing learning experiences for students and improving their written, spoken, visual presentation and technological communication skills within the disciplines.

[7] The projects were supported by the generosity of the LSU and Baton Rouge community, with special thanks to Mark Shumake, Design Shop manager; Paul Callahan, Design Shop staff; Christopher Hentz, professor of art; Stan Holt of Holt Control Systems, Inc.; Vincent Cellucci, College of Art + Design Communications across the Curriculum (CxC) studio coordinator and staff; School of Engineering CxC staff; Marty Miller, art and design specialist at Middleton Library; Mark Martin, processing archivist at Hill Memorial Library; Don Colvin, Engineering Machine Shop manager.

The Practice of Practice

Margaret Fletcher, Assistant Professor of Architecture

Auburn University, School of Architecture, Planning and Landscape Architecture

Introduction

The First Year Architecture Program at Auburn University focuses on the practice of practice or the art of synthesizing thinking, doing and making. The objectives of the studio course concentrate on habits of mind and habits of work—how you think and how you act. It is the very nature of studio culture to embrace such objectives and to understand and convey, studio as a class, studio as a place and studio as an activity. The transference of this understanding of studio culture to the beginning design student lies squarely in practice as in practice makes perfect—do it over and over and over again—as well as in the practice of design, synthesizing thinking, doing and making, the very nature of the act of the profession.

The First Year Architecture Program at Auburn University engages in a professional service project each year in collaboration with the College of Engineering and the College of Science and Mathematics. The studio designs the physical atmosphere—a large-scale stage set—for a two-day national robotics competition, South's BEST. The collaborative project is currently in its tenth year.

South's BEST is the initial project in each cohort's education that is a full-scale fabrication and is the start of the design-build sequence in their design education at Auburn University which ultimately can culminate in the Rural Studio experience. Each year level has embedded in its pedagogy some aspect of design-build strategies in an effort push the educational ethos of learning by making out of the material scale of the architectural model and into the material scale of full-scale architectural fabrication and assembly.

The project is facilitated as if in an architectural practice; the students have a budget they manage, a client they collaborate with, professional sound, lighting and production consultants, a design and fabrication deadline, an installation schedule and a maintenance role. The primary collaborators with the students are professionals within their respective fields. Collaboration in this sense recognizes the fact that students can't learn the discipline of architecture if they are collaborating with students in other fields who are in the process of learning their own discipline.

The installation schedule for South's BEST is less than 12 hours and begins at 8:00 pm. The entire construct has to be able to be quickly, efficiently and without undo wear on the assembly, broken-down, transported and re-assembled on site in the Auburn University Arena, ready for the robotics competition to begin. This assembly process requires a certain amount of ingenuity from the students when thinking of the materiality of the constructions.

This paper seeks to discuss three of the most unusual material choices and assembly methods over the past ten years from large-scale visqueen inflatable constructions to kinetic walking contraptions to systems developed with recycled materials. The discussion focuses on determining the variance in pedagogical value of the project through the lens of the material selections and related issues of material cost and material waste.

South's BEST Robotics Competition Architecture Project Installation

The Foundation Unit of the Program of Architecture has been participating in the BEST Robotics competition for over ten years. Over these years, a wide variety of material and assembly choices have been employed, each year attempting to solve issues discovered by previous years, attack new problems to move the entire project forward as well as responding to the specifics of each years' competition—narrative theme, site, installation schedules and budgets. The material selections and installations have varied widely from plywood decking installations, to inflatable visqueen installations, to pipe and post installations, to large kinetic walking machines, to projected installations, as well as installations using 95% recycled materials.

Budget

The budget model for the BEST project has changed over the ten years that the project has been part of the Foundation Unit pedagogy. In initial years, the budget was established and provided by the partner schools, Engineering and Science and Mathematics. This budget covered not only the work of the Foundation Unit but also was used for lighting, sound and production vendors.

Over the years, the provided budget began to dwindle to the point that it was no longer viable for the Foundation Unit to participate and still meet the general objectives of design-build, place-based learning. At this juncture, the faculty decided to collect a fee from each student at the beginning of the semester that would become the budget for the BEST project. Therefore the budget is established by the number of students participating in the class with each student paying one hundred dollars into the budget fund. This dollar amount ultimately becomes the entire budget for the fabrication and production of the installation and has ranged from $2,500.00 to $5,100.00 depending on the size of the class.

Schedule

The BEST project occurs at the end of the first semester in the architecture student's education. The direct work in preparation for this project lasts three weeks and the pre-preparation—projects directly related and seen as practice or skill-building projects—lasts two weeks for a total direct commitment in the studio of five weeks. The faculty knows the theme of the competition at the beginning of the semester and while they do not specifically plan what the installation type will be, they do have a general sense of what skill set each class will need to develop in order to respond to the theme and prepares a pedagogical plan in anticipation of the BEST project. The full semester is 15 weeks. The general production and meeting schedule for the project is as follows:

Week 01: Students begin pre-project. At this point the students have not been introduced to the BEST project. The pre-project either introduces elements that could relate to the theme of the games or introduces additional skills, or both. During this time the faculty meet with the clients—Directors from both the College of Engineering and the College of Science and Mathematics—to begin to get a better understanding of the theme of the games and to determine changes in policy from previous years.

Week 02: Students are working and finalizing the pre-project.

Week 03: Students are introduced to the BEST project with an introductory presentation from faculty. Students meet with the clients to begin the process of understanding their role and what is expected of them from the client's perspective. Students are given the competition theme, their budget and production timeline. The complex installation schedule is introduced. From this point forward the faculty take a hands-off approach to the development and management of the project. Students are expected to establish their own problem statement, develop design schemes, seek out the necessary resources to solve their problem, manage the large group so that every student stays busy, as well as manage their budget and production schedule. At the end of this week, students present a series of scheme proposals to the client and engage in a discussion with them about design, installation and expectations. The student team then coalesces this information and prepares the redesign/edit until they have a unified proposal.

Week 04: The students test design and fabrication solutions. The students meet with clients and lighting and sound production managers to coordinate. The students establish a team of managers for budget, production and installation. This super-set of managers then coordinates and manages all of the efforts of the collective team and acts as the liaison with the client and production teams. Final fabrication and production begins.

Week 05: Final fabrication and production continues. Dry-run installation schedules are established and the student management team tightly manages daily production schedules. The end of this week concludes with the BEST installation.

Design-Build Place-Based Learning

The Program of Architecture at Auburn University has a long and robust history relative to the pedagogical emphasis on design-build and place-based learning. The program has established an international reputation through the design-build, place-based work that is generated through the Rural Studio in Newbern, Alabama and the Urban Studio in Birmingham, Alabama. At Auburn, we have launched a resounding response to the idea that you must be in an acknowledged urban and cultural center to teach students about architecture and design. What we know to be factually true is that learning opportunities exist in any community with a commitment to design and commitment to the education of students. Our cultural environment is rural Alabama and this is the fertile ground we find ourselves in to teach our students. What has developed over the past twenty years is a strong commitment to the place of Alabama and an understanding of the benefits of long-term, place-centric involvement in community. The Program of Architecture has always been one of hands-on education with the idea that to understand something, the student must be able to not only do it themselves but must also be able to teach their colleague how to do it as well. The place-based, hands-on models of the Rural Studio and Urban Studio naturally generate such activities operating at full-scale in real time.

From the School's Mission Statement: "The School of Architecture, Planning and Landscape Architecture (APLA) is committed to a model of professional education that embraces design and planning creativity, social responsibility, historical perspective, technical competence, and global environmental consciousness, and prepares our students for leadership in their respective disciplines and in their communities.

APLA has two off-campus programs that operate within the Program of Architecture: the Rural Studio (located in Newbern, AL) and the Urban Studio (located in Birmingham, AL). In addition to providing enriched environments for the study of architecture, these programs involve students in intensive community-based, service learning activities."

The BEST project firmly resonates with the objectives of the entire school and lays the groundwork for the success of students as they move through the architecture curriculum and prepares them for the level of self-reliance that is required of them when participating in projects at the Rural and Urban studios.

Pedagogical Objectives

The pedagogical value of participation in the BEST project lies squarely in the realm of the objectives of the Program of Architecture and immerses students in the practice of practice. The project provides a real-time, real-world scenario for students to actively engage in their chosen discipline. Over the past ten years, the overarching value of the experience has largely been the same and has in almost all cases been evaluated as successful as it relates to collaborative practice, design-build, place-based service learning.

There are several areas that are discussed routinely that could provide pedagogical improvements and they largely relate to material cost and material waste. While we firmly believe that a material is not wasted if it is used for students to learn something, it has been the primary area of faculty re-design and in some ways has not reached a satisfactory resolution. If we consider material waste as simply a by-product of production then we can address this problem in a rather straightforward manner: material does not get disposed of if it has enough surface area left to use. In fact, often lumber waste is delivered to the Rural Studio to be used as material for full-scale mock-ups and the like.

However, getting students to actually spend the money to purchase materials to practice or experiment with is another matter entirely. In the recycle-centric mode that the students come to university with, it becomes quite difficult to explain the value of material use for the sake of understanding the material itself. Certainly this is a principle that with time and experience students become more familiar with but is difficult for foundation level students to realize. With the BEST project, students overcome this initial issue of material waste with the real understanding that they are on their own to resolve full-scale fabrication issues while engaging in the available resource network. The first time they actually try to build something that cannot fail in any way and must meet normative levels of safety standards for the participants of the robotics competition, they immediately begin to see the value of testing full-scale with actual materials.

Material waste becomes another issue altogether after the de-installation process when students load the dumpsters with all of their construction materials. At this point it is evident even to the faculty that there is a miss in the lesson being imparted to the students. All of a sudden, the shear volume of material waste can overshadow the pedagogical values of material use. The three case studies outlined below are each distinctive material responses to the volume of material waste at the conclusion of the project and the pedagogical message being delivered about material selection, value and waste.

Case Study One: Visqueen Fabrication

Year: 2008
Theme: *Just Plane Crazy!*
Material: Visqueen
Installation Time: 12.5 hours
De-installation Time: 2 hours

The competition theme in 2008 was "Just Plane Crazy!" It was decided since the theme of the event was related to planes and flying that some sort of light construction would be needed to convey those conceptual ideas. The use of visqueen as a material choice was also a direct response to the volume of material waste in previous years of the BEST project.

The pre-project for the students this semester was the fabrication of large-scale constructs out of visqueen. In this way, the material was introduced prior to the project but the students could opt out of this construction method and into something else. However, they decided to continue the work with visqueen as the primary material. The pre-project organized the students into teams of four or five; each team had a specific fabrication objective that addressed issues of construction with visqueen as the only material available for use. No additional fasteners, etc. could be used in the fabrication of the plastic constructs. The students were instructed to design and fabricate the following: a perfect cube, a perfect sphere, an inflated object as tall as it could be, a perfect arch and a patterned object (Fig. 1). These inflated constructs became the fabrication studies for the final work of the project.

There was a significant learning curve regarding the fabrication technique for the inflations. The students devised a system of folded and ironed seams to create edges and corners in the geometric constructions. The more complex the form, the more internally fabricated structural components were necessary to maintain the form in the inflated state.


Fig. 1. Visqueen pre-project

While the visqueen was less expensive than in previous years where the budget all went to wood and fasteners; the tools needed to fabricate the inflations increased dramatically. The cost waste became centered on clothes irons, flat irons, leaf blowers, fans and the like. It should be noted that some of these tools were stored for future projects but at least in the case of the irons; they were usually used until they no longer worked and were discarded. The actual volume of waste at the end of the de-installation phase was remarkably less than in previous years that used more normative construction materials.

Case Study Two: Recycled Fabrication

Year: 2010
Theme: *Total Recall!*
Materials: Wood, Chicken Wire, Aluminum Cans /Plastic Bottles
Installation Time: 7.5 hours
De-installation Time: 4 hours

The competition theme in 2010, "Total Recall," was based on the six sigma manufacturing process, a manufacturing process used to measure efficiencies in the production and waste streams of large-scale manufacturing processes.

The pre-project for this class was a wood shop project of a series of platonic solids made out of planes of plywood. Each year, the pre-project was usually a response in some fashion to pros and cons from the previous year. In this case, the previous year worked on perfect cubes constructed out of wood.

This particular cohort of students responded of their own accord to the issues of cost and material waste of previous years as well as working with conceptual ideas related to six sigma manu-


Fig. 2. BEST competition with bottle and can screen.

facturing. Instead of continuing to work with wood constructs, they focused on researching the six sigma manufacturing process and they discovered that plastic bottles and aluminum cans were actually designed for efficient methods of packing and shipping and not only to solve ergonomic issues.

They devised a system of stacking the bottles and cans capitalizing on the packing qualities inherent in the design of the cans and bottles to create a large-scale screen. The screen was designed with a thin frame system of 2 x 10's, plywood and chicken wire that capitalized on the differences in the transparency and opacity of the bottles and cans. The end result was a remarkable screen wall (Fig. 2) that created an impressive presence in the competition space.

The work of the project became seeking out sources for used bottles and cans that had already entered the recycling cycle. The students worked with university and community recyclers to gather bottles and cans that could be used in the fabrication of the screen. The students collected, washed, sanitized and sorted the materials. At the conclusion of the installation, all recyclable materials were returned to the recycling center and reentered the recycling stream.

Case Study Three: Kinetic Fabrication

Year: 2011
Theme: *BUGS!*
Materials: Wood, PVC Pipe, Foam, Fabric, Misc. Gears / Fasteners
Installation Time: 9 hours
De-installation Time: 3.5 hours

The theme of the 2011 BEST competition was "BUGS!" The faculty decided early in the semester to use the object of the bug to begin to study issues related to scale, representation and movement. The pre-projects for this cohort of students was more prescribed than in other years. The faculty wondered if there was a way to engage a student group in a more kinetic construct for the competition design. With this in mind, there was a series of three pre-projects that influenced the students' resolution of the BEST project. The first pre-project was a 22″ x 30″ prismacolor rendering of a bug. These highly detailed analysis drawings engaged the students in the mechanical understanding of the joints of their respective bug. The second pre-project was a prototyping assignment to fabricate, in teams, an exact forgery of an Arthur Ganson machine. These machines are highly detailed with an elegant quality to them and required the students to learn a wide range of new skills including welding, soldering and precision motor work. The third pre-project was an additional prototyping assignment of the creation of a full-scale working adaption of a Theo Jansen Strandbeest.

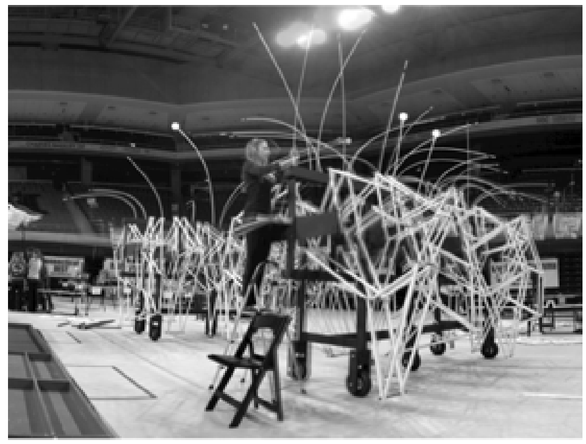


Fig. 3. BUG kinetic machines.

Though the pre-projects for this cohort were much more directed than in previous years, the design process for the students once the BEST project began was the same as in previous years. The students devised their scheme for the competition and determined that they wanted to design and fabricate all kinetic apparatuses for the competition. The kinetic apparatuses all required highly iterative prototyping (much like what they had done with the Ganson machines) in order to prove their efficacy as working machines. At this junction, cost concerns grew immensely simply because the students had to prove the design worked through studying assembly methods with real materials and at a real scale (Fig. 3). This class had to increase their budget by collecting additional funds in order to successfully complete the project.

Conclusion

These three case study examples convey a wide range of material choices, material cost and assembly methods. However, the overarching pedagogical goals for the project identified earlier—relating to collaborative practice, design-build, place-based service learning—remain largely intact no matter how these material issues resolve themselves. Each group brings with it a series of strengths and weaknesses that become evident when the students begin working together in this practice environment.

The faculty remain flexible regarding the nuances of learning objectives that emerge with each class depending on the material selections and fabrication methods. Regardless of these material and fabrication decisions, all cohorts work together to understand the shear volume of work that can be accomplished while working not just together but collaboratively, they learn the rigor required to build an installation at full-scale that can exist safely as intended for public use, and they learn the specifics related to a collection of materials and the proper methods for the real world assembly of these materials.

Design Knowledge and Architectural Detail in Studio Education

Clifton Fordham

Temple University

But there can be no doubt that one of the ways that architecture continues to matter is in how it uses energy and that reducing the amount of energy consumed by buildings needs to be one of the highest priorities of our time.
-Paul Goldberger[1]

The passage of time will guarantee that architects, historians, and theorists continue to wrestle with the question of the purpose of architecture, an important activity since to be effective architects and educators must frame their actions. When critic Paul Goldberg wrestles with the question of the value of architecture, he includes multiple characteristics of architecture exceeding the minimum requirements of accommodation. The fact that he cites goals of energy efficiency suggests that architecture has to be relevant in multiple ways, and reflects the complexity of something that to some individuals might appear as mere building.

Changing views of what makes architecture relevant are part of what makes participation in shaping its course interesting. Change also makes the job of teaching architecture difficult. Perhaps one of the most charged debates spanning practice and academia is what should be learned and where. One thing that is clear is that architecture is a profession, and professions are constructs that are situating within a dynamic social and economic context. Since professions need to function effectively, education matters, and what students learn is important. Within professional schools there is tension between specific competencies necessary in practice settings, broader intellectual interests of schools, and a desire for flexibility in learning outcomes.

Debates are often framed as practical versus conceptual educational models, with practical education being vocational thus promising immediate benefits, and conceptual education promising longer term benefits with the cost of practical training on the job. Often educators argue that practical learning should occur in practice settings and that practical learning undermines the expansive potential of school. Imbedded with this is the notion that creative design thinking is burdened by applied knowledge, exaggerating a dichotomy that contributes to segregation of thinking modes into different types of courses.[2]

An alternative is to consider the role knowledge plays in the design process, how beginning designers can gain knowledge necessary to tackle complicated problems, and how the scope of questions that beginning designers address include more content that is associated with practical knowledge and practice. Shifting the scope of design thinking in architectural studio education prompts questions that include the following. Can technical knowledge be integral to design studio without extinguishing creativity which is generally associated with conceptual thinking as opposed to practical thinking? Also, if knowledge is important to good design, what kinds of knowledge should design students gain for long term efficacy?

If architects are to be more effective, including addressing environmental challenges, tempering ideas of what constitutes meaningful architecture is vital since too wide of a scope would diffuse action. Additionally, educators will have to challenge previous assumptions about what is learned in the academy versus practice. To assume that practice is a place where most beginning architects can make major changes in how they think about architecture understates the importance of the academy. Arguments for more knowledge are not without an important corollary, namely that academic building design problems should be scaled down to effectively allow for integration of building construction knowledge and formal composition.

Why Knowledge is Key to Successful Design

In their book *The Environments of Architecture* Randall Thomas and Trevor Garnham state that

"Architecture needs to be located in an environmental, cultural, and historical context". Their concise definition supports the idea that energy performance that results from site planning, form, materials, construction, and operation are key to what makes architecture along with poetics of form. They also identify Le Corbusier for establishing precedence for modern architecture that bridges culture and science, demonstrating that these objectives are achievable within the scope of meaningful architecture. Throughout their book, the authors address a shortage of academic text written for architects on situated architecture that responds in a balanced way to scientific, natural and cultural influences.[3]

Recent interest in sustainable design is driven by concern that the health of the planet is in jeopardy so as to threaten fundamental quality of life for humans and other species. Since buildings account for a significant portion of energy use and carbon omissions, only addressing non-building centered contributions to carbon emissions, such as vehicle use and industrial activity would be neglectful and miss opportunities to increase the impact of building design. Although other decision makers besides architects contribute to the shaping of buildings, there is strong argument that architects have a moral obligation to play a leadership role in building greener buildings.

The Environments of Architecture is not a traditional technical book that indexes practical solutions, it is a conceptual book that is unusual because it weaves scientific principles into all of the chapters, and relates scientifically based concepts to design culture and history. Throughout their book, the authors are refocusing the lens through which design is understood by making a connection between the poetics of architecture, building details, and performance. It is the difficulty of relating detail to performance in a theoretical context that leaves much appreciation for the work of Kenneth Frampton, specifically his book *Studies of Tectonic Culture*.

Studies of Tectonic Culture is unusual because it addresses architectural details including how building components are assembled within a poetic and conceptual framework. Although Frampton does not discount volume as a traditional means for understanding meaning in architecture, he links significant design works to site specificity, material culture, and building technology. This distinguishes him from most critics who evaluate architecture with a narrower lens.

The way *Studies of Tectonic Culture* is illustrated is also unusual for a critical history text since there are an exceptional amount of section drawings and detailed assembly drawings; often exploded axonometric drawings showing how a portion of a building is constructed (fig. 1). For Frampton poetics and meaning are rooted in construction technology, allotting much of the expressive potential of architecture to building assemblies.[4]

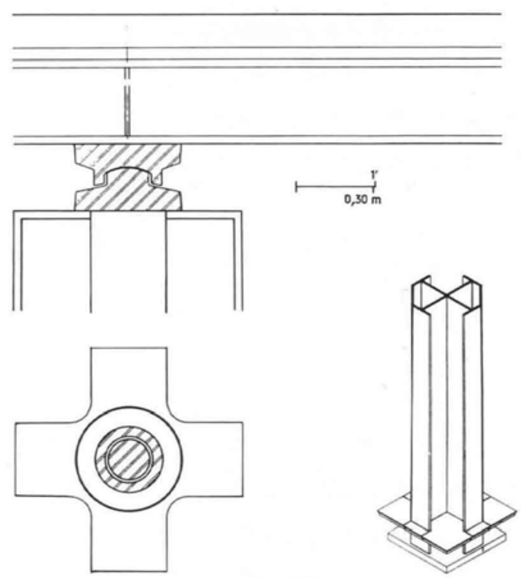


Fig. 1 Mies van der Rohe, Neue Nationalgalerie, details published in *Studies of Tectonic Culture.*

Three architects feature prominently in *Studies of Tectonic Culture*: Mies van der Rohe, Carlos Scarpa and Louis Kahn. Of these the architects, only Kahn's work can be considered exceptional for moments of expressiveness. Mies van der Rohe's buildings are fundamental in shape, and the interventionist nature of Scapra's work difficult to comprehend from a distance. Both van der Rohe and Kahn relied on classically derived systems of proportion for their buildings creating frameworks for details fused within larger ordering systems. Mies van der Rohe displayed what could easily be considered an obsession for illuminating how his buildings are constructed, and resolving details so as to make them seem almost effortless. Kahn differed from Mies in that his buildings appeared heavy and anchored to the earth as opposed to light and immaterial.

The work of Carlos Scarpa is perhaps the most atypical of all the architects documented by Frampton. Scarpa's work can best be understood by focusing on the connections between materials and assemblies, something the Framp-

Fig. 2 Carlos Scarpa, Museo di Castelvecchio, photo and detail in *Studies of Tectonic Culture.*

ton characterizes as the "joint". Inherent in the details of Scapra's buildings is a record of making, utilizing drawings and models; a craft spirit that infuses life, and gives significance to the larger work (fig. 2). Connecting the construction of building assemblies to meaning and their success as works of architecture is difficult since gesture is much more literal. Frampton's critiques help us see building design and materiality as being intertwined and similarly important for achieving the goal of meaningful architecture.[5]

Although most of the architects that Frampton writes about are no longer practicing, there are a number of contemporary practitioners who exemplify the characteristics of work grounded in the tectonic, and are widely recognized as achieving notable architecture. This group includes Renzo Piano, Peter Zumthor, Todd Williams and Billie Tsien. A common thread between the works of these architects is careful attention to space, materials and construction, and a paucity of reliance on highly expressive forms in their architecture. By focusing on construction, Piano's work manages to defy the dullness of large scale commercial architecture. Zumthor instills a sense of aura with materials choice and minimalist detailing achieving a sense of perfection not unlike Mies van der Rhoe. Of these architects, the detail interventions of Todd Williams & Billie Tsien most closely resemble the spirit of Scarpa.

International renowned architecture practices are not alone in achieving meaning with material and detail. In the United States, regionally based architects that receive less attention include Lake & Flato, KieranTimberlake, and Olson Kundig. Work of these architects diverges from design practices where design emanates from the expressive potential of digital modeling and manufacturing. Digitally driven design processes, with an emphasis on form-making, are often at odds with design processes grounded in a dialogue between architect, builders, and fabricators related to how buildings are made. Despite a general gravitation toward the digital in academia, and skepticism that calls for craft are rooted in nostalgia, critics such as Frampton hold onto the value of the tectonic.[6]

Fig. 3 Todd Williams and Billie Tsien, photo of Barnes Collection stair.

Tectonic expression is a valid path toward poetics that does not depend on complex form making. Building details, particular articulation of the façade, mediate interior and exterior environments, with thermal building performance and durability being a key component of detailing. Relegation of detail to practice reflects the awkwardness that the tectonic fits within recent theoretical critiques emanating from the academy, and reflects resistance to integrating technical building knowledge into the design studio.

In his book *The Architectural Detail,* architect and author Edward Ford observes that there is very little theory of architectural detailing, rather examples of detailing in buildings. Although Ford is primarily interested in detail at the theoretical level; the peripheral status of his writings raises questions as to why there is little emphasis on tectonic expression in design school. Even if it is tempting to link detailing with nostalgia for a world of craft that will not return, there are significant benefits to be gained from understanding architecture through detail.[7]

Importance of Design Knowledge

There are valid reasons why there is a shortage of reliance on technical knowledge in the academic design studio. Among them is a legitimate fear that beginning design students will revert to familiar design solutions which emerge from prior experience without exploring design problems deeply and learning to experience new ways of thinking introduced in school. The typical method for avoiding conventional design solutions is to resist the particulars of familiar precedent and emphasize abstract design solutions. Technical knowledge is also seen as a liability in the design studio since the specific demands technical problems place on design can became central to problem solving inquiries, perceivably limiting the potential for innovative form.[8]

An additional argument underlying lack of specific knowledge in beginning studio environments is that specific knowledge, particularly technical knowledge, should be gained after graduation in practice settings. However, limiting external and technical knowledge in the academic design studio is not without negative implications. Discounting knowledge brought to a design problem before the design process starts for a specific project underestimates the importance of knowledge and precedent in framing questions and offering relevant solutions, something that distinguishes effective designers. Specific knowledge is also critical for understanding building details, and integrating them into design thinking.[9]

Design knowledge is different from other types of knowledge since it depends on a personal approach to problem identification and design generation. While scientists research problems until they fully understand them, designers pose solutions before they fully understand a problem. Skill in identifying essential components of a problem requires knowledge least proposed solutions be inappropriate. A significant part of a designer's contribution to building design is the ability to situate poetics within a context of pragmatic objectives that come from external sources. Since designers cannot effectively solve for all problems, learning how to make strategic choices about what problems to solve is critical and school is where this capability is best developed.[10]

Building Design is Complex

Limiting technical knowledge in the design process has steered many architects away from a concern of building performance based on technical criteria, particularly early in their careers. The segregation of technical concerns and formal design concerns undermines potential for merging performance based detailing with design poetics. Within the context of sustainability this is not only unwise; it is inconsistent with the idea of sustainability which is synonymous with durability. This bifurcation can be traced back to the Ecole des Beaux-Arts studio model that prevailed as the model for the first American architecture programs. It is also reflects the development of a profession that distinguishes between broad formal problems to be solved by designers and narrow, and often hidden technical issues to be solved by builders.[11]

As the profession formed, labor divisions emerged among those who supply design direction to builders, resulting in teams comprised of engineers who address problems pertaining to complicated mechanical and electrical systems. Within this context, the architecture profession has hinged on the ability to see the big picture and ensure safe, well-functioning buildings, as well as aesthetically pleasing ones, although noted architects have downplayed the pragmatic portion of these responsibilities. Between the divergent acts of building shaping and pragmatic life-safety responsibilities, the majority of architects have limited opportunities to influence buildings in a manner that can be critically acknowledged.

Within architecture discourse, issues related to life-safety, and construction, are uncommon. Even during the post-war era when the culture of technology promised a future of improved life quality through science, architectural education retained an emphasis on form making. This reinforces a view of architecture as aesthetic, and loosely tied to pragmatic concerns and performance. With the exception of the specialization of urban design which addresses broad quality of life questions, the architecture community has not cohesively related itself to the health interests of the broader community until the sustainability movement gained traction across the profession.

Shifts in practice landscapes where increased importance of building technology evidenced by the array of consultants typically working with architects, and increased budgets for building technology have had a muted impact on instruction in architecture school studios. Difficulties exist in adapting the culture of design to recognize complex building systems, and natural and man-made ecologies in which buildings are situated. Teaching design is difficult considering the complexities of practice today as opposed to when the profession first established itself. When awareness of complexity in building design first emerged in the 1960's, architecture schools were already vested in a traditional model suitable for a simpler world.[12]

Most academic studio design problems filter out problems that require a foundation in technical knowledge relegating instruction of pragmatic topics to lecture courses, something that is consistent with the Beaux-Arts model. Lecture courses, sometimes called support courses, are clearly subordinate to studio courses. Specific knowledge is peripheral to studio discourse, and design expression is usually limited to shaping of buildings to the exclusion of design at the human and material scale. Filtering of pragmatic and performance concerns allows for fluidity of design postulation and often results in dramatic building forms that often elude measure.

Architecture school projects usually graduate from small scale to larger scale towards the latter years of degree programs. This progression acknowledges that students should grapple with complex programs after being introduced to basic design concepts, but generally does not acknowledge knowledge gained in technical courses with the exception of structures courses. Large project sizes increase the amount of knowledge a designer must handle, and crowds out potential for technical integration when macro formal issues are of primary consideration. An alternative is to consider the potential of design at a finer scale, includes questions of how material systems join, and how building systems, particularly enclosure assemblies mediate environmental conditions.

Integrating Building Technology

Developing a knowledge base in building technology is key to understanding the design potential of detail and performance based design. Knowledge is also important for appreciating design in a nuanced manner. One of the underlining objectives of the Materials & Methods course at Temple University is to place building technology within the scope of design thought. To accomplish this, the course is taught by an architect who versed in design theory, has experience with building construction, and who is capable of leading design studio. This helps avoid the pitfall of staffing the course with a technical architect who has limited interest in design.

Students are introduced to the major material systems through the lens of material properties and prevailing assembly methods, something that is a necessary to establishing a foundation in the subject matter. Although objective material is covered in the course, students are engaged in a discussion focused on identifying reasons for utilizing various material systems, relating the choices to environmental and economic factors, and evaluating aesthetic ramifications of material assemblies in exceptional and ordinary buildings.

Assignments for the course are designed to relate design to the built world. Students are tasked with evaluating an older building in the city of Philadelphia and are responsible for describing its construction in detail. In the assignment that follows, students are tasked with observing a notable contemporary building in the city first hand, and constructing digital details of a key building moment by combining knowledge they gain in the field with information available in reference books. One of the primary intentions of this exercise is to reinforce the relationship between the technical art of detailing and overall aesthetic design objectives.

Students in the third-year undergraduate sustainability design studio which follows the Materials and Methods course are challenged with integrating energy use into building design, something which is complicated by the fact that they

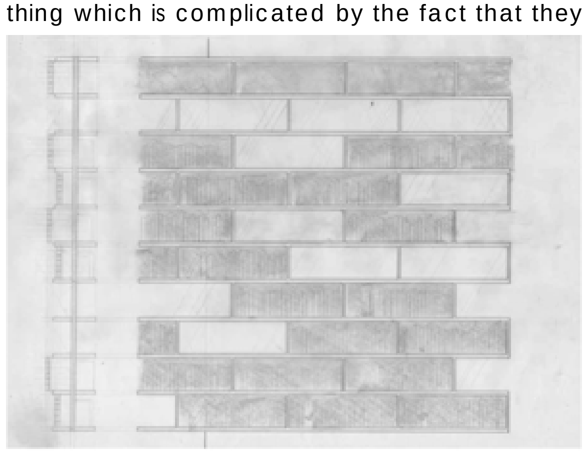


Fig. 4 Mike Sollenberger, Temple University, detail section and elevation study of building enclosure.

are relatively new to building design. Because of student's limited knowledge of structure and prevalent mechanical systems, passive design strategies requiring knowledge of solar and weather patterns across time are emphasized. Even though the students are required to consider building performance, aesthetic expectations are not relaxed. Rather, students are directed to design a building in phases so that they can understand how design changes affect energy performance.

During the first half of the semester, students consider site issues, program, and environment while developing an interim building design proposal for mid-term. A caveat is that they perform an energy audit of their building at the midpoint of the semester with software introduced in studio. After the mid-term students are tasked with redesigning their buildings so that the overall design and energy performance improve. This nuance reflects practice settings where broad design improvements after the initial schematic phase are difficult when not initiated by the client, something that studio design projects rarely acknowledge. Another objective of the studio is for students to advance their designs at the level of detail, something that architects who embrace the tectonic do effectively.

In order to develop their designs further, students are asked to produce detail drawings and models of a significant space in their buildings at the exterior envelope (fig. 4). This entails creating an interior space and enclosure solution that mediates environmental conditions between exterior and interior through glazing exposure, elements such as horizontal or vertical shading devices, and integration of program with the enclosure. By focusing on a portion of the building, students are less likely to stall, or seek drastic formal changes that erase progress made during the first phase of the design. Subsequent to the small space design, students continue to develop the larger building in the spirit of details resulting from the small space assignment, and preform another energy audit (fig. 5).

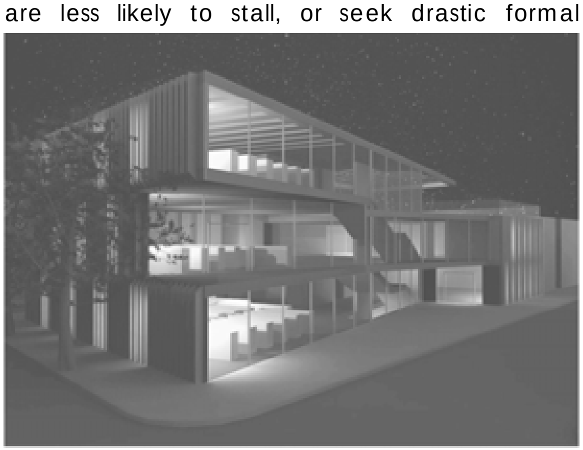


Fig. 5 Rory Wolf-Beilwa, Temple University, library perspective.

Conclusion

Knowledge is a vital component of successful designs and school is the primary place that future professional designers have an opportunity to learn how to formulate questions and propose solutions. Although there are justifications for filtering knowledge, specifically technical knowledge, out of the beginning design studio context, opportunities are lost for developing pertinent design thinking approaches prior to entering practice. Design at a smaller scale allows students to integrate knowledge that relates to energy performance, environmental quality, material economy, and orients students to opportunities for architectural expression that are available without exceptional costs.

Notes

1 Goldberger, Paul, *Why Architecture Matters*, Yale University Press, New Haven, 2009. p. xiii.

2 Thomas, Randall & Garnham, Trevor. *Environments of Architecture*. Taylor & Francis, New York, 2007. p. 2.

3 Ibid. pp. 1-3.

4 Frampton, Kenneth, *Studies in Tectonic Culture*. The MIT Press, Cambridge, 1995. Pp. 1-3.

5 Ibid. p. 307.

6 Frampton, Kenneth, *Intention, Craft and Rationality* in *Building (in) the Future*, Deamer and Bernstein editors, Princeton Architectural Press. Pp. 34-37.

7 Ford, Edward, *The Architectural Detail*, Princeton Architectural Press, New York, 2011. pp 13-18.

8 Lawson, Bryan & Dorst, Kees, *Design Expertise*, Architectural Press, Oxford, 2009. pp. 150-151.

9 Ibid, 2009, p. 140.

10 Lawson, Bryan. *What Designers Know*. Architectural Press, Oxford, 2004. pp. 1-4.

11 Lewis, Michael J., *The Battle between Polytechnic and Beaux-Arts in the American University*, in Ockman, Joan ed. *Architecture School: Three Centuries of Education Architects in North America*, Association of Collegiate Schools of Architecture, 2012, pp. 80-84.

12 Bachman, Leonard R. *Embracing Complexity in Building Design*, published in *Embracing Complexity in Design*, Routledge, New York, 2010. pp. 19-23.

Loft(y) Goals:
Tectonic Investigations of Polygonal Geometry

Liane Hancock, Damon Caldwell

Louisiana Tech University

Twenty-first century virtual modeling has opened up complex new realms of form and construction. Difficulty often manifests itself, however, in negotiating the transition from analog methods of production and understanding to digital ones. This essay discusses an analog methodology for introducing beginning design students to the complex geometric forms available through digital modeling.

As a point of examination, students are introduced to the concept of 'lofting' as a connective method of 3-d construction. While common in digital modeling, it is seen as a command rather than a process; students press a button and have little understanding of how the results are constructed. By making the loft analog and thus explicitly student-controlled, beginning design students can better understand the loft's geometric opportunities.

Understanding that modeling software facilitates complex geometries through surface construction of polygons, our project also introduces how curved surfaces can be manifested through triangulation and faceted form. Additionally, we present a procedure which encourages students to develop tectonic and material resolution for these geometries. Finally, students translate their tectonic studies into a habitable space, learning how to retain the language of their constructions while tailoring them to a specific program and scale.

Action and Abstraction

The project begins by generating closed 2-d shapes informed by a verb from Richard Serra's "Verb List Compilation: Actions to Relate to Oneself." [1] Students abstract these sections from imagery expressing the verb: a) people or objects engaged in the action; b) expressive alterations of the landscape; and c) experienced through abstract art. The students gather two images for each of the three categories.

To create base sections they employ two methods. First, they trace the underlying geometry of one image to create a closed shape. Second, they analyze the six images describing one verb, find common visual traits, movements, and spatial relationships, and then use the base drawing to create a section which captures the overall char-

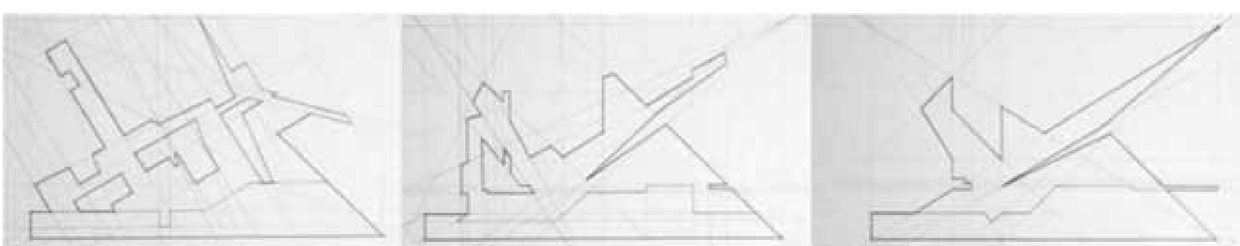


Fig. 1. Interpolated sections for "To Split," Alex Shows.

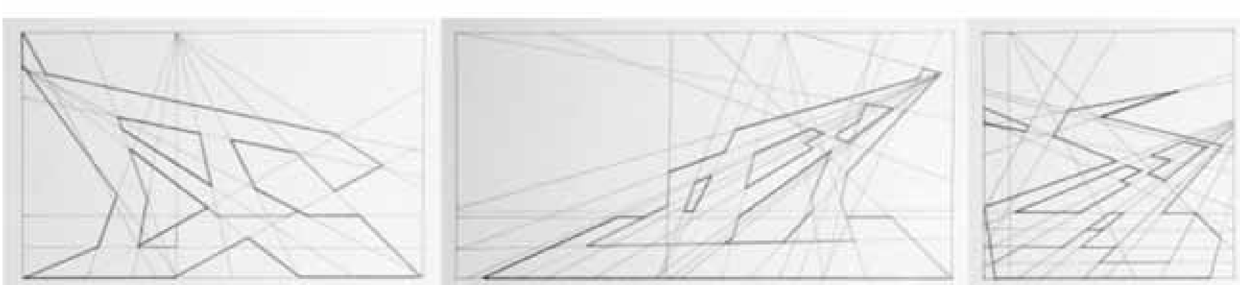


Fig. 2. Distorted sections for "To Flow," Daniel Campbell.

acter of the images. Students must evoke the formal and spatial character of the images in a closed shape that has at most 25 line segments. The closed shape is required to have between one and three internal cavities or voids, and lines may not cross.

They are given a base drawing which includes a shaped ground condition, and a bounding box which constrains their drawing. Students are required to alter the ‘ground’ condition in response to the verb and how it impacts the relationship between their section and the ground condition – cantilevered, balanced, embedded, etc. In addition to achieving a series of closed sections, this exercise also teaches students how to abstract geometry and organizational principles from realistic and experiential imagery.

After they abstract the images, the drawing sets are analyzed for their expressive and geometric potential.

Selecting one verb’s set of drawings, the students draw a third section that interpolates between the first two drawings (figure 1). Students then distort their drawings through a set of rules: the geometric frame of the drawing is altered from a golden section to both a square and a double square, maintaining height but creating three varied widths. Students decide which of the three sections they elect to keep in the original proportion, and which ones take on the new wider or narrower proportions (figure 2). This operation provides greater difference in dimension between sections, helping to activate the form in the following step. It also enhances the abstraction, as students consider how the change in proportion might allow them to further emphasize the effect of their verb on their sections.

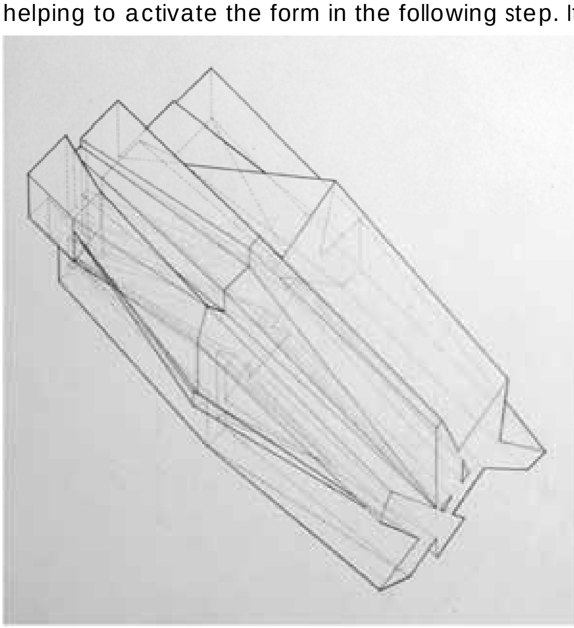


Fig 3. Axonometric, "To Crease," Colton Franklin.

Lofting

Lofting, generally understood, is the connecting together of differing elements of 2-d geometry with interpolated bridging surfaces. In this phase, the three closed shapes serve as sections for volumetric exploration. Students manually construct an axonometric by aligning the sections – as a beginning, mid-section, and end (figure 3).

They then creatively interpolate triangulated and warped surfaces between the sections, thinking through which connections and types of surfaces further express the underlying generative verb. The resulting form folds and twists while projecting generally along a single axis. A second iteration is physically built in chipboard, where students are encouraged to angle and re-position the originating sections, and thus create even more dynamic constructions that emphasize the power of lofting (figure 4).

This exercise teaches students the opportunities of polygonal geometry and how to control that geometry through faceting and triangulation. They learn how the insertion of vertices along edges creates inflection points, allowing the opportunity to model convex or concave surfaces through the insertion of facets and triangulation. They also learn that lines extending from a vertex do not need to be symmetrical or evenly spaced, permitting a variety of facet shapes to extend from one vertex. Students also come to understand that edges generated from a vertex can be controlled to reduce or increase the number of facets from the vertex, creating complicated areas of geometry, or more streamlined regions. These variations in density can

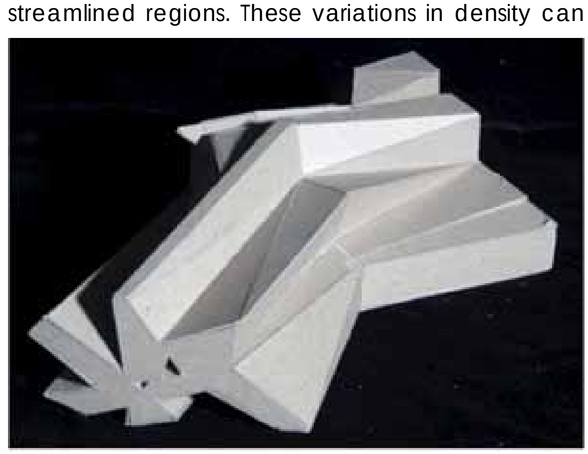


Fig. 4. 2nd iteration in chipboard, “To Crease,” Colton Franklin.

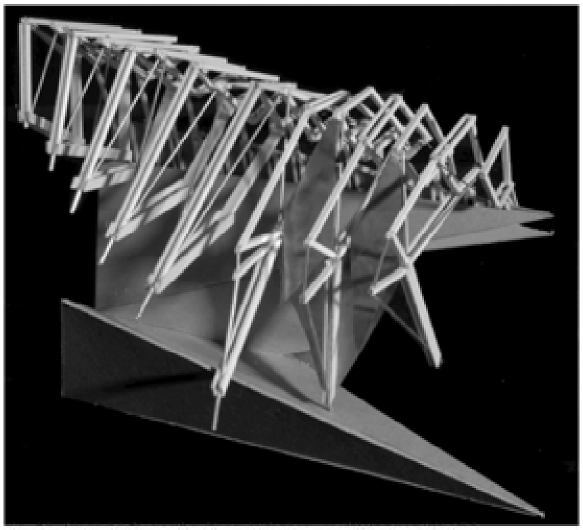


Fig. 5. Tectonic investigation, "To Droop," Kendell Webb.

be strategically located to emphasize hierarchy of form, and to evoke a sense of movement and dynamism within the lofted volumetric exploration.

The volumetric operation also allows students to explore the voids and cavities that they initially included in their sections. Students explore whether a void penetrates the form, or merely travels part way into the form, creating a depression or cavity. Students also consider whether multiple voids connect and aggregate into a single void. These voids also impel students to explore the continuity of surface as it moves from the exterior to interior.

Tectonic Investigation

After the volumetric exercises, students engage in a tectonic investigation of the project. Students divide up the volume into a series of interconnected ribs, with a minimum of ten ribs required. Many students find it helpful to draw ten evenly spaced transverse sections across their lofted solid to be able to visualize the initial geometry for the ribs.

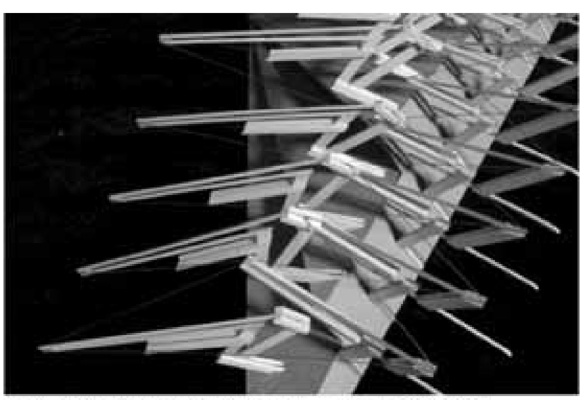


Fig. 6. Tectonic investigation, "To Flow," Daniel Campbell.

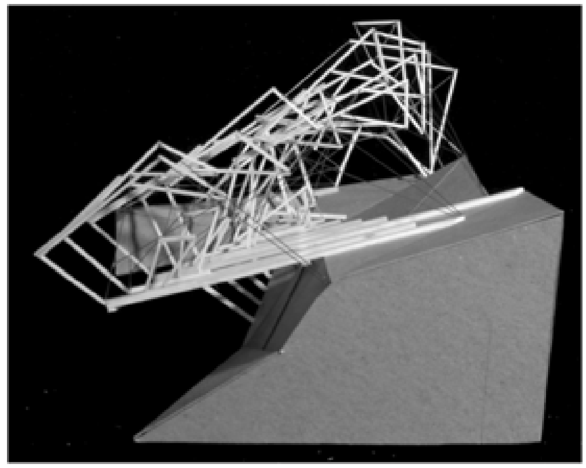


Fig. 7. Ground form investigation, "To Roll," Lauren Caswell.

Through this process, students simplify the volumetric studies while preserving their general character and reintroducing underlying lines of organization and meter from their drawings. These geometric underpinnings are used for additional connective tectonic expression.

The ribbing of the form translates the solid into a structural skeleton, providing discussion on structure and material selection. Framing ideas are examined; including module and bay strategies, how hierarchy in member size might be explored, and the introduction of lateral bracing. When developing a language for members, students consider repetition of members within the ribs, and the rhythm by which that repetition is accomplished. Conversations include how ribs might act in compression, tension, and cantilever (figure 5). Students work with a material palette of basswood, wire, and various metals – linear members which have rectangular and circular sections, solid and hollow extrusions. The original verbs continue to be reexamined in this new tectonic context. Students research precedents for their investigation into detailing and tectonic resolution. In particular, they must consider where members should be doubled or tripled, altered in size or materiality, and how changes in direction might be resolved through joinery (figure 6). Additionally, they develop a 3-d site 'ground' form, and an engagement strategy between the skeleton and ground that is both sympathetic with their verb and which accentuates their design tectonics through changes in materiality and scale of the members (figure 7).

Once the structure is developed, students clad a portion of their project to understand the relationship of structure to enclosure, and to generate new ideas about this relationship. They are encouraged to investigate materials that relate to and/or compliment the palette they investigated in their rib structure, and whose opacities accentuate or downplay areas to improve hierarchy and the conceptual verb. The elements of enclosure bring back the faceting and connective conditions of the loft, now understood as reliant upon an underlying structural condition.

Architectural Investigation

To reinforce the architectural relevance of the project, students complete an architectural investigation – a greenhouse and seed library – easily translatable from the tectonic exercise. This program allows students to more fully investigate their structural explorations, considering how the volume enclosed within the ribs might be inhabited (figure 8).

They also consider the scale of the original tectonic construction and how it relates to the scale of the building. They design an enclosed greenhouse area of 3000 ft2, with an additional seed library of 200 ft2 which allows no light penetration. The assignment provides the opportunity to introduce glazing strategies, shading elements, and operability of apertures – beginning a discussion of sun protection and ventilation. Utilizing an actual campus site, students must take into account the greenhouse's orientation to sun and natural ventilation. Students are encouraged to develop a two story structure in order to explore inhabitation in section (figure 9). The abstract surfaces of lofting are thus ultimately expressed as functional surfaces of light transmission, diffusion, protection, and operation.

The more abstract geometry of their initial constructed ground forms now inform their modifications of the real site. Programmatic requirements of planting beds, an exterior gathering space, and exterior paved circulation encourage this modification.

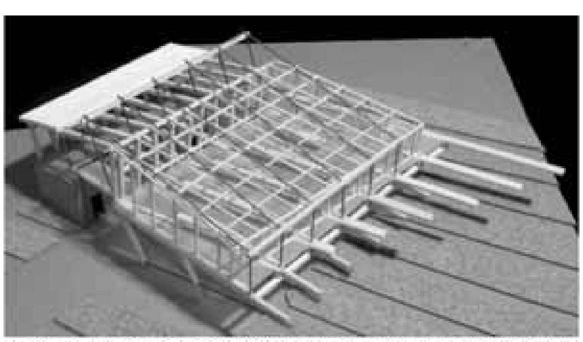


Fig. 8. Architectural investigation, greenhouse, "To Layer," Trenton Harrison.

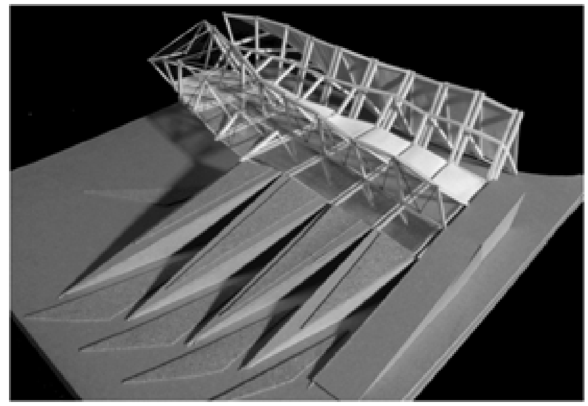


Fig. 9. Architectural investigation, greenhouse, "To Droop," Kendell Webb.

Conclusion

The final assignment challenges foundation students' preconception of what architecture is, using a universally recognized typology, the green house, as a program. Applying a rigorous design methodology rooted in abstraction, the manipulation of geometry, the application of materiality, and tectonic resolution, the students arrive at solutions that they would never have envisioned if simply instructed to design a green house.

The exercise also provides a springboard for digital modeling and its architectural implications in following coursework. By introducing polygonal geometry and the idea of the loft, students better see digital modeling as a tool to explore form and geometry, rather than as an unquestioned generator. And by introducing faceting and ribbing as structural extensions of the loft, structural understanding becomes implicit in their future digital endeavors, informing the design instead of being shoe-horned into a completed form as an afterthought. We note that students who have completed these exercises are more rigorous in their construction of curvilinear and polygonal geometries in the computer, and have a greater understanding of the architectural implications of those geometries in more advanced projects. Overall, the project facilitates larger pedagogical discussions between faculty on the relationships between analog and digital processes and when we introduce these concepts and their implications into the curriculum.

Notes

[1] Richard Serra, *Writings Interviews* (Chicago and London: University of Chicago Press, 1994), 3-4.

Cinematic Architecture

Dave Lee

Clemson University

Abstract

One of the most conceptually challenging and fundamental lessons in design education exists in the progression between two important abstract concepts, both under the pedagogical guise of 'Design Thinking': Space as formal composition and space as meaningful experience. Introductions to architectural composition will inevitably approach composition as a visual language of parts within a whole, of ordering systems, of diagramming and analysis.[1] Conventionally, a shift more directly toward architectural design would then be applied to some notion of the human occupation of space, practically, to serve purpose and function. On the other hand, the notion of architectonics must also then be addressed, introducing attributes that may be used to describe architectural meaning and its relation to the functional aspect of design. The challenge for a design student at this stage is to resist the temptation to solely follow the utility of function as a means for tectonic resolution. It is important that students seek methods of crafting both the organization and assembly of space with the potential to embody experience.

A useful approach for the introduction of tectonics in the design studio can be found by drawing cinematic metaphors to describe programmatic elements and the experience of space as narrative[2]. This paper presents the development of an undergraduate foundation design studio over the course of six iterations whose purpose is to pair the often static notion of tectonics with a dynamic understanding of event and space to appropriate architectural meaning. The project uses cinematic techniques[3] as a vehicle for spatial transformation. Narrative is developed as an agency toward tectonic resolution, becoming a physical, constructed path through a set of experiences related to the storyboarding of a scene. Event and space find an inseparable relationship in the duration of the path as a progression of animate form[4]. Emotive affects are also produced by exploring action-perception[5] relationships in the analysis of the film, with students appropriating an emotive-material-tectonic palette to their designs.

While architecture and film have held close ties for nearly a century, the ability of narrative analysis as a prescribed sequence of events thrugh time persists as a relevant pedagogical topic. At the same time, this project focuses on a process-based approach to design. By using film analysis, it has the flexibility to adapt to a wide range of themes and techniques. Most importantly, material is presented with the goal of arriving at an understanding of architectonic meaning in a contemporary culture immersed in complex flows of information and new modes of representation.

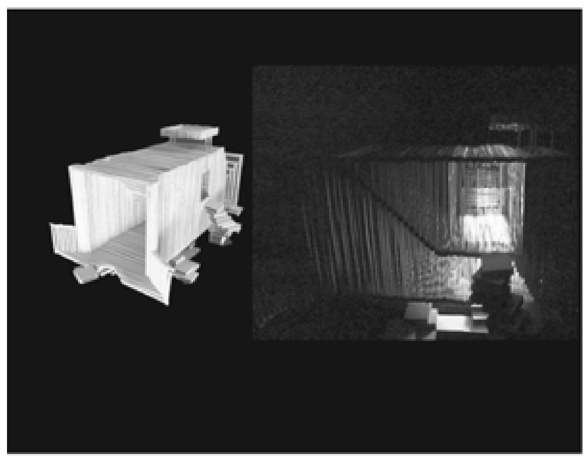


Fig. 1. Student: Kemper Fagan.

Cinema and Narrative

In his early theoretical writings Bernhard Tschumi attempted to transcend modernist functionalism[6], opting to explore the relationship between 'ideal space – the product of mental processes – and real space – the product of social praxis'.[7] By correlating cinema and architectural program through montage – the event-space – he was able to decontextualize function in design and introduce meaning to architecture without preconception.

This becomes a useful point of departure (pedagogical tool) for the introduction of architectonics in beginning design education because it is possible to remove site, context, and concrete notions of program from a design process. With a focus in narrative as a generator of space, the design student is then able to comprehend the art of assembly in the context of meaningful experience without excess burden or constraint which often lead to misinterpretation, preconception, and confuse the clarity of the exercise.

To begin an architectural design project through film analysis, with no identification of a future building program, site, scale, or other demarcation is to instantly suspend a student in a state of limbo. Even the most rigorous student will search for a concrete beginning, for some form of constraint, in an attempt to clarify the intent of the design project and develop a purpose. The problem with clarity of purpose, however, when introducing the design student to themes of tectonics and meaning in architecture, is that it is routinely associated with a purely pragmatic functionalist view. To follow an argument for architecture as a meaningful spatial experience, practical constraints can be viewed as a distraction from the essential psychological affects spatial configuration and tectonic assembly can produce. An architecture that, if given a specific site and context would likely be out of place, might actually benefit the development of a student's sense of tectonic clarity through a somewhat myopic exercise that only considers the internal constraints of narrative on an architectural assembly.

Film Analysis

A student coming from a background in visual analysis and composition following Gestalt principles will have a clear sense of how to extract spatial qualities from film, but not necessarily how to associate them with architectural design. As a point of departure, a film or short video is selected for investigation. In addition to an investigation of the historical background of both film and director to develop an initial understanding of context, it is important to understand the relationship between the camera and the field it captures. This combination, what Tschumi describes as 'filmic' space[8], is a product removed from the necessity of the spatial arrangements to provide a place for events to occur. The camera itself is capturing a very specific, intentionally organized fraction of the events that unfold. This time-based composition can be classified by the type of camera movement and plot organization through editing[9]. The student will benefit from an understanding of the technical aspects of film direction in terms of the use of the camera to define space and develop a relationship with characters, context, and narrative.

After the selection is made, students are asked to storyboard a film scene in sketch and descriptive text. As a companion to their storyboard, they create *Cinemetric*[10] orthographic projections of the film scenes to further analyze the relationship between the space, characters, and cameras as a development of the plot.

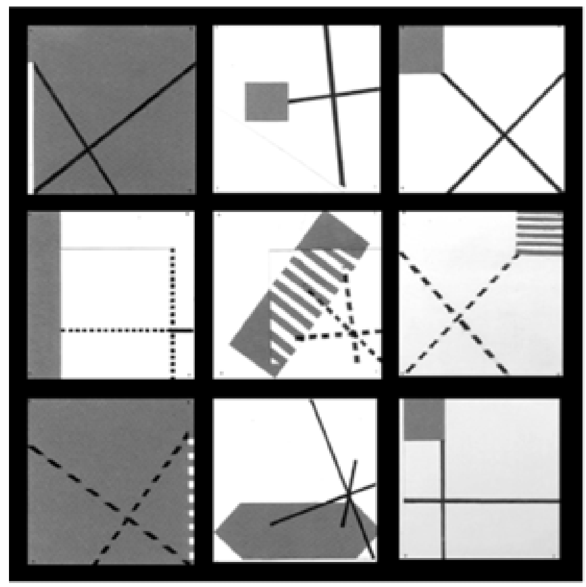


Fig. 2. Student: Erin Welsh. Point-Line-Plane Composition.

They are then asked to create spatial compositions that extract the qualities of the scene as explained in their storyboards and drawings. At this stage it is important that students initiate a transformation from the reality of the scene to a de-contextualization of the essential qualities they are exploring. To facilitate this, a neutral field is introduced as a compositional space and a linear sequence of 'keyframes' is produced that follow the duration of the scene. A familiar compositional exercise of point-line-plane[11] is used to explain singular or discrete characteristics and relationships of a scene. This method avoids a reduction of the project to solely formal iterations because an inherent and inseparable property of cinema is time. Likewise, a narrative (plot) develops as a meaningful experience, and thus, experience is inherent in a formal-spatial composition.

Archetypes + Composition

Two parallel interests are at play. One is to introduce design – in all aspects – as always having an inherent meaning. The other is to begin to develop an understanding of architectural space, how objects in space may be composed, and how this may be done with precision, craft, and purposeful expression. Of course, the two are entwined, and although I have suggested a de-contextualization of the artifact in this design process, the introduction of archetypes in architecture as an analogy for the occupation and experience of space becomes quite useful to humanize and embed a cultural significance to these exercises. This is not unlike Tschumi's *Manhattan Transcripts*[12] whereby he creates sequences of diagrams to relate space to events in a film.

Architectural archetypes are explored in this exercise, through diagrammatic compositions. Techniques are identified, cataloged, and developed concerning object and material relationships that help to manipulate and describe the nature and quality of spaces. Three archetypes are explored – windows, stairs, and doors – and are related to abstract notions of pause, itinerary, and threshold.

A window is a pause, a place for reflection and contemplation. Spatially, it serves as a connection between two things not accessible.

A stair is an itinerary, a prescribed transition between two discrete moments. It has rhythm and influence. It is at once an anchor and a vehicle.

A door is a threshold, a point of transition between two moments. It is a transition and carries a duration, rather than an instant.

For example, a window may have been conceived as transient in nature; 'window of opportunity', as a stationary and distant object; 'the dining room window', or a device used to frame a view; 'The room was filled with the scent of the ocean. She slid to the window where the night sky illuminated the crashing waves below.'

As an object, we understand the window as an assembly of materials, as a solid and a void simultaneously, as having a spatial relationship to its physical context. The window, however, is merely one element that helps to define a space. In fact, it is impossible to define a space without drawing a relationship to a context. A sheet of paper alone is still on a desk, in a room, in a building. A single line drawn on that sheet still must exist within the boundary of the sheet itself.

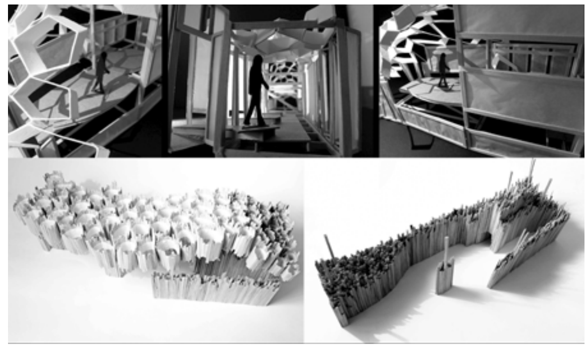


Fig. 3. (Top) Student: Nicole Bronola, (Bottom) Student: Melanie Sage.

Compositional Meaning: The Emotive Material Tectonic Palette

With a compositional understanding of events and space extracted from their film, students are then asked to produce a pamphlet that merges the cinematography of their film with an emotional-material-tectonic palette. There are two discrete components to this assignment.

The position of a camera and its relationship with a subject can dramatically influence one's perception of space and place. When combined with the plot of the film, a narrative is produced. However, another critical component is necessary in the definition of an event-space: The staging of the space, its characters, its physical composition, its materiality and presence. How do these things contribute to the emotion produced in the film? The first component, therefore, is the definition and investigation of an emotive space. How can space elicit an emotion? How is environment tied to an emotive space? What roles do texture and materiality play in the experience of space and place?

The second component of the assignment is to design and construct a pamphlet to collect and display their film analysis and emotive-material-tectonic palette (EMT). Practically, the EMT becomes a catalog of materials, textures, and environmental conditions that they are to attempt to use as a design inspiration. The primary purpose of the EMT, however, is to make tangible the emotional context of their design narrative.

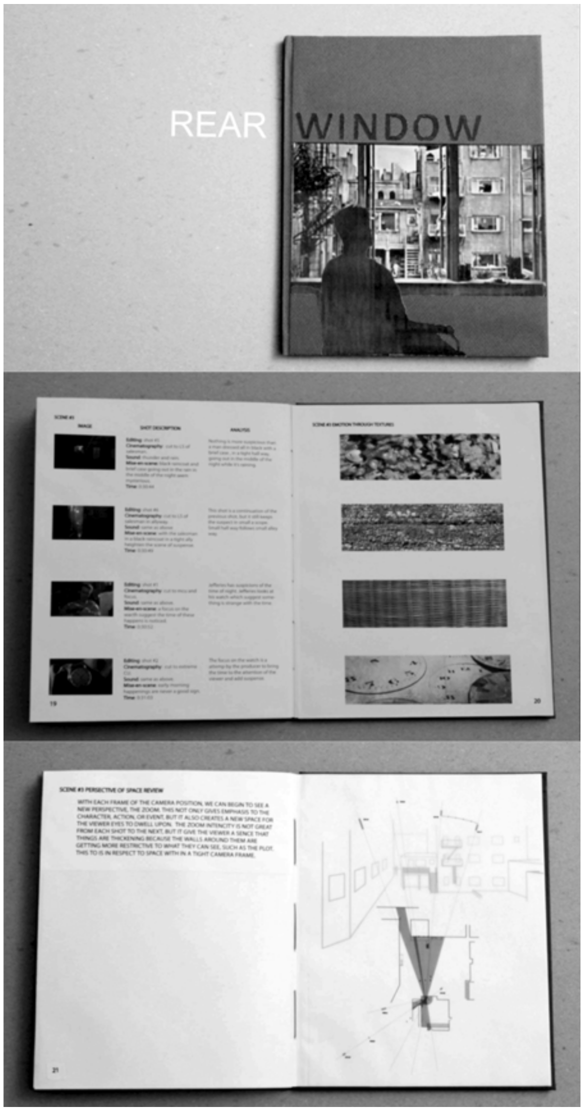


Fig. 4. Student: Justin Harrison. EMT pamphlet.

Narrative and Site

Before moving forward with their design, students are asked to create a path from their diagrams as a three-dimensional line in space. The path is simply another spatial composition but, once defined, it cannot change and their future design must respect its condition. I have found it useful, in this critical point of the introduction of a path, to return to a question of the conditions of site and place.

Throughout this project students find themselves reaching for context, either as an anchor for their design or in order to have something to react to with a design. However, when students in their first year or two of an architecture school are given a site and context without the entire project focusing on the introduction of these topics, the results are often diluted or shallow in content. I believe it is important for students to understand that site and context exist everywhere, even in a highly abstract project such as this. In this project, I explain 'site' in terms of a field or boundary condition.

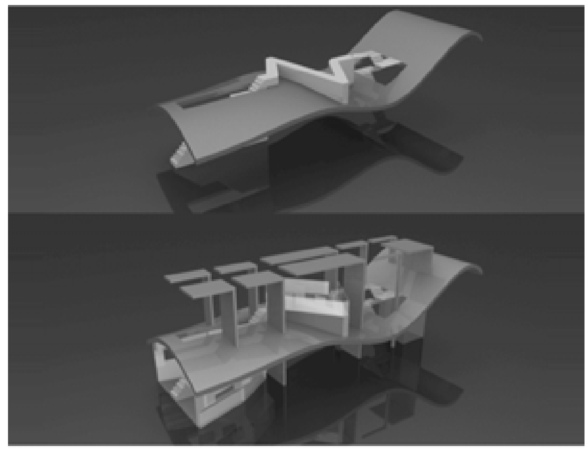


Fig. 5. Student: Savannah Frick. Narrative path diagram with program moments in translucent red.

I have used several versions of a 'site' for these projects, ranging from an empty volume or container students must not penetrate to an arbitrary two-sided surface that may be used in any orientation. The path in students' designs is always required to proceed in such a way that challenges preconceptions of space. For example, in a surface-based site, students must always have their path cross from one side of the surface to the other rather than simply considering it a ground plane.

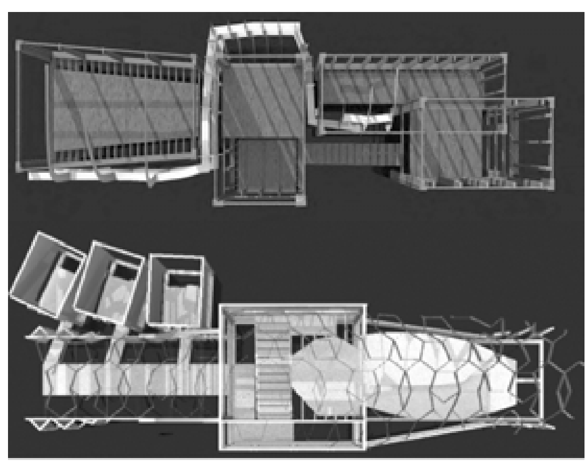


Fig. 6. (top) Student: Katherine McGill (bottom) Student: Nicole Bronola. Plan perspectives illustrating path division of program moments.

The path becomes analogous to the *narrative* of a film, now the story of their design. Like conflicts that develop between the timeline and sequence of events in a film, the path may intersect itself, however the design must consider it a linear procession from one end to another. With their narrative 'fixed in space' they are asked to define a specific tectonic assembly drawing from their EMT as a series of sectional frames tangential to their narrative (path).

A Narrative Unfolds: Transmutation

Having created a series of sectional frames, a simple transition to enclosure would be to connect the frames directly. These designs, however, are not complete buildings but fragments of space identifying experiential moments. Rather than move to a simple enclosure, students are therefore asked to consider how the definition of a sectional profile acts as a boundary condition, another form of threshold, to define three types of space: enclosed, semi-enclosed, and open.

At the same time, it is also possible to further explore meaning in their projects' cinematic metaphors by once again approaching theoretical discourse concerning compositional arrangement. Here, it is important to revisit the point-line-plane compositions created earlier in the project.

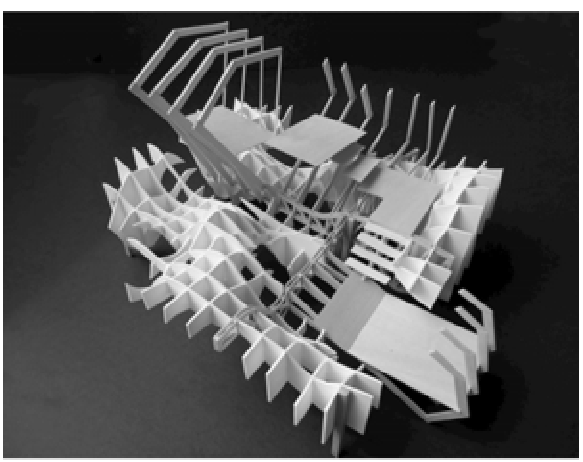


Fig. 7. Student: Sarah Siegler. Euclidean and Non-Euclidean spaces converge through a tectonic device.

Deleuze, in his discussion of points of inflection, contrasts Kandinsky with Klee: For Kandinsky, in the point-line-plane composition, the angles are firm, the point is firm, and the piece is set in motion by an external force. Whereas, for Klee composition is an expression of the 'active, spontaneous line'[13]. He is developing an argument for non-Euclidean thought, one that assumes variation and infinitesimal change. This divergent attitude toward composition is an important one to present to the students. Here, they are able to understand that there is more difference at play between Kandinsky and Klee (or, to propose an architectural contrast, between Mies Van Der Rohe and Greg Lynn) than straight lines and folding surfaces. Just as the students' films unfold in time – often in a nonlinear sequence of events – and are necessarily conveyed as a series of discretized events, the sequencing of frames and their connectivity in the students' designs ought to follow a similar logic. It is to suggest that their can be meaning in complex formal arrangement that transcends purely aesthetic value.

It is also possible to forge a relationship between action and perception, particularly concerning the body in space. Movement and perception become implicated in the early work of Greg Lynn and Lars Spuybroek quite literally through the production of formal and spatial relationships. Lynn's 'Animate Form'[14] describes architecture that itself becomes a time-based tectonic narrative, one also of discretized events. His early experiments with automotive design and digital animation software as a design tool reveal an investigation of the tectonics of the computer software. Because Bezier splines are the tool behind voluptuous surfaces, his Artists Space Exhibit[15] explores the structural formation of Bezier splines as an expressive element. Similarly, because a meta-ball function describes a regional relationship of points in space, his Hydrogen House[16] attempts to reconcile compositional arrangement using solid-void formations resulting from meta-ball forms. Architecture, then, can be explored as a marriage of space and event in addition to form and function.

Spuybroek also explores action and perception in his work through the determination of specific body-space relationships. In his H2O Pavilion[17] and wetGRID[18] exhibition this is an exercise in proprioception. Formally, these projects bear striking similarity to Lynn's projects discussed earlier. However, both of these projects also differ in an important experiential manner. In these Spuybroek projects the ground plane is altered in an unconventional way to create a gravitational imbalance that forces the occupant to contend with a discomfort of physical conditions. As one moves through the H20 Pavilion, for example, the ground plane begins to slant along a narrow corridor from left to right, forcing the body to move ahead while wanting to lean to the side.

This also makes the occupant more aware of their body in space.

One can also resolve body-space relationships as a measured, fixed relationship. In Spuybroek's Sonohouse[19] project spatial narrative is also presented formally, however this time through the mapping of body movements in space. Joints are measured at three scales of movement associated with their overall influence on the body's total movement and correspond with surface formations in the design. The Sonohouse then becomes an analog of a body's movement and fixed in time whereas the narrative of the H2O Pavilion and WetGrid are more unique and dependent on each individual occupant's movement.

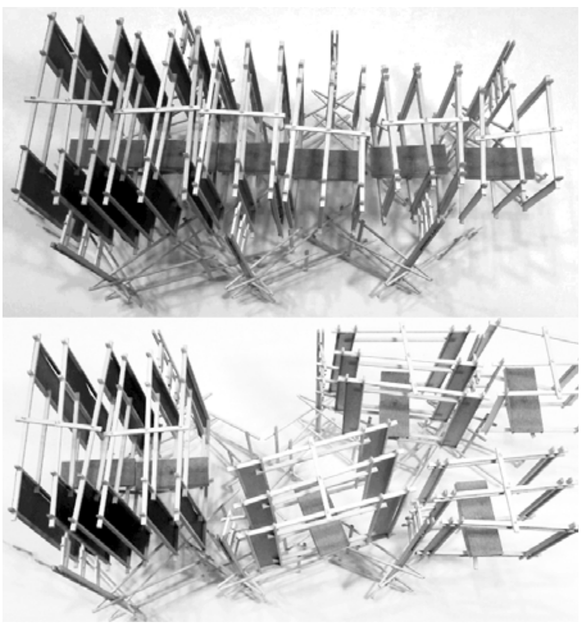


Fig. 8. Ashley Davis. Dynamic model producing range of experiences.

Architectonic Meaning

Here the path as narrative is explored explicitly. As a final design iteration in their projects, students are asked to reconsider narrative through the development of specific moments – an abstract notion of functional program – designed for occupation and interaction within the space. These are intended to be the events captured in their designs that activate the space. Students must define three events as a way of shaping the qualities of the space as a direct relationship to function. The introduction of an abstract program both reinforces the nonlinear development of their design as well as simultaneously reengages their tectonic narrative through the experience of human occupation. Their program elements, narratives of their own, become subplots of the design experience.

As in the introduction of a site or boundary condition, I have conducted this project with a range of abstract program elements. One similarity I have found consistent, however, is that the manifestation of the program finds a significant relationship to human occupation. In all cases, three spatial characteristics are defined: The relationship of a body to another in space, the relationship of a body to a space, and the collection of bodies in a space.

In all cases, program is developed in the form of an anticipated event in space as a consequence of emotional, textural, and material characteristics extracted from the film analysis. The result is an emotive-material-tectonic device.

Conclusion

At a theoretical level, this project presents two divergent attitudes toward meaning and space and asks students to reconcile them in a single tectonic device. This is intentional, of course, as it is used to introduce students to a critical shift in architectural discourse in the 20th century. More importantly, it presents it in a way that allows them to form their own conclusions without prejudice.

But students ultimately discover that the apparently contrasting views on compositional space actually have a great deal of overlap in their intention. In their projects, it becomes evident that the compositional difference in these contrasting styles is not one of aesthetics, but of the appropriation of meaning.

This discovery is important for beginning design students because they are able to divorce form from compositional affect and come to the realization that their design products – like the arguments formed by theorists, transcendent or period – strive to relate to their cultural contemporary. In a point-line-plane composition, this is the machine for architecture. In an inflection composition, this is the architecture of information.

Notes

[1] Michael Swisher and Jeffrey Balmer, *Diagramming the Big Idea: Methods for Architectural Composition*. New York: Routledge, 2013, 234. Although many have written on the subject, this is one useful resource for an introduction to spatial ordering systems through diagramming.

[2] Bernard Tschumi, *The Manhattan Transcripts*. London: Academy Editions, 1994. Tschumi explored this concept in his early theoretical writings and introduced a method of analysis with his Manhattan Transcripts.

[3] Brian McGrath and Jean Gardner, *Cinemetrics: Architectural Drawing Today*. New York: Wiley, 2007.

[4] Greg Lynn, *Animate Form*. New York: Princeton Architectural Press, 1999, 8.

[5] Cinemetrics, 263.

[6] K. Michael Hayes, *Architectural Theory Since 1968.* Cambridge: MIT Press, 1998. This is summarized concisely in an introduction to a collection of architectural theory and criticism.

[7] Tschumi, Bernhard, *Architecture and Disjunction*. Cambridge: MIT Press, 1994, 31.

[8] Bernard Tschumi, "Filmic Space" in *ANYHOW edited by Cynthia Davidson, Cambridge: MIT Press, 1998.*

Filmic space is the field of view presented on the cinema screen when a film is viewed. It is used to describe the difference between what is actually there (in context, on site) and what is visible to the audience.

[9] http://classes.yale.edu/film-analysis/

Further description of editing techniques such as Jump Cuts, Cross Cuts, Transitions, Montage can be found here.

[10] Cinemetrics, 114. These drawings and diagrams present the physical space of a film with an overlay of time. Character and camera movement, as well as the projected image and sequencing of images are presented in a single drawing.

[11] Wassily Kandinsky. *Punkt und Linie Zu Flache*. New York: Guggenheim Foundation, 1947.

Point, Line, and Plane are essential Euclidean assumptions of three-dimensional space. These terms became popularized in the art world in the 20th century as principal to compositional development. A **point**, in essence, is a single location in space. It is without scale and is universal in proportion. A point can become a reference; it can be a beginning, a connection, or a marker in space. A **line** is a vector and can describe movement, position, direction, scale and proportion. All of these factors should be considered when creating a line. A **plane** is further space defining in that it implies a boundary enclosure, but also a relationship to the space outside of its boundary and its orientation to other points in space.

[12] Manhattan Transcripts, 7.

[13] Gilles Deleuze. *The Fold: Leibniz and the Baroque.* Minneapolis: University of Minnesota Press, 1993,14.

[14] *Animate Form, 8.*

[15] Greg Lynn, Michael McInturf, and Martin Treberspurg, "Exhibition and Visitor Center for New Technologies" in *The Virtual Architecture*, edited by Ken Sakamura and Hiroyuki Suzaki, 128-129. Tokyo: ATC, 1997.

[16] Animate Form, 44.

[17] Lars Spuybroek, *Machining Architecture.* London: Thames and Hudson, 2004,18.

[18] Machining Architecture, 138.

[19] Machining Architecture, 174.

Digging Deep:
The Focused Investigation of Building Workshops

Charles MacBride, Sara Lum, Brian Rex

South Dakota State University

Introduction

The academic model for teaching architecture as a hands-on, haptic process serves as the foundation for the newly established Department of Architecture (DoArch) at South Dakota State University.

Professional study begins in the 4+2 curriculum with the introduction of design as a systemic, conventional, and iterative practice through a series of required elective Building Workshops. Where design studios in the pre-professional sequence teach the foundations of broad, generic, abstract, and conceptual conditions of design practice: the introduction of materiality, component systems, and assembly is where the professional curriculum begins. The Building Workshop isolates a grounded and specific material system or representational technology and “digs deep” into its specificity to carry design practice into its professional mode.

Students take a Building Workshop course during the first three semesters of professional study. Three successful examples of the workshop were recently offered. The first, “Precast Concrete Building Workshop,” delivered instruction in the precast industry, its practices and delivery methods, and in the design of a large, single story warehouse building. The second, “Tensile Structures and Lightweight Building Workshop” concentrated on geometry and basic structural principles through iterative modeling exercises. The third, “Surveying, Mapping and Scanning” introduced 3D laser scanning technologies as a design and representation tool. Each of these Workshops focused on professional technologies or systems as their starting point and primary guide for instruction methods.

Unlike many design studio models, the Building Workshop begins investigation by accepting established industry standards, tools and/or techniques. Student exercises and projects are thus framed by defined and commonly understood constraints. The exploration therefore begins not from abstract concepts but rather from measured, identifiable systems. Studio pedagogy often encourages exploration for a variety of less quantifiable outcomes: media and representational technique, spatial and surface complexities, programmatic variations, etc. The Building Workshops are not meant to challenge studio processes. Working within a given set of known conventions and industry standards, Building Workshops assign students the task of deconstructing why these constraints exist, and then assign proposals and demonstrations of creative thinking within these boundaries.

Framework / Pedagogical Positioning

The balancing of practical training vs. academic education remains the central dilemma in developing young architects. The pedagogical discussion of how/if these two approaches should be mixed has been debated by the best known architects and educators of the past century, including Gropius, Mies, Wright, Sert, Hejduk, and more. At SDSU DoArch the distinction between studio and the Building Workshop has helped to clarify a place for both.

The delivery of a hands-on, shop-based course recalls the traditional precedent of training apprentice craftsmen and artists. This model included the training of draftsmen at the beginning of architectural education and the development of the master builder. The apprenticeship also included the training of painters and sculptors, and continues today in the “trades” including many in the construction industry. As the availability of classical education grew, the apprenticeship tradition led to an accepted academic model, and formalized by academic institutions, such as the École des Beaux-Arts. A few specific contemporary academic models have served as precedents for striking a balance between academic and applicable training.

Twentieth century advancements include the Bauhaus, where students were trained in various crafts, and the distinction between "craft" and "art" was significant, both physically and pedagogically. The two co-existed and an emphasis was placed on teaching fundamentals of technique, material understanding and composition, all towards a greater goal of total design or, literally, "building arts."

The example of the Cranbrook Academy of Art also sets a valuable precedent. Through its initial founding in the Arts and Crafts movement, and establishment of the value of learning through making, Cranbrook continues to teach architecture as a hands-on endeavor. The "heritage of this place, from Saarinen to Eames to Libeskind to Hoffman, is about making, about engagement, and about questioning directed at finding real, working solutions." [1]

Today, digital investigations at the MIT Media Lab create "disruptive technologies that happen at the edges" offers an updated guide for digging deep.[2] The work is driven by the experimental use of digital tools outside of the limits of prescribed or fixed outcomes. The Building Workshop model is best explored without pre-determined outcomes, but rather with the possibility of further questions formed through an investigative process.

The distinction between the "real" and the "representational" that has most recently been addressed by Mario Carpo, among others, has also influenced the pedagogy of DoArch. Carpo discusses the beginning of the architectural profession using the contrasting examples of project delivery by Alberti and Brunelleschi.[3] Brunelleschi was the master builder, in command of the construction and having a daily presence at the building site. Alberti, on the other hand, employed a representational process of describing the construction project to builders that he didn't need to personally oversee. Alberti promoted an allographic method of working, in which a building is designed by one to be constructed by another.

This admittedly simplified distinction can be applied to many of the teaching practices in place today. Studio, as the educational substitute for the professional office, is the academic space of learning building and construction *representation*. Learning construction itself is still largely dependent on the apprentice system, and mostly outside of the realm of formal architectural education. The studio has become the standard educational mode, and arguably, the result has been the dominance of the students' "representational" talents above the hand-crafted investigations that can better teach the "practical" uses of materiality and tools.

Carpo suggests that contemporary digital tools may provide the possibility of a pre-allograpic way of working in which the designer is more engaged with the process of making. A notational approach revered by Alberti is dependent upon the ability to produce identical copies; this method is based on processes of mechanical reproduction. Carpo alludes to the evolution of digital tools that have allowed architects to eliminate the representational step in the production of buildings. The capabilities of digital production workflows enable the potential return, albeit altered, state of the architect as "master builder". This is seen today in a few advanced practices, but is still mostly being explored experimentally in the schools, in models, singular objects, and component design. The construction industry, of course, has recognized the benefits of such variability, efficiency and mass-customization, as studio instruction continues with composition and representational technique. The DoArch Building Workshops have explicitly attempted to accept the tools, components and methods that the industry has adopted as the beginning of student investigation (fig. 1).

Fig. 1. Student access to the variety of available tools is key to workshop experimentation (DoArch photo).

Workshop Examples

Precast Concrete Building Workshop: Brian Rex, faculty

The Precast Concrete Building Workshop intentionally flipped the natural desire of the architecture student from the design project to the building assembly. The course began with discussions on the history of both precast concrete and the wider use of pre-manufactured systems in the building industry. Instruction and thinking through design not as formalism "from scratch" but rather as component and system specification was paramount. Research and adoption of standard industry spec-books and detail catalogs were intentionally made as starting points for the workshop.

The course project was then effectively designed, "by committee," in a single class session. Decisions regarding building site, size, type, structural grid, and limited set of precast component panels were made surprisingly and, to many, disconcertingly fast. This process demystified the decision making process of many buildings; theoretical questions regarding the "architecture" of such structures were debated as the semester progressed. To understand basic precast building systems, each student was responsible for detailing the agreed upon building (a large, exurban, precast warehouse) using the standardized, precast catalog. The Building Workshop intentionally and quickly moved through the "design" process so as to emphasize building detailing and assembly, a more accurate portrayal of the precast type.

Fig. 2. Student field trip to precasting facility (Brian Rex photo).

The semester also included field trips to precasting plants (fig. 2), forming and casting exercises, formwork design, and experimentation with admixtures and reinforcing. One field trip was made for students to experiment with baking soda and additives, providing a finish texture to precast panels being installed in the new SDSU Architecture, Mathematics and Engineering Building.

Building Workshops are meant to challenge and question the seemingly natural inclination of the design studio in the making of precious objects using novel and valuable ideas, to one where buildings are *systems*, and the designer must understand and control construction standards and industry methods as a precursor to design. The Precast Concrete Building Workshop has resulted in a subsequent design-build studio project. A grant from the Precast Concrete Institute (PCI) and support from a local, nationally recognized industry leader has moved the design research of this workshop into a soon to be realized student construction project.

Tensile Structures and Lightweight Building Workshop: Charles MacBride, faculty

Tensile structures and lightweight building systems continue to evolve and are becoming commonplace in contemporary architectural practice. Fabric membranes, cable nets, rigid shells, frames and other lightweight components are being implemented for reasons that include increased daylighting and performance, and decreased embedded energy expenses.

This workshop introduced basic structural and geometric concepts and related tensile and lightweight material choices through texts, design, and hands-on construction of models, full-size mock-ups and test structures. Assignments were formulated using the basics of tensile structures and materials. Following a long series of modeling exercises, students completed the workshop in teams with proposals and construction of a complex geometry that displays an integrated structure and skin.

Design research and hands-on use of the metal and wood shops were required. The Workshop model expands on processes and techniques introduced in studio including craftsmanship, project development, creative exploration, and iterative design. A presentation and exhibition of completed projects concluded the workshop at the end of the semester.

The initial concept for the course came from a combination of ideas. The first was a personal interest in exploring tensile structures, a system not typically covered in the general architecture curriculum. Another was an interest in basic geometries and how they are subsequently developed into the more complex forms seen in contemporary practice. The arrival at these forms and surfaces was to be pursued, purposely, through an "analog" and physical building process. This provided a tactile, material foil to today's more familiar process of development using parametric software. Finally, an historical understanding of the "alternative" modern canon was to provide the framework for student work. This history is defined by construction, material and structural exploration as a tectonic trajectory of modernization, and includes notable figures such as Buckminster Fuller, Frei Otto, Eero Saarinen, and Matthew Nowicki, amongst many others.

The semester was divided into four sections with accompanying modeling assignments: suspension structures, cable-nets and non-rigid shells, geodesics, and rigid shells.[4] Each of these required multiple student models, made from simple materials such as dowels, nylon, cloth, steel cable, string, and chain (fig. 3-4). Multiple models for a single assignment allowed for variations and eliminated the "preciousness" of the singular object, in favor of modeling as a scientific testing method. Some assignments were completed with students working in pairs, and the final assignment was done in teams of up to four.

Suspension models were completed using chains, similar to the tests completed by Frei Otto, and demonstrated in structures such as the Dulles Airport Terminal by Eero Saarinen.[5] These models led to research of the more contemporary deployment of cable nets, and by extension, an understanding of the distinction between non-rigid and rigid shells. With the introduction of rigid shells came assignments into basic geometry. This led to Platonic, Archimedean and Johnson solids, folded plates, geodesics, and tensegrity. By mid-semester, hundreds of study models filled the seminar space. Understanding of basic structural concepts including tension, compression, bending, slenderness, shear, and torsion had been introduced without explicitly delivered instruction, and was discernable by students having built and tested models (many of them failing) that clearly portrayed these lessons.

A final project was assigned that required student teams to propose and construct a full size installation using one or more of the structural or surface examples previously completed. Five teams presented work, and projects included a rigid shell cardboard entry canopy, a six-foot diameter tensigrity structure, and a 65-foot suspended tension "cloud" spanning the length of the studio.

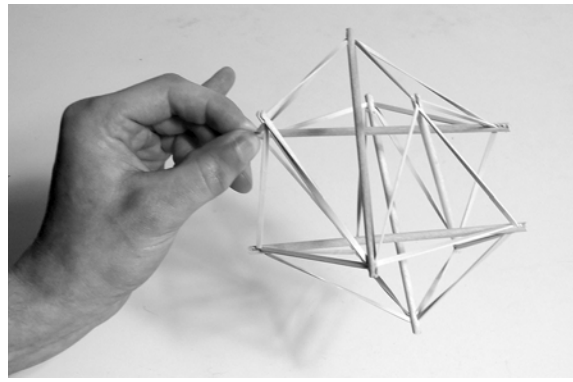


Fig. 3. Tensegrity-icosahedron study model (DoArch photo).

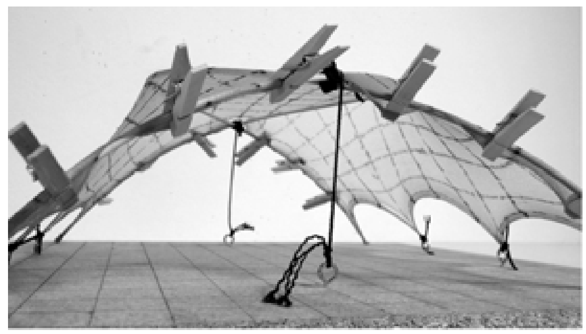


Fig. 4. Non-rigid shell study model (DoArch photo).

Surveying, Mapping and Scanning Workshop: Sara Lum, faculty

Surveying, Mapping and Scanning was positioned within the building shop curriculum as a representational technology; the course introduced 3D laser scanning technologies through a hands-on, research based approach. 3D laser scanning is changing the way designers visualize buildings, but it is also closely tied to an increasingly collaborative and data-driven design and building industry. Preparing architecture students for this type of practice is a challenging necessity, and is partly accomplished by exposing students to the tools of contemporary workflows in building shop coursework.

The theoretical and historical framework of the 3D laser scanning workshop was based on fundamental surveying and mapping methods. In addition to the assigned coursework, lectures, discussion, and fieldwork, three specific hands-on experiences were planned including a demonstration of traditional surveying methods, a field trip to a USGS research and management center for remotely sensed data, and a demonstration and presentation of 3D laser scanning tools and applications by a local engineering company. In addition to these experiences, all of the students had the opportunity to operate the department's FARO Focus 3D laser scanner.

One of the guiding topics of the course was how the utilization of different tools and techniques affects the built environment; introducing the course through surveying and mapping provided a platform from which to demonstrate this relationship. One example specific to the context of DoArch is the marking of the upper Midwest with the Jeffersonian grid. This demarcation of the land—based on surveying methods and tools from the nineteenth century—has a significant impact on urban development today. To understand and be critical of the relationship between design tools and the built environment is valuable to students entering a profession with many technological approaches.

Building information modeling and its associated inputs, including three-dimensional laser scan data, problematize representation; these tools collect and manage large amounts of data and the question is no longer how much data should be added, but how much data should be deleted. The goal of the assigned coursework was for the students to research, experiment and question the limits of 3D laser scanning technologies as a design and representational tool. Subsequently, a series of incremental project exercises, titled *how low can you go*, asked students to research 3D laser scanning and its associated inputs and outputs, build a 3D laser scanner as inexpensively as possible, and experiment with collecting, manipulating and representing data collected from their machine. The final project challenged the students to consolidate their findings into a focused experiment to "properly misuse" the tool—their own or the department's scanner—and to represent their findings.

A few of the most interesting projects included a laser scan system built for $5 (fig. 5), a hologram contraption built as a representational method for 3D scan data, and a laser scanner built using a Microsoft Kinect that was connected to a 3D modeling environment (Rhinoceros) and used to interact with a computer model through body movement. By isolating variables of 3D laser scanning in a design research environment the device's tolerances were exploited to reveal opportunities for implementation in the design process. The building shop approach carves out time for the research and experimentation necessary to acquire a depth of knowledge about an architectural system or tool beyond what is possible in the studio environment.

Fig. 5. Student built $5 3D laser scanner (Sara Lum photo).

Outcomes / Analysis

The Building Workshop courses have quickly emerged as a successful and popular model allowing students to quickly see simple, tangible, and pragmatic results of established materials and technologies in the familiar and creative context of the studio. The Workshops are offered as two-credit courses, and are intended as a supplement for studio, encouraging students to use familiar surroundings and production techniques for projects. Student response to the Building Workshops has been quite positive, largely because it actually helps, by contrast, to better define the goals of studio. The intellectual task of separating the process or system driven experimentation of Building Workshops has served to improve and define the distinct "conceptual" thinking of the design studio.

Common traits, learning outcomes and curricular goals for the Building Workshops continue to develop. They include:

Workshop and Studio Production Similarities: Whether physically or digitally focused, Building Workshops have a hands-on, experimental trajectory. While historical background and a theoretical framework may supplement the course, learning outcomes result from an experimental and iterative process of making. While strategies and quantifiable methods such as lecture and testing may be utilized, the primary focus is hands-on discovery from working within the defined constraints of a building system or representational technology.

Depth and Specificity: As a supplement to studio coursework, the Building Workshops provide a setting for in-depth, tactile study of a specific and narrowly defined subject. The Workshop courses focus on a specific body of knowledge that can be transferred to studio coursework and professional experiences both. Led by faculty, students are guided through an explorative research process, and encouraged to follow the process rather than work towards a predetermined outcome.

Exploration as an End In Itself: Unbridled exploration is the end goal of the Building Workshop courses. Work produced is less of a composed representation of a culmination of design exercises than simply the current investigation itself. Unlike many studio courses, a final project (if any) demonstrates an understanding, investigation and "digging deep" into the topic itself. Like a scientific process, the results may prove fruitful, but the learning is in the methodology.

These processes and goals are not meant to detract from the myriad of beneficial, layered and proven strategies of design studio. It has been shown that the experimental and narrowly focused topics of Building Workshops support the aims of studio through this basic juxtaposition.

Measurable Craft: Craft in the Building Workshops are inherently part of each project, and in some cases, the subject of investigation itself. The techniques of working within the constraints of a material, building system, or representational technology become the questions driving production, as opposed to the visual, qualitative results of a studio and final presentation. The simple experimentation with a material or tool is an effective starting point and introduction to a Workshop, narrowly presented, and contrasting with the open-ended studio brief.

Conclusions and Projections

The success of the workshops after only three semesters suggests further expansion for strengthening the overall professional curriculum, as well as opportunities for continued faculty research. The workshops offer faculty a venue for teaching to their own research, and have connected students and the department with professionals and the industry.

Student interest in Building Workshop content is likely to resurface in their personal upper-level work. This may be seen in advanced studios, independent study, or upper level topics courses. These instances will provide the faculty member an opportunity to further expand on research, with the student's help as an investigator.

Upper level professional and technical coursework can adopt the course delivery model established in the Building Workshops. Like the workshops, courses in building technology (materials, structures, environmental systems), representational technology (construction documents, detailing, specifications), and professional practice can use teaching methods including iterative, hands-on modeling, and focused investigations supporting broader studio projects. The ability to simultaneously supplement one course with another, or to mandate a co-requisite set of courses, is difficult but can create a synergy that is worth the effort.

Finally, the Building Workshops reinforce the effectiveness of balancing the layered, broad scope studio project with a narrowly focused and intensive material investigation. While the studio remains at the center of architectural education and is the course requiring the most time-consuming and credit-heavy outcomes, the workshops offer a supporting elective investigation. The foils of the academic vs. apprentice, art vs. craft, and education vs. training are contrasted as a mutually beneficial strategy. The delivery of the workshop as a specific, topic driven investigation without the expectations of a final review has proven successful as an alternative to the studio, while offering students a chance to explore creative, material, and representational experiments. It is in this way that the Building Workshops does not challenge the studio's own status as much as it supplements the commonly encouraged but often incomplete goal of expanding and rewarding student process and experimentation.

Notes

[1] "5 Points Towards A New Cranbrook Architecture," *Architecture Department, Cranbrook Academy of Art,* http://www.cranbrookart.edu/Pages/Architecture.html. Retrieved 09 Feb 2014.

[2] "5 Points Towards A New Cranbrook Architecture," *Architecture Department, Cranbrook Academy of Art,* http://www.cranbrookart.edu/Pages/Architecture.html. Retrieved 09 Feb 2014.

[3] Carpo, Mario. *The Alphabet and the Algorithm.* MIT Press: Cambridge, MA. 2011; and, "Form and Indeterminacy in Digital Design Theory," (lecture, SDSU Department of Architecture Lecture Series 2013/2014, Brookings, SD, October 17, 2013). Carpo's book was the first required text assigned within the DoArch curriculum. His lecture on campus marked an early milestone for the young program.

[4] Bechthold, Martin. *Innovative Surface Structures: Technologies and Applications.* Taylor and Francis: New York. 2008. This was the required course text, and proved essential in developing the initial course outline.

[5] Otto, Frei, ed. *Tensile Structures, volumes 1 and 2,* 1962. MIT Press: Cambridge, MA. 1967.

Dallas Community Studio

Heath MacDonald, Professor in Practice

The University of Texas at Arlington School of Architecture

Often pedagogical philosophies in architecture adopt theoretical positions as a model for producing relevant work. The notion of practicing architecture, participating in its execution, and engaging the contextual culture is frequently relegated to the sidelines. Perhaps this viewpoint stems from the perceived limitations of the academic model as one that is disengaged from the economic world and one that can only exist at the virtual level; or possibly, it begins with the perceived limitations of a mentor/apprentice potential. Regardless of where the disconnect lies, it is inherently important to understand how tectonic conceptions become realized. Architectural education must embrace both the realm of dream and possibility, as well as the process of construction.

Equivalence

There are examples of initiatives in apprentice-based curriculum that delve into the development of context-based design/build scenarios. They regularly examine the parallels between theoretical approaches combined with the act of assembly; notably so, the Ghost Laboratory founded by Brian Mckay-Lyons engages in these assessments. In his teachings, Mckay-Lyons comments about the evolution from a student to a professor, and the typical context of which architectural education exists:

While daydreaming in the classroom and looking out the window at the life on the street outside, I felt a recurring desire to knock down the massive brick walls of the building and let the fresh air and sounds of the outdoors fill the Academy. In 1994, as a professor in that same school, I saw an opportunity to take architectural education out of the classroom and into the landscape.[1]

The comments express scepticism for studying a subject matter, which is rich in contextual relevance, in an enclosed and withdrawn environment. What started as an examination of architectural education and how the traditional model of an apprenticeship may benefit its quality, Mckay-Lyons developed a “test tube”[2] with the Ghost Laboratory in Nova Scotia Canada. The Lab extends his values of producing works of architecture that display accountability to its context, spatially and culturally, through materials, details, and the act of construction. The projects, generated with the purpose of educating the student participants, incorporate lessons from the historical construction and methodological processes from the local region.

Fig. 1 Ghost 7

Making through culture

It is easy to assign studio assignments to students adopting hypothetical postulations removed from the essence of place. In many ways this method eliminates obstacles experienced from societies, and cultural influences in order to position oneself as the sole determinant of the proper course of action. These situations, removing the voice of the patron, can become restrictive when generating solutions to architecture designs and tectonics simply because individuals may not have an adequate scope of expectations when searching for alternative visions to solve particular problems. Architects design for others and theory enables ideas and methods to progress, yet common scenarios with lesser ideal social and cultural circumstances frequently become lost within the principles of theoretical devices.

Samuel Mockbee writes as follows about making architecture:

The best way to make real architecture is by letting a building evolve out of the culture and place. These small projects designed by students at the studio remind us what it means to have an American architecture without pretense. They offer us a simple glimpse into what is essential to the future of American architecture, its honesty.[3]

Believing in an "architectural education [that] should expand its curriculum from 'paper architecture' to the creation of real buildings,"[4] Mockbee, professor of architecture at Auburn University, founded in the early 1990's what he called the "Rural Studio." Seeking to "sow a moral sense of service to the community,"[5] Mockbee proposed a transfer of studio objectives from the academic realm into that of the built environment. Through this system of transfer, Mockbee intended to "challenge the status quo into making responsible environmental and social changes."[6]

It could be argued that the success of the Rural Studio is derived from its displacement from urban rules and regulations. Nevertheless the resulting projects consistently engage communities and provide various works of architecture for social and civic reasons rather than theory or style.

Mockbee's legacy, the transfer of architectural pedagogy (from typical educational proof through plan, section, and elevation studies) into a realm of physical verification through construction has influenced architectural teaching and reminds us that architectural theory isn't the element of change for social and cultural notions; but has an obligation to include them in the design process.

Investigating the Uncertain

The Dallas Community Studio was established in 2004 as a prototype studio model. It was set within a once impoverished urban context in South Dallas that was procured by a Canadian developer. The studio was situated in the heart of the new development in the ground level of the acquired historic Sears Roebuck building. Named the South Side on Lamar, based on location within the city, the development postulated that setting goals connecting residence with common ambitions could reunite a community and effectively generate change without abandoning the social and cultural lineage of the area. The SOL renovated the old Sears building into residential lofts on the upper levels with ground level gallery and workspaces for local artist and small businesses. With the focus of housing individuals that would promote the growth of an artist's quarter, the SOL engaged various education facilities to investigate grant structures for tenants in the community. The DCS participated in the growth for three years, working on projects with the community and serving as an interface for the School of Architecture at UTA with the SOL and providing experience in working with community clients focusing on architecture as construction agents of social change.

The DCS set objectives to explore three questions in pedagogical design operatives. The questions were:

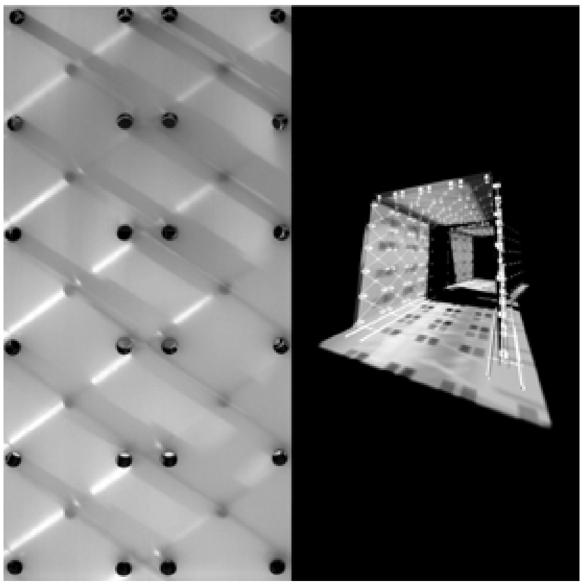
1. How does design/build engage the social community and what is its value?
2. How does the science of construction embrace design?
3. How do mentor/apprentice methods of teaching establish a form of critical thinking skills that differs from standard classroom studio teaching?

Architecture education today can be perceived as a visual art in many ways. With the growing use of the computer and virtual visualization tools, the tactile qualities that were once a key investigative tool in design studios are beginning to disappear. It could be stated that the closest many students of architecture may come to engaging construction and detailing of a building is through the rigorous structuring of scaled models generated to exhibit tectonic doctrine. Perhaps crafting these models exhibits a more critical thinking, regarding detailing, than the surface illusion of digital models. Design/Build models reinforce the ideal of realizing what you are conceiving.

The DCS focused on engaging in inquiries of theoretical graphics and design, verified through hands-on construction. Its scope constitutes three executed projects. Design inquiries required students to engage in community culture, at the South Side on Lamar, and architectural materiality. The projects culminated in in-situ exhibitions of works to examine the outcome of the aforementioned questions and Design/Build education.

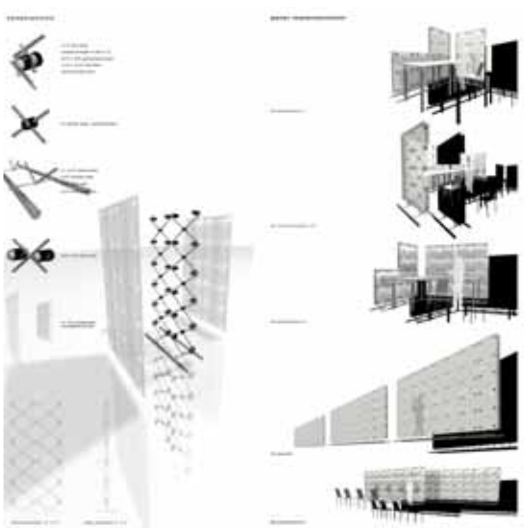
Inquiry One: The Constructed Wall

The first inquiry investigated the construction of a wall system for the entry to the local community galleries housed at the SOL. It was the first project that established a DCS connection with the resident artists and sparked the engagement of the community in the participation of the studio projects. The wall system evolved from a simple entry containment piece via conversations, with the artists, to an interactive lighting display upon arrival at the gallery. The wall in itself was designed to be both art piece and architecture.



Inquiry One

The wall system incorporates electrical conduit and recycled steel cans as structure for hollow core board shell. Designed on a 4' x 8' module with internal led lighting, partitions can be joined for linear runs. The system serves as movable partitions for manipulation of space.



Inquiry One

Inquiry Two: Assemblage-Exhibit

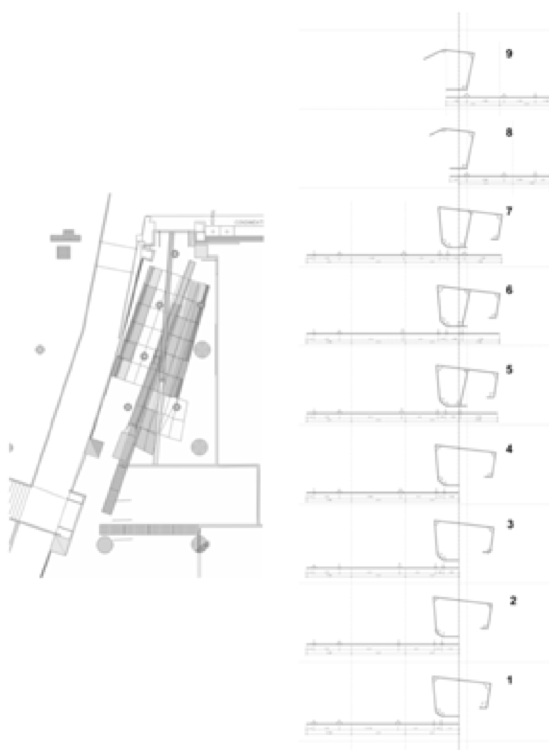
The second inquiry was designed to facilitate two functions with one solution. The first function was to provide an exhibit to display current student work, from the University of Texas at Arlington School of Architecture, while promoting the latest achieves edition TEX FILES volume I during the annual Arch Voices meeting. The second function was to facilitate a threshold connection from the DCS studio to the community gallery space.

Conditions:

The exhibit cannot impact any existing building components and must fall within a budget of $750.

The exhibit must also be temporary, easily dismantled, and must not obstruct any existing forms of circulation and egress.

The exhibit must meet fire code restrictions, and cannot impede the South Side building safety systems including but not limited to the fire extinguishing systems.



Inquiry Two

Inquiry Two

Solution:

Investigating standard ceiling grid frame, the design manipulates the material purpose to become more than a simple overhead containment. The system defines a wrapped container, within a portion of the studio space, and physically connects the thresholds of the community gallery with the back entry to the DCS studio. It is braced with a sheer wall constructed of translucent hollow-core board and a floor paneling system composed of MDF. The hollow-core board, suspended from the ceiling grid, becomes the shell of the exhibit space, internally masking the structure, which is exposed on the exterior. Lighting incorporated donated fluorescent lamps that were re-housed within hollow-core membranes, illuminating the exhibit internally.

Inquiry Three: Temporary Art pavilion

The DCS culminated in a joint effort with the SOL community, for the design and erection of a temporary art pavilion. This was the largest project completed by the student participants.

The open-air pavilion functioned as temporary extension of gallery space for the growing South Side art district during the summer months to activate outdoor community events. Local community businesses donated the location for the pavilion along with access to electrical power supply for the phases of the pavilion erection. Many members of the community invested personal time either participating with the students during the erection process, or by providing food and beverages during construction phases and events.

Inquiry Three

Inquiry Three

The design process for the pavilion began with an internal studio competition with 15 design submittals, and ending with a short list of three proposals. The winning entry was designed to serve as an intimate setting for the arts within the urban fabric. Form and enclosure of the pavilion derive from simple skin over structure, extending to an open stage. The design of the pavilion focused on portability and various detailed reconfigurations of standard materials and systems. The components of the pavilion were manufactured off site, and transported for assembly. System construction incorporates wood frame and simple bolt connections for rapid assembly with a recycled billboard vinyl canvas for an exterior membrane, and polygal envelope. Re-configured components included such things as pier and beam leveling jacks designed to serve as footings that could be easily adjusted for site flexibility.

The pavilion accommodated the exhibition of artwork, architecture and music events. The final celebration incorporated the display of artwork produced by the children within the community district. Construction of the pavilion commenced in June 2005 and completed August 2005.

Inquiry Three

Notes

[1] Quantrill, Malcolm. *Plain Modern*. New York: Princeton Architectural Press, 2005 p146.

[2] Quantrill, Malcolm. *Plain Modern*. New York: Princeton Architectural Press, 2005 p 147.

[3] Oppenheimer, Andrea. *Rural Studio: Samuel Mockbee and an Architecture of Decency.* New York: Princeton Architectural Press, 2002 p 2.

[4] Oppenheimer, Andrea. *Rural Studio: Samuel Mockbee and an Architecture of Decency.* New York: Princeton Architectural Press, 2002 p 1.

[5] Oppenheimer Andrea. *Rural Studio: Samuel Mockbee and an Architecture of Decency.* New York: Princeton Architectural Press, 2002 p 1.

[6] Oppenheimer, Andrea. *Rural Studio: Samuel Mockbee and an Architecture of Decency.* New York: Princeton Architectural Press, 2002 p 1.

The Weight of Things

Mark McGlothlin and Bradley Walters

University of Florida School of Architecture

Fig. 1. Material Detail: Screen Door, Aluminum Frame and Photovoltaic panels (photo by Mark McGlothlin)

Time Heals All Wounds

We mean not to trivialize our ideas by employing popular clichés, as these tired phrases rarely offer traction in advancing scholarly work. Yet, our choice to begin with the familiar phrase, "time heals all wounds," is quite apropos. To clarify, the focus of our thoughts lies between two broad and overlapping terms; *material* and *materiality* and it is our intention to examine how these terms inform, and are informed by, the larger context of architectural education. That being said, we need to acknowledge that our comments are also heavily colored by experiences nearly four years old, born of the peculiar project known as the Solar Decathlon.

Anyone who has participated in a Solar Decathlon competition can understand our opening quip. The decathlon was, and continues to be, an intense experience and we needed to establish a critical distance from the project before we could critically reflect on its educational merits. In looking back to our experiences with the University of Florida RE:FOCUS House in the 2010 Solar Decathlon Europe competition, we find ourselves still somewhat conflicted, as our pleasant recollections of the project have overshadowed the more dire moments of a two-year long design project – with students at the helm.

Context and Clarity

Situating the Solar Decathlon within a larger curricular structure is a difficult challenge. The U.S. Department of Energy is quite clear in its purpose for establishing the competition. While the goal of educating the broader public about the possibilities of clean energy is paramount, the DoE is quite clear that the competition "provides participating students with unique training that prepares them to enter our nation's clean-energy workforce."[1] The DoE's decision to refer to *training* is straightforward, hinting at the specific skills that can be gained through hands-on learning while also offering a clever allusion to its origins in track-and-field athleticism. There is a more subtle reading of this word choice as well. Though the term *educating* would arguably be better aligned with the academic institutions that have invested their resources in designing and constructing the houses that are the centerpiece of the competition, the notion of *training* connotes technical precision more than artistic ambition, and in doing so reveals a rub within the architectural academy that is stubbornly entrenched.

Getting Terms Straight

A more careful examination of the distinctions between the synonyms *training* and *education* proves useful, recognizing that both terms are facets of the larger concept of learning. The idea of training, and more so its active form *to train*, targets a narrow kind of learning, wherein a particular skill or ability is developed with the expectation of repeated efforts leading to increased levels of mastery. This sensibility is commonly associated with physical skills, such as those exhibited in sports, but equally so within discreet disciplinary learning, such as that found in music, engineering, and certain aspects of architecture.

In comparison, the term *education* typically refers to broader concepts of learning, and more so the knowledge gleaned from the intersection of these concepts. This principle is more pronounced in the active form of education, *to educate*, which is intended to "give intellectual, moral and social instruction to (someone, especially a child), typically at a school or university"[2] The expansive logic offered in the definition is quite clear, and as such helps to establish the breadth of knowledge that may be brought into focus. Though educational experiences may narrow with the higher levels of study, they never fully detach from the broader context of knowledge, allowing students to explore personal interests within a structured, but flexible curriculum.

This brief escapade into the tension between training and education is not simply a scholarly aside. Architecture has a foothold within these two spheres; one drawn from architecture's position as the mother of the arts[3] and thus stoking the conceptual furnaces of the intellect; and the second from its intersection with the world of physical materials and construction, which hints at technical training and narrow degrees of expertise. The pressure of juggling these competing spheres has pushed architectural education into a perpetual argument about pedagogical priorities, with one side favoring technical precision and empirical thinking in a manner that aligns more with engineering than art, and the other championing open-ended design inquiries that resist the comforts of simplistic conventions in favor of more critical, imaginative inquiries.

It would be unfair to suggest that this debate is balanced. Though architecture studios, classes and coursework are envisioned to be in synergistic play with each other, the reality is that many design school curricula are driven by a dominant design studio sequence, where the students' collective efforts are directed to the work of the studio first and concurrent coursework is shifted to the back burner. More so, students that choose to place technical coursework over studio often pay the penalties in the public shaming that is destine during design reviews. Technical proficiency in student work, though admirable, is rarely praised and more likely viewed as a liability, particularly if the design decisions have been steered only by technical concerns. Alternately, design juries are far more generous to projects that demonstrate the conceptual, spatial and tectonic ambition, regardless of the technical inadequacies and material indecisions that may litter the work.

Like many of our peers, our school remains unsettled in our balancing of the poetic and pragmatic. Our curriculum is centered on the tenets of Modernism and has proven surprisingly resilient to the pressures of shifting architectural fashions. Our pedagogical model focuses on studio-based learning, with technical coursework carefully coordinated within the larger design curriculum. We challenge our students to embrace a design process that relies on making as the primary means towards design thinking. This principle finds its origins in the teaching methods of the Bauhaus, wherein design fundamentals establish the initial step of the process, upon which complex questions and new systems can be layered. This approach relies on our students' ability to embrace an attenuated, open-ended, and iterative design process that is rooted in unbounded curiosity and invention, a willingness to risk failure, and the inculcation of obstinate rigor[4] in pursuit of architectural space. This open-ended process is the heart of our design methodology, and while we enjoy the theoretical and conceptual depths that may be illuminated, this search always begins with and returns to the act of making space, framed and materially defined through tectonics.

Tectonics Comes First

Sometimes we may be close to despair when trying to cope with the visual world through words: the harder we try the more we seem to get lost between shifting and elusive drifts of irrelevancy, inappropriateness or vacuity.[5]

The opening words to Eduard Sekler's "Structure, Construction, Tectonics," offer a certain resonance with which we sympathize, namely the strained relationship between the making of a thing and the words used to describe it. Sekler's emphasis was directed the challenges of establishing a clear and critical conversation about architecture through the three words of his title – *structure, construction, tectonics*. Sekler was quick to acknowledge the unevenness of these three terms, noting, "in colloquial usage the distinction between structure and construction is blurred and the word tectonics is rare."[6] This unfamiliarity is not surprising, as *tectonics* is not a term common in day-to-day conversations. Tectonics, or its more narrowly defined variant architectonics, posits the essential relationship between the structure of a thing (such as a building) and the processes of its making (such as construction). This reduced sensibility may imply tectonics as being merely the transition between the preparatory actions of structuring and its conclusion in making through construction. This narrow view, however, overlooks the more complex influence of tectonics on the process of making. As Sekler noted,

Through tectonics the architect may make visible, in a strong statement, that intensified kind of experience of reality which is the artist's domain – in our case the experience of forces related to the building. Thus structure, the intangible concept, is realized through construction and given visual expression through tectonics.[7]

Sekler distinguished tectonics as both integral to, and independent of, the abstract, immaterial principles of structure and the material acts of construction, positioning tectonics as "the one most autonomously architectural"[8]. More so,

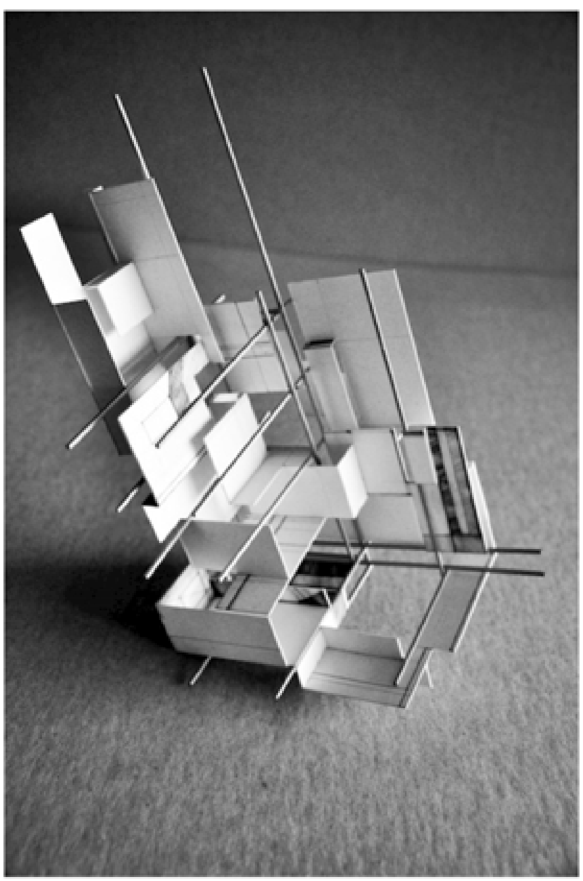


Fig. 2. Spatial | Tectonic Study (student work: John Fechtel, 2012)

Sekler's posited tectonics within "artist's domain", reinforcing the essentiality of the architect's aesthetic judgment in providing the spatial expression to the act of building. It is important to note that Sekler was clear in uncoupling the obligations of structure from the concerns of material, reinforcing the understanding that tectonics, and more so construction, are inherently linked to material concerns, but in very different ways. The trade-specific knowledge associated with construction intersects directly with the physical reading of material, where specific properties, techniques and limitations must be understood in preparation for making. The broad strokes of architecture, in comparison, focus on expressing space through tectonics, which is referent to both the physical and metaphysical properties of material - or more precisely, materiality.

The connections to the earlier discussion of training and education now become more apparent, as the tension between the material and materiality is a subset of the larger and more palpable tension between design and construction, as well as the corresponding tension between training and educating.

Provisional Lines and Tectonic Shorthand

As its protagonists say, the word 'building' is not a noun, it's a verb.[9]

As we noted prior, our curriculum finds its greatest strength through the obstinate rigor of our students, which is best exhibited in the reflective process that makes manifest their architectural thoughts. In establishing this process, we insist that our entering students participate in an act of conscious forgetting, with the intent of stripping away preconceptions and prejudices that would leave the work depleted. Instead, we ask our students "to undertake processes which stimulate invention, so that they arrive at architecture for themselves, finding it as a solution to their inventive concerns."[10] In working this way, our students are quick to embrace new ways of thinking and to couple their nascent spatial ideas with the methods and materials offered in the design process. In this sense, material is understood to be literal rather than representational, where issues of line, plane and solid are brought to bear in the process of making in a direct and accessible manner. This strategy allows students to examine the relationship between material properties, such as the weight of a solid piece of wood suspended from a network of thin linear elements or the reflective character of a surface as it intersects a dense and textures plane (fig. 2). In this way of working, materiality is referent to the tectonic systems being examined, empowering the student to further speculate on material properties without committing to a premature and naïve representational mindset.

Our methods of drawing are similar in character, wherein provisional lines are introduced and gradually built upon like scaffolding provoking an architectural possibility that has just begun to emerge (fig. 3). In this regard, the drawing is a construct in its own right, informing the process and anticipating the next set of steps while remaining critically distant from the illusions of real building. More so, the residue of process is encouraged to linger on the page, with the smudges, erasures and disruptions serving as testimonials to the spatial and tectonic thoughts that remain just beyond reach.

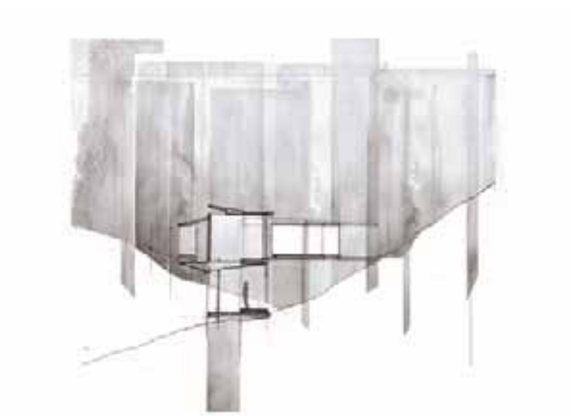


Fig. 3. Intervening in the Devil's Millhopper (student work: Susanna Grasel, 2011)

In this regard, both model and drawing approach the expressive potentials of tectonic systems, and anticipate the spatial and material relationships that lead to more direct material connections, but neither presumes to provide absolute answers in terms of material precision or constructional merit. This is not to suggest that our students are directed to indulge purely in fictional worlds, but rather say that they are encouraged to linger in the realm of materiality and postpone the material decisions that would impoverish an otherwise promising proposal. Our position here is not unique nor do we claim it to be novel. As Michael Brawne notes of drawing a wall,

To draw the studs of a timber wall or the gap in a cavity masonry wall is to introduce information which is irrelevant as far as our visual understanding of the wall is concerned; it tells us nothing about the nature of the material of the wall. On the contrary, it produces a visual density of the drawing which is spurious.[11]

Brawne's acknowledgement of accumulating "spurious" visual information is both accurate and revealing. The drawn wall need not depict its full material assembly or construction, merely its exteriority, as the drawing is expected to allude to specific materials and assemblies. This logic, however, assumes that the eyes of the viewer are fluent and familiar with reading those intentions. In a professional setting, this assumption faces few challenges, but the academic context offers no such guarantee. As an example, our students are remarkably skilled in crafting drawings and models that are tectonically provocative and provide for the allusion of assembly. Upon closer inspection, however, these allusions quickly dissolve, particularly as the questions move away from tectonic speculation and drift towards more precise material sensibilities. It is common for students to retreat to familiar territory when this pressure is applied, finding comfort in the vague suggestions of materiality while avoiding the penalties of more precise material ideas. Occasionally students will even conjure the ghosts of architectural idols, noting the geometric volumes playing in the sun or of the honest expression of a material. These comfortable tropes offer a convenient deflection of the broader questions of material, but in doing so become symptomatic of a student culture increasingly disconnected from material as a thing.

Inching Towards Inches

Our words here are targeted and critical, perhaps unnecessarily so and while we could position them as simply polemical, the more candid explanation is that they have been colored by our experiences with the Solar Decathlon. It would be flippant of us to suggest that our decathlon experience was soured by the material inadequacies of our student team. Quite to the contrary, our students were our greatest resource and their unrelenting energy was among the most important reasons that the project was realized. Rather, our reflections of the project are better framed as a cautionary curricular tale, steered by an open-ended design process that was unexpectedly lost in the morass between the concerns of materiality as an idea and the realities of material as a thing.

To be fair, the lessons we have drawn from the decathlon are cloaked by a number of complex layers, and any attempt to explore one layer reveals that all of the layers are inextricably knotted together. In this regard, we defer to Mark Twain to offer to offer a pithy summary to the broader experiences of our team; *A man who carries a cat by the tail learns something that can be learned in no other way.*[12]

Though both the faculty and the students were aware that the decathlon would be an oddity within the larger curricular structure at the University of Florida, we expected the curricular challenges to be primarily logistical and were confident that the studio culture and coursework would accommodate the fundamental needs of the team. More so, we hoped that our tectonic strengths and open-ended design process could be tailored with relative ease to meet the more stringent demands of the competition brief, and with it the transition from speculation to construction.

In starting the project with the students, we embraced the initiatives of the decathlon organizers by letting the student team lead the charge.[13] The faculty would offer critical guidance for issues beyond the expertise of the students, but otherwise we would refrain from overstating our influence. We knew at the outset of the project that this strategy would push the students well beyond the conventional expectations of studio and they would not be allowed to remain content with tectonic speculation as an end to their work. Rather, the design process would need to cross the bounds of materiality and move into the more precise conditions of materials. As this process unfolded, it became increasing clear that our students' energy and enthusiasm was more than sufficient for the demands of the project, but they were surprisingly naïve about the tectonic transformation that needed to occur, and more so about the kinds of strategic questions that would need to be asked and answered.

At this point, the constraints of the competition were advantageous. Limited to an overall footprint of 800 square feet, the house would need to be exceptionally efficient in its use of space. The house also needed to be conceived in a nomadic state of existence, as its brief repose in the sunny parks of Spain would be quite different from its more permanent grounding in the swampy air of Florida. This complicated the larger questions of building systems, but also limited the ideas of materials, with issues of dimension, modularity, assembly and weight becoming paramount. This also meant that the students would need to address the questions of material in a direct, tactile manner, using this material reality as a provocation for new methods for inquiry and invention.

To our surprise, we discovered that the students, though excited about the romantic promises of swinging hammers, were ill prepared for the reality of the material concerns of assemblies and construction. They had an intimate understand of the lines on the page, and parallel systems found study models, but they simply did not realize the full extent of materials, connections and sequences that needed to be considered. To their credit, the students recognized that the layered assemblies of the house offered the opportunity to reconsider the envelope as a didactic tool, in turn leading to a tectonic language that sought to celebrate its construction and material character (fig. 4). This decision meant that the team would need to move away from the diagrammatic sensibility of construction and begin to wrestle for every quarter-inch that could be afforded within the assembly.

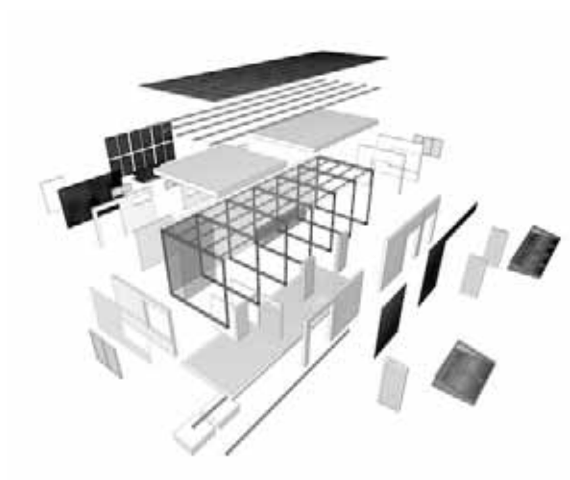


Fig. 4. Exploded Axonometric, RE:FOCUS House

Brawne's suggestion of "spurious" information in design drawings becomes instrumental at this moment, reinforcing the necessity for a deeper understanding of material and assembly if the speculative drawings are to be useful in the transition towards construction. Our students were exceptionally adept at dealing with the exteriority of the drawn envelope as an expression of materiality; the visual porosity of the wooden screen, the depth of shadow that it offered, the steel bents that referenced earlier traditions of construction while also expressing the structural modules and means of moving, the richness of the reclaimed heart-of-pine floors. These constructed narratives embedded cultural connections into the project that cannot be dismissed as superficial. More so, the students advanced these narratives to include the poetics of construction, wherein the sequence and assemblies became an integral part of the overall tectonic expression.

Fig. 5. North elevation and breezeway, RE:FOCUS House (photo by Clay Anderson)

That being said, the dependency on these poetic connections can be considered to be equally spurious, particularly when they interfered with the simple facts of construction. While our students were quite comfortable at providing graceful narratives to complement their tectonic ambition, their ability to shift these ambitions towards the material realm was clearly strained, in part by the materials in question, but also by the consequences that these material choices incurred. They had never been confronted with the dimensional limits of materials in other studios, let alone specific material properties that cannot be simulated; the hardness and weight of steel, the fragile edges of wood, the simple requirement of sealants around doors and windows. At that moment, we realized more fully the naivety of our students, as we had hoped that they were more aware of the full range of issues that would need to be addressed. We both taught required coursework in materials and construction, and while we understood that the students would face a steep learning curve within the project, we also knew that many of the fundamentals of materials and assemblies had already been introduced.

Coda

In hindsight, this level of naivety should not have surprised us. At the start of the design process, the majority of students on the design team had only completed one of two required materials courses, and though we cannot measure the influence the second course may have had on the process, we would expect there to have been some beneficial carryover. That being said, both of these courses operate in support of studio activities, and we should not fool ourselves into believing that they would have garnered the same attention as the concurrent studio work. As we noted previously, our school remains unsettled in balancing the poetic and pragmatic aspects of design. In moments of tectonic uncertainty, our students naturally defer to the poetic and we champion this strategy, as neither of us would advocate for a design solution enervated by vain attempts to prematurely infuse material ideas. We are equally dismayed with students who strive for the illusion of material reality and lose sight of the broader spatial implications of those material decisions.

However, we also recognize a noticeable gap in our students' understanding of material in design, and more so in construction. We can argue that our process emphasizes concepts of tectonics and materiality, and as such provides the strategies for approaching the more vexing problem of material precision. We can also argue that we consciously postpone material decisions in the design process as a way of preserving invention and innovation as a critical part of our students' education, deferring to their future engagement with the profession a more complete and requisite training in materials. These statements, and a bevy of similar statements like them, are genuine responses to a simple question about how we choose to teach our students about the role of materials in architectural design. We suspect that every design school would posture themselves differently, and thus we have no desire to make proclamations about a preferred pedagogical approach. We would recommend, however, that the ideas of materiality not be confused with reality of materials, particularly at punctuated moments were the two principles are most likely to collide.

Notes

1 "About the Solar Decathlon." *Department of Energy Solar Decathlon*. Department of Energy, 19 Dec 2013. Web. 9 Feb 2014. <About the solar decathlon. (2013, 12 13). Retrieved from http://www.solardecathlon.gov/about.html.

2 "Definition of educate in English." *Oxford Dictionaries*. Oxford University Press. Web. 9 Feb 2014. <http://www.oxforddictionaries.com/us/definition/american_english/educate?q=educate>.

3 The perception of Architecture as the mother of the arts has a long and tumultuous history. We mean not to dismiss the contributions of the visual or performing arts. Rather, we draw our influence from Frank Lloyd Wright, and more distantly Victor Hugo, both of whom have confronted the relationship between Architecture and the Arts. See *The Hunchback of Notre Dame,* Chapter II – This Will Kill That, by Victor Hugo.

4 The term *obstinate rigor* is borrowed from Robert McCarter's essay in the University of Florida School of Architecture publication, *Constructions.* McCarter, Robert. "With Obstinate Rigor" in *Constructions*. Edited by Nina Hofer and Martin Gundersen. Florida: SorterChilds Publishing Co., 1993. p 4-9.

5 Sekler, Eduard. "Structure, Construction, Tectonics" in *Structure in Art and Science. Gyorgy Kepes, ed.,* George Brazilier, Inc.: New York. 1965. p 89.

6 Ibid. p 89.

7 Ibid. p 92.

8 Ibid. p 94.

9 Shepheard, Paul. *Artificial Love: A Story of Machines and Architecture*. The MIT Press: Cambridge, MA. 2003. p 30.

10 Hofer, Nina. "Invention is Forgetting the Name of the Thing One Makes" in *Constructions*. Edited by Nina Hofer and Martin Gundersen. Florida: SorterChilds Publishing Co., 1993. p 3.

11 Brawne, Michael. *Architectural Thought: The Design Process and the Expectant Eye*. Burlington MA: Architectural Press, 2003. p 126-127.

12 "http://www.twainquotes.com/Cats.html." Accessed February 15, 2014.

13 The composition of the RE:FOCUS team was complex, consisting of four academic units from the College of Design, Construction and Planning (namely Architecture, Building Construction, Landscape Architecture and Interior Design), the College of Engineering, the College of Business Administration and the College of Journalism. The primary faculty advisor to the project was Dr. Robert Ries, faculty with the Rinker School of Building Construction (currently Director of the Rinker School of Construction Management). Additional faculty advisors were: Mark McGlothlin (Architecture), Bradley Walters (Architecture), Dr. Maruja Torres-Antonini (Interior Design), Dr. James Sullivan (BCN), Russell Walters (BCN), and Diana Pelfrey (Public Relations). The central student team was primarily made of students from two units, with addition support coming from other units, as follows: Architecture (11 students), Building Construction (15 students), Interior Design (3 students), Landscape Architecture (3 students), Engineering (3 students), Business Administration (1 student), Journalism (3 students). The overall student contribution was immense and it would be difficult, if not impossible, to accurately count all of the students who helped with the project at some point. The total number would likely exceed 150.

Recycling Design Thinking
through the Plasticity of Expressive Space

P. Jeanne Myers, MHP, B.Arch, AIA, NCARB

Jenna Thompson, M.Arch, LEED AP BD+C, ID+C

Jennifer Barker, M.Arch, B.Arch

University of Memphis

Abstract

In order to instill a mindset that embraces sustainability from inception, it must be presented as an integral way to think about form, space, and order. To facilitate a shift in design genesis, sustainable concepts and applications are introduced into first year design studios with special focus on “remaking the way we make things.”[1] The projects are designed to help students decipher how they receive and process information related to sustainable design issues. While it is important for them to be presented with a concept of sustainability and to investigate case studies, it is also important for students to work in a tactile way with materials that pose threats to the integrity of our environment.

Utilizing commonly discarded materials such as plastic bags and bottles, students were challenged to explore the reuse of these materials in a tectonic way. Through a collaborative process, students were asked to explore various manipulations and future uses of these materials. In these explorations, students discover not only the design properties but also the inherent limits for each material. This connection is then related back to the limits of the earth and its ability to sustain and regenerate.

Once students worked through various explorations, they were asked to create a connection, module, unit, and finally a system, to install in a selected location on campus. Installation included display and community interaction with the plastic construction as well as disassembly. Students prepared a presentation based on their individual and team goals for the project. In addition, the display included a team-created information board showcasing the creative process and sustainability facts pertaining to their use of the materials. The entire process was recorded for presentation to the whole class.

The project is in its third iteration, and has improved each year with the intent to assist beginning design students in accessing and applying sustainable practices. It also allows for the development of critical thinking skills thereby transforming their design process.

Introduction

The Recycling Design project was initiated by faculty because of observations of the local environment which showcased the absence of sustainability from student mental models.[2] The unique cultural diversity present in our student body, including differences in race, socioeconomic status, and ethnic backgrounds, provides both opportunities and challenges. In conversations inside and outside of studio, we learned that some students did not possess awareness for the importance of recycling, water and energy conservation, reuse, and other conceptual ideas about sustainability. In order to address the discrepancies between professional design expectations and the levels of student knowledge, we designed the project to begin with the simple acts held in the mantra reduce, reuse, recycle, with the specific intent to add the regenerative aspect of design to the mental models of the students.

As members of a campus community, we have experienced the “silo” effect with green initiatives. These experiences can send a message that the culture of our city is one of waste; however, we believe that embracing and promoting local systems of sustainable initiatives (solar farms, extensive bike lanes, improved and developed greenways, and comprehensive recycling programs) is an effective way to transform our students into pioneers of green design in our local community.

What is sustainability?

Education and awareness of sustainability encompasses a broad spectrum of definitions. McDonough and Braungart define sustainability as the capacity for society to create products, processes, and services that are inherently healthy for humans and the environment.[3] Using this concept of how to achieve sustainability a first year studio project was developed to encourage students to upcycle their design thinking by becoming more aware, taking action, and developing knowledge through creation.

Theory: Thinking in Systems

In support of this design philosophy, systems thinking serves as a theoretical framework in which humans learn to understand patterns that exist in life and to embrace the understanding that nature, all humans, and their endeavors "are bound by invisible fabrics of interrelated actions."[4] This way of thinking informs our teaching by reminding us that all learning is connected and experienced through inter-relationships that affect our way of knowing psychologically and physiologically. From a psychological perspective, understanding the mental assumptions about sustainability held by our students is important to implementing first year studio projects. Without exploring and understanding the mental models of the beginning design student, and thus starting where they are, developing an effective teaching dialogue is difficult.

Systems thinking is comprised of Five Disciplines including mental models. Sharp notes, "people within colleges and universities, like people everywhere in society, have mental models that inform their behavior towards our natural life support systems."[5] Sharp describes the mental models of individuals that do not see their overall connection to the planet as "subconscious and unspoken assumptions."[6] These assumptions include beliefs that 1) The Earth is infinite; 2) There is an "away" where you can throw things; 3) Materials from the earth's crust can be removed and re-emitted almost anywhere; and 4) The individual is powerless to affect change in large and complex systems.[7]

Many of our students adhere to these assumptions because they are rarely challenged to think about how their individual and collective waste streams impact the Earth.[8] Following from this understanding, the goals of this project were to encourage and challenge students to design alternative uses for common waste materials and therefore consciously consider what they typically throw away.

Methodology: Action Research in Studio Process

Action research, both as a theory of understanding and as a methodology, aligns with educational research and systems thinking, and is inclusive of everyday, real-life problems.[9] By its nature, action research is action-oriented, commanding the possibility for all involved to be transformed through shared knowledge generation and participation.[10] It is a cyclical process that involves multiple steps (plan, act, observe, reflect) over several iterations.[11] It is this repetitive experience, with emphasis on growth and development, which connects so well with the equally iterative design process. In regard to teaching, action research makes no clear distinction between the practice of, and inquiry into, the activity itself – they are not separate understandings, but rather, interconnected processes that should be embraced as such.[12]

For these reasons, we feel action research is an appropriate methodology for gauging both the comprehensive and the component parts of the teaching and implementation of the Recycling Design project. Moreover, this methodology, embraced and practiced as a way of participating in knowledge gathering, is a form of research that lends itself well, not only to the practice of teaching, but also to the practice of learning within design. We find that it serves the student and the professional in pursuit of continuous personal growth. The following presentation of the design project is aligned under the cycle of action research.

Planning

The meaning of sustainability for this particular project was incorporated in the desire for students to appreciate multiple uses for materials designed as one-use products, i.e., plastic bottles and bags. Many of our students have not developed a personal definition of sustainability. Those that have are still learning the breadth of sustainability and therefore refining their definitions. This understanding led us to challenge student thinking by asking them to upcycle[13] these typically single use items. By introducing this way of thinking in the first year of design, students begin to look at materials as opportunities to be creative. This helps students to challenge conventional norms of material use later in their educational and professional careers by promoting design that is intentional and "loves all children of all species for all time."[14] In this way, the project serves as a seed that is programmed to transform into the next cycle of knowing.

Acting

The first step in the Recycling Design project was to introduce students to global issues related to sustainability, specifically with the misuse and discarded nature of reusable and recyclable items. Students were presented with videos that showcased artists who use beach plastic and recyclables found in landfills as their media.[15] Many of the students had not considered alternatives for plastic other than recycling centers or landfills. Using the experiential learning model[16] as a teaching guide, students entered into a group discussion directly after watching the videos. The discussion explored their concrete experiences with material collection and encouraged the students to reflect on what they did in the past and what they might do in the future.

As part of their research, a few students took the initiative to look for materials outside the comfortable environment of the campus and their homes. One team visited a local single-stream recycling center to see if they could acquire specific materials. These students were able to tour the facility and learn how the process worked. More importantly, they transferred the new knowledge by sharing their experience with the class.

Another student contacted the office of a family member. From this office the student was able to acquire several bags of used plastic bottles. This donation was able to provide the class with an insight into the consumption habits of others and was an opportunity for students to engage others with this project.

To further demonstrate how the Recycling Design project is a transferrable learning experience, a first year design student is trying to arrange an opportunity for future first year students to have access to a large stock of recyclable materials. The idea will allow students to "dumpster dive" for materials at a commercial retailer, providing them an opportunity to see the extent of waste created.

Project Explanation

The process for the project was implemented under the following steps:

- Individual Work
- Material Collection and Site Analysis
- Collaborative Work
- Grid Construction and Site Analysis
- Material Manipulation
- Connection Detail
- Case Study
- Module
- Unit
- System and Installation

Individual Work

Material Collection and Site Analysis. Prior to beginning the project, students were asked to bring in cleaned plastic bottles and bags. They were instructed to only collect post-consumer items. Students were then asked to investigate campus landscapes through a qualitative and quantitative lens. This included sketching, writing, and photographing elements of interest and observing and specifying a location that embodied experiential space and place in terms of social interaction, light or the absence of light, and climate. Upon completing the task, students were asked to submit a reflection of their experience.

Collaborative Work

Grid Construction and Site Analysis. As an introductory exercise, student teams were tasked with constructing a grid made of hemp string to be installed along a Homasote-lined corridor. The grid served as a frame for the work as each phase was completed. The teams were instructed to revisit their individual site selection and collaboratively determine a site that best represented the team understanding of the project. Then the team conducted another site investigation following the steps of the individual process.

Material Manipulation. The student teams were asked to study the part-to-whole relationship of the plastic bottles and bags through deconstruction and reconstruction. The goal was to challenge the teams to understand the components and the limits of the material in terms of structural composition including: molds, seams, applications, ridges, material thickness and integrity. The students were then asked to reconstruct a new form reusing only the deconstructed parts of the bottle and bag.

Connection Detail. From the material manipulation analysis the teams created connection details that demonstrated their understanding of the integrity of the materials. The connection details included, but were not limited to, the following: weaving, stitching, interlocking, tying, crunching, twisting, compressing, knotting, braiding, shredding, ripping, etc. The new connections were created without gluing or melting.

Case Study. Prior to moving to the next step in the process the student teams were tasked with conducting case study analysis. The case study related to the site investigations of light, site, and installation. This exercise connected the students back to their previous work while allowing them to incorporate design ideas from their material manipulations and connections details.

Module. Combining the previous learning steps, the teams created modules as a repetition of the connection details. The modules expanded upon and combined their connection details.

Unit. Each team was asked to develop a unit as a repetition of the module. The teams demonstrated the ability of the unit to be easily assembled and disassembled back to the module. Here the students learned the importance of efficiencies in production. They also became aware of how repetition within a system begins to formulate components and the ability to generate a holistic design within a system of nested designs.

System and Installation. The final step in the design process challenged the teams to combine what they learned in creating the connection, module, and unit into a system. The dimensional parameters were to register 10'x10'. At this juncture, the teams learned if their previous actions led the design to an effective system that could be easily installed and uninstalled on their specific site.

Each step was continuously refined throughout the process. This created an end result that pushed the structural and physical limits of the initial plastic bottle and bag. All steps in the process were documented by the student teams in their studio sketchbooks and on 1'x4' strips of white trace paper. Upon completion of each step, student teams pinned their work in the grid for display and critique.

Observing

Team Dynamics

As faculty members we were aware of team dynamics throughout the project. There were some teams that worked well together from the beginning, while others struggled. This was predominantly noticed during the interim critiques. For example, students were encouraged to discuss individual contributions as well as their various strengths. Teams discovered that utilizing their individual strengths to teach and train other members helped to make the tasks move quicker, and in turn, create a better product.

Furthermore, we found the collaborative spirit extended beyond the first year studio. For instance, one student team collaborated with fourth year interior design students to learn that a typical plastic bag can be transformed into a single length of nine yards of material with an approximate width of one and a half inches. In further explorations, the team created a structurally sound "ribbon" by attaching it to an electric drill and spinning it into a thread-like material that was used to stitch pieces together (Figure 1). This inventive technique was then shared with classmates who utilized this new process to hang pieces in situ as well as within the grid.

Fig. 1. "Ribbon" creation process.

Building the Living Classroom

At every step in the project, the teams displayed their work within a grid constructed on Homasote along a department corridor (Figure 2). This included their sketches recorded on trace paper as well as the plastic constructs. This display allowed other students, faculty, staff, and visitors to follow the explorations of each group throughout the project.

During the process, classmates who had participated in earlier iterations of the Recycling Design project, studied the displays and commented on the work. In some instances, first year students sought out upper-class student critiques, thus creating a vertical feedback loop[17] within the program and allowing for networking opportunities between academic levels.

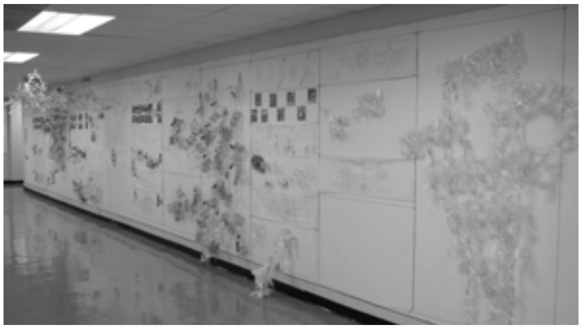


Fig. 2. Living Classroom showing team process and completed systems.

Site Installation

The teams installed and uninstalled their systems within the campus landscape. During the process, other teams were tasked with video documentation of the installations. This process was implemented similar to consulting work, in that, the documenting teams acted as consultants hired to produce marketing material. This was to ensure quality work and promote collegiality between the various teams.

Prior to installation, students considered how users would interact with the project and were challenged to think of space as more than a wall, roof, or floor. Instead, the teams were urged to consider an abstracted creation of space and experience it in terms of plane, opacity, transparency, light, color, and intimacy.

Critique

The Recycling Design project was critiqued at the various stages of project iteration. The culminating critique was held in the gallery space of the department. Various jurors, including diverse members of the campus and professional design community, were invited because of the project embodied awareness to global issues concerning sustainability, focused on the impacts of waste within the campus community, and highlighted the importance of designers to help create new solutions for better products and services.

During the critiques, teams were given the opportunity to discuss their process, trials, errors, and success, and field questions from the jury. After all the teams presented, the class was tasked with combining their projects and displaying a composite piece in the center of the gallery as an extension of understanding systems thinking in design (Figure 3). While the composite piece was installed, jurors were invited to watch short videos of the in situ installations and interact with the projects and students (Figure 4).

Fig. 3. Students combining projects after group presentations.

Fig. 4. Students discussing connections with juror.

Reflecting

Upon completing the critiques, jury members and students were asked to reflect on the project in verbal and written format. The following is a discussion of student reflections.

Reflections. Most students commented positively regarding the process of working in small steps without knowing the end result.

The mystery of what the final product would be seems to be a very successful way of letting the project develop itself.

I believe that every step was necessary. It isn't the end result but the process that is beautiful.

Several students were able to relate the project and process to the design professions.

This project relates [to the profession] in the way that we deconstructed a material and began to understand the way that the separate parts of it were to function and how they all related. It is also similar to the way that there are building blocks in architecture that are useful in certain situations and not in others. In this same manner there are many ways that a bottle can be altered but not all of those alterations yield the best outcomes.

In terms of designing, it has showed us not to strive for a preconceived vision but to let the materials determine the outcome. In doing so it allows the final product to become one of pure creativity.

Other students recognized the iterative process, a part of both systems thinking and action research.

It forces you to think step by step throughout the whole project instead of focusing on the end result.

This project also helps in the designing process of focusing on the process and ideas that can come along the way instead of jumping the gun and focusing on the end result because good design is always a process and there is always inspiration when you perform things in a series of events.

Student critiques included more time to complete the project, the incorporation of light and music, the re-introduction of a client component, and use of other recyclable materials.

Continuous Growth Process

As the reflections indicate, the project is successful in providing the students an opportunity to develop their understanding of sustainable design. Students and jury members believe the project is useful and important to the first year design studio.

The Recycling Design project is now in its third iteration. The process of evaluating the project over several years involves learning what worked, working within required topic parameters, and trial and error.

Elements of the project statement to be reconsidered in the next iteration include: incorporating public awareness by displaying the in-process work to the campus community; implementing campus installations of the final systems that are more permanent; auctioning the final installation at various student organization events; and re-introducing interdisciplinary client interaction, among other items.

Conclusions

The inception phase of the project revealed that many students did not consider what happens to an item once it is recycled or how that item might be repurposed. However, once the project was introduced, students became aware of the amount of recyclables their friends and family discarded. Students reported that their participation in this project encouraged their family, roommates, and friends to become more conscientious about recycling.

By challenging student understanding of space in both architecture and interior design, students were encouraged to identify how space can become place using non-traditional building materials. The greater challenge, however, is still to be solved. That is, until products, processes, and services are intentionally designed to continually cycle in either a biological or technical nutrient food source, waste will be an undervalued resource.[18] Currently, a large part of the waste stream embodies economic value that is underutilized. By mining waste streams for materials, a redistribution of waste into second life products can be realized. The way to this solution, we believe, is to start where you are.

This project is presented as important to the unique culture of our specific department of architecture. However, it is our belief that the lessons learned over the past three years of implementing the Recycling Design project can be used to benefit other beginning design curriculums.

Notes

[1] McDonough, William, and Michael Braungart. 2002. Cradle to cradle: remaking the way we make things. New York: North Point Press.

[2] Mental models are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. See Peter Senge, 2006.

[3] William McDonough and Michael Braungart. 2013. The upcycle: beyond sustainability, designing for abundance. New York: North Point Press.

[4] Peter M. Senge. 2006. The fifth discipline. London: Random House Business, 7.

[5] Leith Sharp. 2002. Green campuses: The road from little victories to systemic transformation. International Journal of Sustainability in Higher Education, 3, 134.

[6] Sharp, Green Campuses, 134.

[7] Ibid.

[8] We take the stand that higher education should be about human development and therefore, should foster critical consciousness. Challenging preconceptions follows from the idea that to foster critical thinking and the possibility for transformational learning, students should be reflective and critical of their own presumptions. See Freire, 1970/2000, 1998; Jack Mezirow, 1991; Jack Mezirow and Associates, 1990, 2000; Malcolm S. Knowles, Elwood F. Holton, and Richard A. Swanson, 2011; and Stephen D. Brookfield, 2012.

[9] Davydd Greenwood and Morten Levin. 2007. Introduction to action research social research for social change. Thousand Oaks, Calif: Sage Publications.

John Heron and Peter Reason. 2001. The practice of co-operative inquiry: Research 'with' rather than 'on' people. In P. Reason & H. Bradbury (Eds.), Handbook of action research: Participative inquiry and practice (pp. 179-188). London: SAGE.

Robin McTaggart. (1991). Action research: A short modern history. Victoria: Deakin University.

[10] Greenwood and Levin, Introduction to Action Research.

[11] Ortrun Zuber-Skerritt. 1992. Action research in higher education: Examples and reflections. London: Kogan Page.

[12] Wilfred Carr and Stephen Kemmis. 1986. Becoming critical: Education, knowledge, and action research. London: Falmer Press.

James McKernan. 1996. Curriculum action research: A handbook of methods and resources for the reflective practitioner. London: Kogan Page.

[13] McDonough and Braungart, The Upcycle

[14] Ibid, 9.

[15] Richard Lang and Judith Selby Lang. 2012. "One Plastic Beach," High Beam Films, http://youtu.be/3W4s2CjDU3M.

Lucy Walker, João Jardim, Karen Harley, Angus Aynsley, Hank Levine, Moby, and Vik Muniz. 2011. Waste land. London: Almega Projects. DVD.

[16] Experiential learning refers to the Experiential Learning Model developed by David Kolb. See David A. Kolb, 1984; and, David A. Kolb, Richard E. Boyatzis, and Charalampos Mainemelis, 2001.

[17] See Donella H. Meadows and Diana Wright. 2008. Thinking in systems: a primer. White River Junction, Vt: Chelsea Green Pub.

[18] McDonough and Braungart, The Upcycle

Free Will and Determinism:
Building Materials and Assemblies in Architectural Design

Miriam Neet, AIA

Adrian Smith + Gordon Gill Architecture LLP

Get the feeling of the brick into your hands or you can't build a brick building that's worth looking at as a work of art.[1]
– Frank Lloyd Wright (1958)

Louis Kahn famously said, "You say to a brick, 'What do you want, brick?'"[2] For him, this was a rhetorical question since he knew for himself what the brick "wanted". His architecture embodied his understanding and attitude toward brick as a building material. If other noted architects were to ask the same question, the answers would be quite different. The brick architecture of Frank Lloyd Wright, Alvar Aalto, Laurie Baker, Mies van der Rohe, Eladio Dieste, Karl Friedrich Schinkel, Sigurd Lewerentz, to name a few, are just as compelling and legitimate as that of Kahn's architecture but they embody very different understanding and ideas toward brick itself and masonry construction.[3]

Fig. 1 Indian Institute of Management, Ahmadabad, India, Louis Kahn, 1962-74.

Kahn believed that there was an inherent order and hierarchy to nature and that it was essential to understand the nature of a material to properly "honor" it. For him, it would "shortchange" a material by giving it an "inferior" job to do – such as using brick as an infill material.[4] For Kahn, using brick to span structurally was a more honorable task and more in keeping with its nature.

Eladio Dieste, the Uruguayan engineer, shared Kahn's ideas of "honoring" the nature of materials which reflected a "cosmic economy." For Dieste "there is nothing more noble and elegant than resistance through form... because of their form that they are stable, not because of an awkward accumulation of matter".[5]

For Alvar Aalto, on the other hand, there was no static cosmic or natural order: "On deeper examination, architecture is not merely a set of given

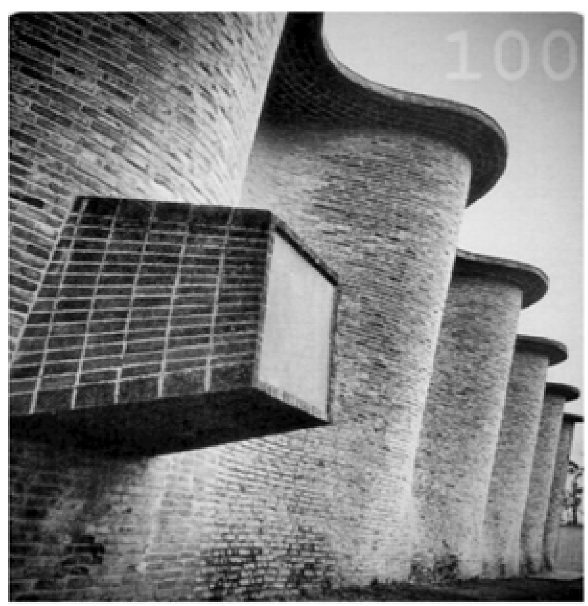


Fig. 2. *Iglesia de Atlantida, Atlantida Uruguay. Eladio Dieste, 1952.*

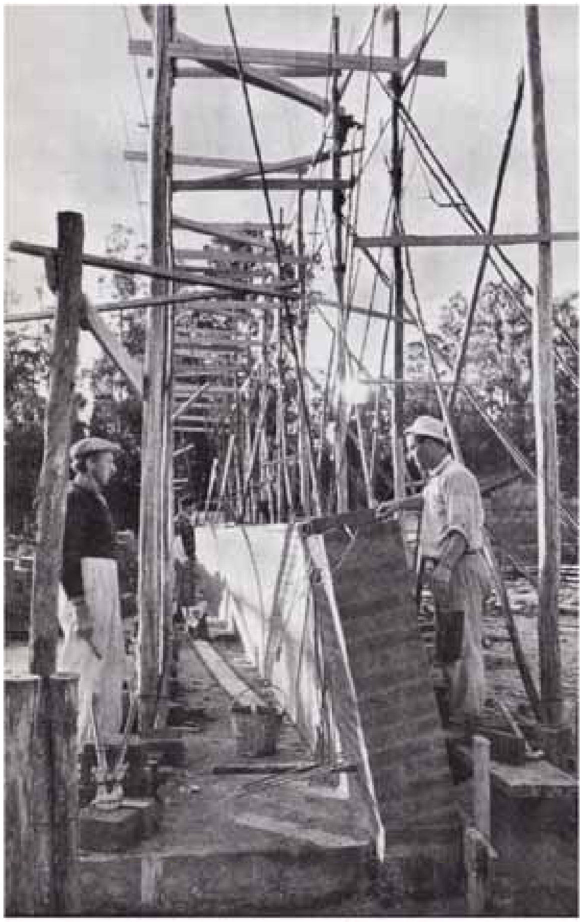


Fig. 3. Construction of Iglesia de Atlantida.

structural results, but to a much greater degree a complex process of development, whose inner interaction steadily produces new solutions, new forms, new building materials and constant changes in structural ideas." [6] His architecture reflected his belief in a dynamic nature where structural potential of brick was less important than its textural qualities. [7] The suspended planes of brick on Saynatsalo Town Hall, supported by steel structure, run counter to the beliefs of Kahn and Dieste.

In understanding the divergent ways that architects have used building materials in the context of their design intentions and philosophies, the beginning students can begin to see that there is no single, wholly deterministic and "correct" way to utilize any given material. Determining the way a building material will be used and detailed becomes just as much a design and philosophical activity as developing a design *parti* for a building.

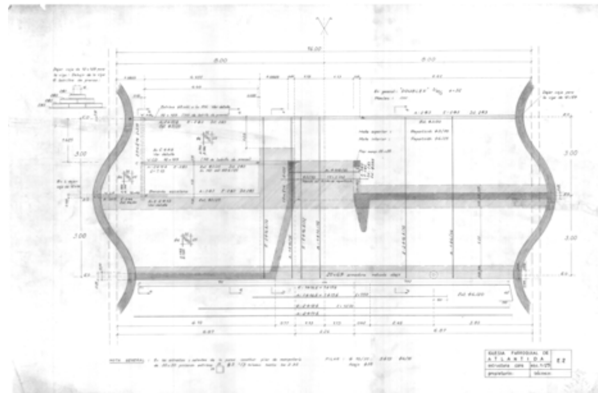


Fig. 4 *Working drawings for the Iglesia de Atlantida by Eladio Dieste.*

In many instances, students think of building materials as "wallpaper" in their studio projects. A quick click of the mouse on the pull-down menu of material hatch options on their computer screens is the extent of the decision process in choosing building materials. For the beginning design student, the significance of building materials and assemblies in the context of the overall design of the building needs to be introduced and reinforced early in their studies. The purpose of this paper is to articulate the pedagogical strategy to achieve this in the context of an architectural curriculum.

Fig. 5 Saynatsalo Town Hall, Saynatsalo, Finland. Alvar Aalto, 1949-1951

Robert McCarter in "On and By Frank Lloyd Wright: A Primer of Architectural Principles" described Wright's design process as proceeding from the general to the particular and so conversely, an analyses should go from the particular,(i.e. building), to the general,(i.e. principle) and so "we may work our way 'backward' attempting to draw out from the architecture the ordering principles that shape it'.[8] The idea of deducing larger design principles and ideas from the particulars of building materials and construction points to a useful way of teaching the relationship between two. Typically, when we think of analysis in an architectural classroom or studio, whether of the particular or of the general, we think of precedent study or case study – an investigative process in which the design principles or philosophy underlying the building is revealed. It is a process typified by dissection or de-construction: the completed building is metaphorically taken apart and examined piece by piece. For example, Violet-le-Duc, inspired by an analytical method used in comparative anatomy and geology, used exploded views for the first time to explain buildings in his *Dictionnaire raisonne*.[9]

Fig. 6. Darwin Martin House, Buffalo New York – Frank Lloyd Wright (1903-1905)

What if we were to extend the meaning of analysis to mean construction? What if students, in teams, could literally build several noted buildings (or a representative portion of it) using brick, for example, by architects of divergent philosophies piece by piece from the ground up? Consulting a set of working drawings generated by the architect, the students would construct the buildings (or a representative portion) with prescribed building materials and assemblies. (Here students learn the 'aliveness' of architectural drawings in serving as exact roadmaps in construction.) By having several teams build a representative portion of several noted buildings of divergent philosophies in one class, students can make comparisons and begin to understand the power of ideas to influence material choices and, at the same time, the power that materials have on the ideas underlying the building. The pedagogical objective is to understand the variety and differences in design intentions and construction approaches possible, given a building material. Analysis through construction may best be taught orchestrated across the curriculum in construction technology/building science, history/theory, structures and studio classes.

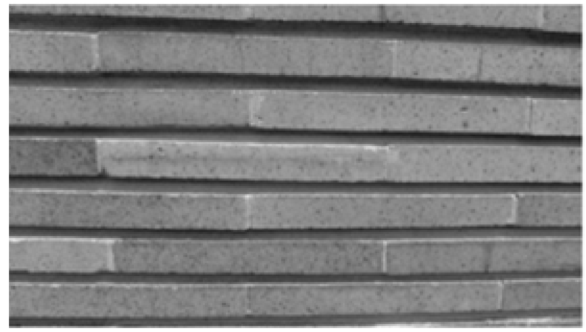


Fig. 7. Detail of roman brick coursing with flush head joints and deep bed joints expressing the horizontality of Prairie Style organic architecture.

Students can then work to develop their own philosophies or principles toward building materials which can then inform their designs and strategies in using building materials. The deterministic, linearity of decision making in the studio – that is, first thinking about abstract forms and then thinking about materials (which in itself is abstract at best) can now be reversed at will. Students can first think of the design possibilities of the material, based on the analytical activities of deconstructing and constructing case studies and those ideas can then inform the design of their architecture projects.

The determinism and the linearity in design thinking in a typical studio leads to the disconnect between ideas and materials/assemblies. By understanding the connection between design intentions and architectural construction, students are empowered to design with greater knowledge and therefore more freedom and intention.

Notes

[1] Meehan, Patrick J. ed. "Philosophy of Organic Architecture" in *The Master Architect: Conversations with Frank Lloyd Wright*. A Wiley-Interscience Publication: New York 1984. p. 86.

[2] Latour, Alesandra, ed. "1973: Brooklyn New York – A lecture at Pratt University, Fall 1973" *in Louis I. Kahn: Writings, Lecture, Interviews.* Rizzoli International Publications: New York 1991. p. 323

"You realize that something has a certain nature. When you think of making of a school, the school has a certain nature. In making it you must consult the laws of nature, and the consultation and approval of nature are absolutely necessary. There you will find, discover, the order of water, the order of wind, the order of light, the order of certain materials. If you think of brick, for instance, and you consult the orders, you consider the nature of brick. This is a natural thing. You say to brick, 'What do you want, brick?' And brick says to you, 'I like an arch.' And you say to brick, 'Look, I want one too, but arches are expensive and I can use a concrete lintel over you, over an opening.' And then you say, 'What do you think of that, brick?' Brick says, 'I like an arch.' It is important, you see, that you honor the material that you use. You don't bandy it around as though to say, 'Well, we have a lot of material around. We can do it one way. We can do it another way.' It's not true. You can only do it if you honor the brick and glorify the brick instead of just shortchanging it or giving it an inferior job to do, where it loses its character. When you use it as infill material, for instance – which I have done, you have done – the brick feels like a servant. Brick is a beautiful material and it has done beautiful work in many places; it still does because it's a completely live material...And so you can talk to nature about many other things."

[3] Weston, Richard. *Material, Form and Architecture* Yale University Press: New Haven, CT 2003. p. 94.

[4] La Tour, op cit. 323.

[5] Anderson, Stanford ed. "Architecture and Construction" by Eladio Dieste in *Eladio Dieste: Innovation in Structural Art.* Princeton Architectural Press: Princeton, NJ. 2004. p. 107

"The resistant virtues of the structure that we are searching for depend on their form. It is because of their form that they are stable, not because of an awkward accumulation of matter. From an intellectual perspective, there is nothing more noble and elegant than resistance through form. When this is achieved, there will be nothing else that imposes aesthetic responsibility...For architecture to be truly constructed, materials should not be used without a deep respect for their essence and consequently for their possibilities. This is the only way that what we build will have the cosmic economy that we spoke of, and this cosmic economy is what sustains the world. When we use materials with this profound respect, we must be modest and be careful of our own aesthetic refinement. It is not enough to use brick because we like its texture and the fact that it is a material full of historical references. It is not that this is bad in and of itself, but we can take much better advantage of its possibilities. In this sense the current risks are much greater than before because modern technology apparently gives us the possibility of doing anything, of realizing any fantasy. It seems as if we can use construction materials as the set designer uses cardboard."

[6] Schildt, Goran, ed. "Influence of Structure and Material on Contemporary Architecture" in *Alvar Aalto: In His Own Words.* Rizzoli International Publications, Inc.: New York 1997. P. 98.

[7] Weston, Richard. Op. cit. p. 94.

[8] McCarter, Robert. "Integrated Ideal: Ordering Principles in Wright's Architecture" " in *On and By Frank Lloyd Wright A Primer of Architectural Principles* Phaidon Press Limited: London 2005. p. 286.

[9]Weston, Richard. *Op. cit.* p. 72.

Photo credits

Figure 1: Louis Kahn
http://www.flickr.com/photos/arnout-fonck/8553681647/

Figure 2: Eladio Dieste
http://www.pinterest.com/pin/229331805998120982/

Figure 3: Eladio Dieste
http://www.archdaily.mx/48931/clasicos-de-arquitectura-iglesia-del-cristo-obrero-eladio-dieste/1310760575-800px-cortes-iglesia-de-atlantida-jpg/

Figure 4: Eladio Dieste
http://thetemplesofconsumption.blogspot.com/2011_07_01_archive.html

Figure 5: Aalto
http://en.wikipedia.org/wiki/S%C3%A4yn%C3%A4tsalo_Town_Hall

Figure 6: Frank Lloyd Wright
http://www.darwinmartinhouse.org/visit.cfm

Figure 7: Frank Lloyd Wright:
https://www.bluffton.edu/~sullivanm/newyork/buffalo/martinhouse/south.html

Inhabiting Material:
Material Manipulation and Special Engagement

Roya Plauché

University of Houston

Familiarities of material conditions are a crucial part of a beginning design student's introduction to the design process and the understanding of Interior architecture, architecture and Industrial design. Accordingly, the exposure and analysis of assemblies, systems and tectonics of those materials and the ability to affect economies, efficiencies and ecologies are equally important in the foundation design curriculum. From the beginning the students are tasked with researching and testing the properties of materials available to them in an effort to perfect craft and the physical realization of the making process. The understanding of material, embodied physiognomies, mannerisms, limits, and boundaries are all tested in some manner even amongst the most conservative curriculum today. The simple process of making something into a physical form requires a knowledge and familiarity of the maker, which can only be learned as part of the making process.

The methodologies of material use and assembly should be inherent to the beginning design trajectory. The conventional use of material as a representational tool has dictated our teaching methods in the past. Embodying years of traditional mannerisms, materials in architecture have stood as a representation of the actual intended system. How can we go beyond conventional norms in the way we use and manipulate material in academia today? What can we learn from the ways we assemble? How can we apply strategies in which students go beyond the conventional use of a tectonics system and allow them to understand the emergent special qualities of tectonic space?

This paper will discuss the findings of a sequence of courses with a focus on assembly techniques and tectonic form-finding. The first course used primarily two dimensional methods, the second introduced the human body as a form of inhabitation and the final course focused on tectonic assemblies using steel.

"Inhabitation"

In Tung's vision even those without a roof over their head, the ones living within an imaginary property of a city, street, or other common territories can be said to inhabit space. [1]

Inherent to any material is the embodied tolerances and parameters that allow for the performance of that material to occur. These parameters intrinsically tell us how they want to be assembled and disassembled. It is in the assembly or arrangement of the material that inhabitation occurs. In the preceding case studies, students are encouraged not only to investigate assembly methods but to reveal the underlying performative aspect of that assembly and its notion of inhabitation. In each method the students are encouraged to be aware of the emergent spatial engagement. While some engagement is visual others are physical taking into account the human body and arrangements of programmed space. The students are instructed to create inhabitable assemblage, created by edges, boundaries, volumes, and territories that can both generate form and are occupiable.

Case Study 1 (2D Inhabitation)

The art of folding paper has a documented use as early as 1490 with the invention of paper in China in the 6th century[2]. The importance of this technique as an assembly method is that students are developing skills relating to scale manipulation, aspect ratio and proportion, modulation and aggregation, connection and structure, etc. The iterative process of folding and cutting narrates a method of three dimensional form generated of a two dimensional material. The transformation of the planer surface in to a three dimensional assembly heightens the students understanding of tectonic systems and the emergence of rhythmic and special experiences.

The emergence of system based parameters has altered the discourse of the way we use materials today. Systematic assemblies influence both economics and time, the modular approach allows the students to build complexity using a simple unit. Although formal, this approach allows students to learn form-making using a system based method.

Dynamic Systems

In the project series "Dynamic Fields"[3] the students must define a process of assembly as a means of generating their dynamic patterns using action / reaction. (Fig.1). Begging as an analogue drawing method using a ¼" grid, the student's process of rule based addition and subtraction of lines, manipulates the grid. Some orthogonal some non-orthogonal with an awareness of depth, proportion and repetition until a single unit has emerged. The unit then is aggregated, generating a pattern. The pedagogy of this controlled approach is that if students are encouraged to begin within a framework, they develop skills relating to rigger, calibration, and subtlety. The students are encouraged to use critical thinking in understanding the limits and boundaries of the technique and test whether it can be broken in order to establish individuality.

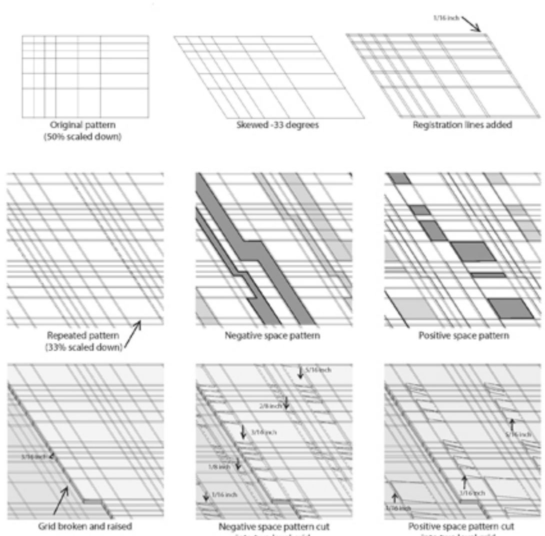


Fig. 1. Dynamic Fields (Student Cass)

Relief

As the students move to the physical manifestation of their systems, the materials constraints and abilities are tested in order to discover the tectonic range available to them. At this scale, the inhabitation of the material is visual; the reflectance of light and shadows created three dimensional depth. The assemblage technique is crucial to the overall tectonics of the patterns, as student test density and scale they understand that the notion of depth can be controlled. Some of the students initially began with strictly folding paper and through the iterative process of making, allowing for other technique of layering, cutting, disassembly, reassembly and density to emerge. The resulting patterns were varying in that the students who chose to deconstruct the paper and reconstructed it were able to get more depth and three dimensionality then those who simple relied on folding. The transformation of a planer surface into a valley filled with light and shadow is the desired outcome.

Case Study 2: (3D Analogue Parametric)

The advent of the industrial revolution, mass production and large-scale manufacturing industries during the last two centuries has had a revolutionary effect on architecture. The fathers of modern architecture, such as Le Corbusier, Mies Van Der Rohe and Walter Gropius were inspired by the automobile factories and methods of the era; this gave birth to the computer as a design[4]

While students are introduced to a rule based generative method in the first case study, the second case study is an introduction to mathematical and computational generators. The latter is only discussed in research and precedent studies rather than implementation. The notion of performative systems and assemblies has been tested in many curriculums today[5].

The goal of this case study is to familiarize the students with the language and tectonics of assembly systems and exposure to full scale assemblies. The students are asked to investigate the role of parametric design not using the computer as generally referred to but an analog method meaning a method of designing architectural objects based on numeric values and relationships. The resulting outcome is a unit that can be modularized and aggregated to create a division of space. This division assembly should be performative in that it could be engaged by the human body. The students are encouraged to exercise precise regulation, creating an interrelationship between each unit. Therefore the parametric model will be a controlled set of relationship that are directly related to the single unit and any change to the original unit will directly change the entire module and aggregation.

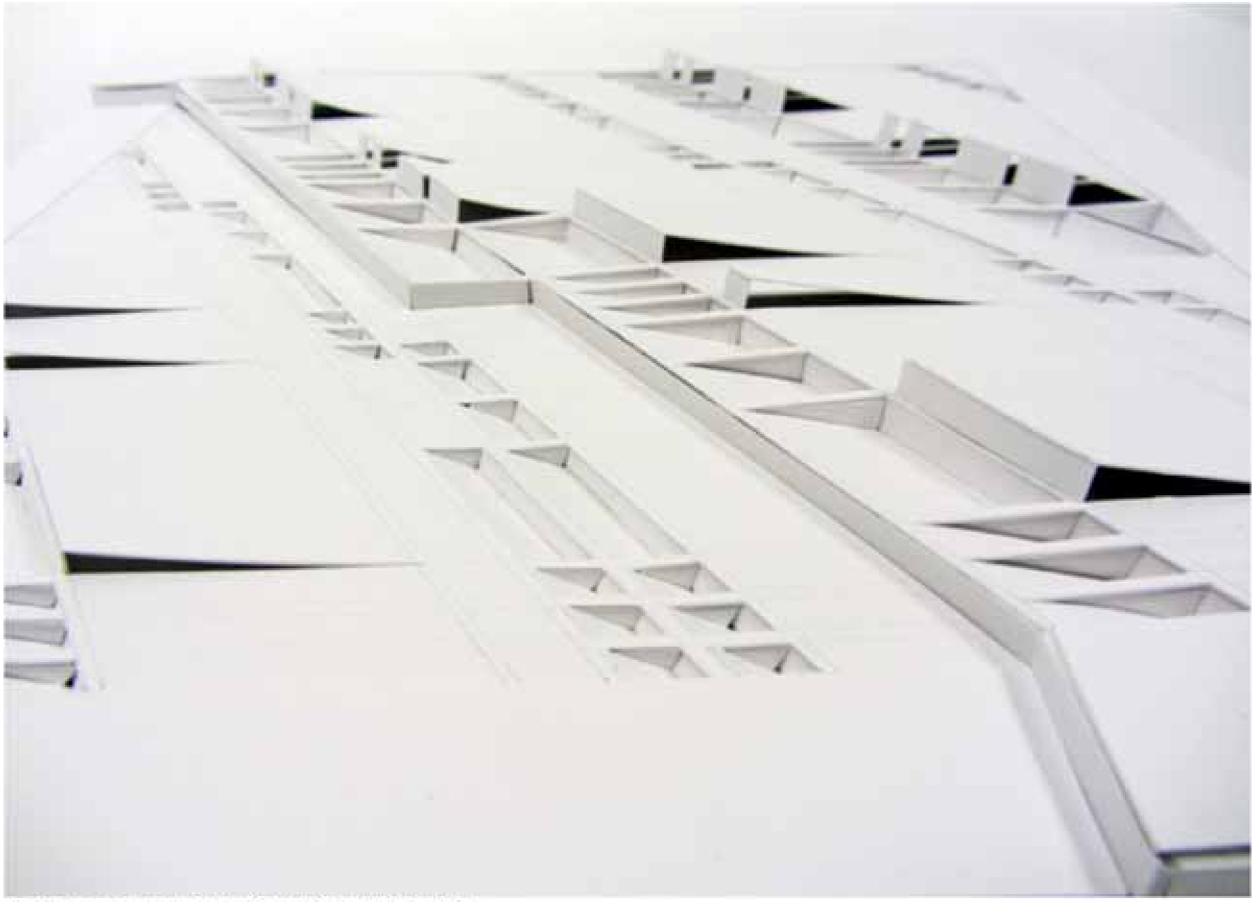


Fig. 2, Dynamic Field- Pattern, Cass Drew (UH, Plauché)

Assembly and Material techniques

Initially the students start with the numeric value of 5” applied to a grid using a 20” X 20” sheet of material; the material used is .03” styrene plastic. Using the numeric based rules of 5” proportion, division, rhythm, voids and solids the students cut away from the material to allow for the 2D sheets transformation into a 3D unit. Beginning with small scale studies the students iteratively made a variance of units looking for the emergence of opportunity in connectivity and assembly. Through the making process the students used problem solving techniques and critical thinking in conceiving the unit and testing the materials ability to be formed. The awareness of the constraints of the material was encouraged. How much could they cut before the material was no longer structural? What were the implications of the folding techniques in relationship to proportion? What were the results of the assembly technique they used? For instance, if the assembly technique was a redial ordering system, the unit became more structural (Fig. 3), if the assembly

Fig. 3, Sara Skinner Photo by Sophie Loloi (UH, Plauché) technique was a linear ordering system, the performative aspects of the modules were minimal. They discovered the importance of connectivity; the modules were stronger with two points of connectivity rather than just one and the placement of each connection point effected the three dimensional girth of the module.

Once they created a module, each student began the aggregation process. The inhabitation of the material is encouraged through the exploration of the performative aspect of the exercise, and the student's documentation of interaction with the physical model (Fig. 4).

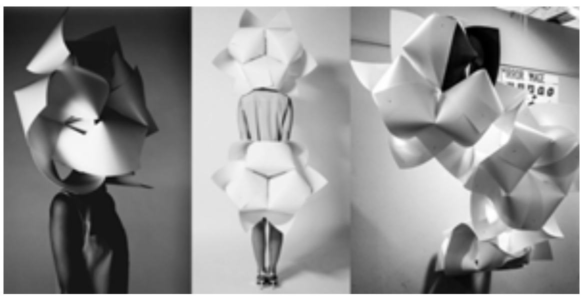


Fig. 4, Sara Skinner Photo by Sophie Loloi (UH, Plauché)

Case Study 3: (Steel Construction)

In the third case study the students are introduced to construction techniques and tectonics. Construction methods have a direct relationship to aesthetics and intent of the design process. The parameters are to use light weight structure to create enclose and protection from the environment in a remote location. In this approach the students are encouraged to think about the tectonic structural assembly not only as a structural material but a skin system that could interweave the structure, allowing the material to be used both structurally and tectonically.

Drawing from their learned skills of assembly and a scale shift of a larger structural assembly, the students begin the project with site documentation and analysis. They proceed to assembly models and tectonic structural scaffoldings along the cliff edge. The students are encouraged to begin both by applying a three dimensional grid, creating inhabitable frame structures and parasitic tectonic conceptual language they feel represent the site, taking into account ecological and environmental conditions (Fig.5). Construction methods have a direct relationship to aesthetics and intent of the design process. This iterative process of model making is conducted in an abstract manner allowing for assembly overlaps in technique.

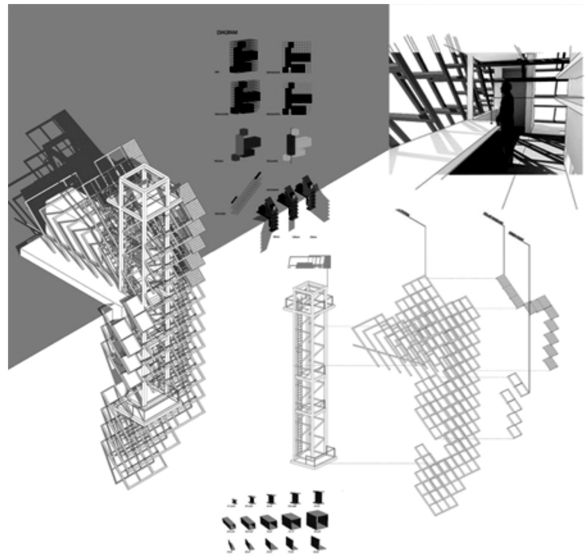


Fig. 5, Ranger Station, Filza Khan (UH, Plauché)

As we begin program interjection into the assemblies, the students are asked to define similarities and differences between the assembly typologies and define the parameters best soothing in order to generate a deformation of the frame structures, bringing them closer to the parasitic tectonic conceptual language models. Using parasitic and tectonic language the goal of this exercise is to give three dimensionality to the assemblies, allowing for the human bodies inhabit of the space (Fig. 6). The frame structures allow for an organized start but should not be the

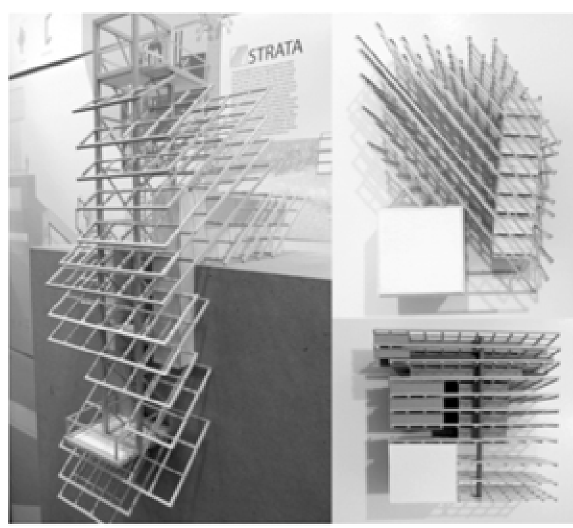


Fig. 6, Ranger Station, Filza Khan (UH, Plauché) final result. The parasitic tectonic conceptual models require the student to use critical thinking in understanding form finding along with the boundary requirements of inhabitable space and sequential movement.

The inhabitation process in this instance happens in between the structure and skin. As most students were able to make the transportation from frame to form, some struggled and stayed entirely in the orthogonal frame stage not applying enough deformations to allow for the inhabitation experience to be varied.

Conclusion

The notion of inhabitation a material brings into light not only the material in its natural state but the interaction with that material. The assembly process and the interaction of our bodies with a material have transformed the way we build today. The fundamental knowledge of assemblage and tectonics that change the way we experience space should be part of a beginning design student's trajectory. As educators the narration of critical thinking into this making process will impact the tool sets students need to be creative. This influence of experimentation does not have to be arbitrary nor without merit. If defined within a systemized process, the students benefit from a explorations within boundaries that can be and should be tested or broken.

Furthermore, the introduction of beginning designs students to analogue parametric assemblies can strengthen their awareness of self-directed rule based making and individual thinking. As we setup the notions of craft, rigger, and making, it is important to keep in mind that the beginning design curriculum influences and shapes the students design process extensively. If the curriculum is too rigid and conventional, it is difficult for student to develop the critical thinking aspect of the design process not knowing that boundaries can be broken with intention.

Notes

1 Srdjan Jovanovic Weiss. "Inhabitation is Unusual and Importatn " in *Ann Tyng Inhabiting Geometry*. Press: Contemporary Art Philadelphia and the Graham Foundation of Advanced Studies in the Fine Arts P.83.

2 Chinese Paper Folding (n.d.). In *Wikipedia*. Retrieved February 02, 2014, from http://en.wikipedia.org/wiki/Chinese_paper_folding

3 Curriculum development by University of Houston Foundation Coordinator Cord Bowen and Adjunct professor Meg Jackson.

4 Adel Zakout (2011, March 24). Top 10 Buildings: Parametric Design. Huffingtonpost.com. Retrieved February 12, 2013, from http://www.huffingtonpost.com/adel-zakout/top-10-buildingspara-metr_b_838268.html#s256708title=Walt_Disney_Concert

5 The PERFORMA Studio run by Professor Mike McKay at the University Of Kentucky College Of Design was used as precedent.

Material Culture + Design Studio

Jeana Ripple

University of Virginia

Abstract

Architectural material histories are complex stories of innovation, improvisation, fashion, economy, availability, labor, politics, and technology. Yet beginning design students working at the scale of material systems are often so focused on learning the *craft* of material tectonics that they fail to engage relevant cultural influences. This paper documents the Design-Driven Manufacturing studio taught to undergraduate architecture students at the University of Virginia. By asking students to consider material tectonics as a *culture* with interrelated influences and traditions, this course promotes creative, rational design toward a relevant and open field of possibilities.

Background

Culture, a derivation of "cultivation," implies both collective and cumulative behavior. In the Design-Driven Manufacturing studio, material culture is investigated as a collection of influences, including economic forces and tectonic traditions developed over time (Fig. 1).

In the past twenty years the conversation surrounding material culture and its influences has shifted its emphasis away from aesthetic symbolism toward economy and performance. For example, Kenneth Frampton's *Studies in Tectonic Culture* published in 1995, makes mention of labor, machining, and material capacity as informing tectonic development. But much less attention is paid to the technological and economic than the aesthetic context surrounding tectonics (and by extension, material culture). This study quickly sparked responses

calling for, "architectural significance that results from neither painterly nor sculptural techniques... [rather] significance that arises out of the means specific to architecture—namely, *structure* and *construction* as they give durable form to places and dwelling practices."[1]

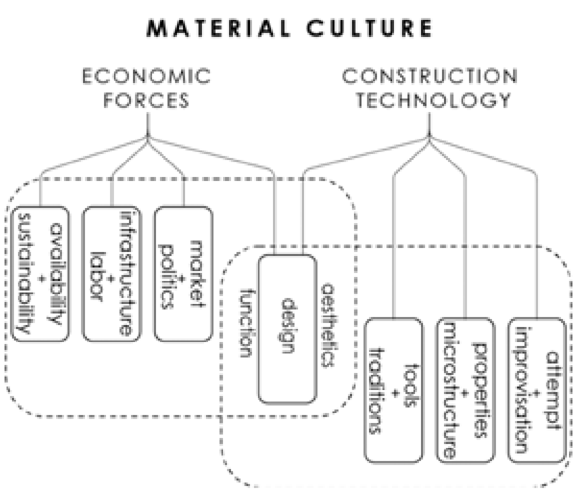


Fig. 1. A web of critical influences on material culture was defined based on the written dialogue surrounding tectonic culture, construction and structural histories.

Accepting that structure and construction shape architecture's material culture, then what factors shape *their* development over time? Rinke and Schwartz, contemporary structural design practitioners and educators at the ETH, describe three essential components influencing the historic development of structural form—material properties, natural and mathematic principles, and theories of structural behavior. They also draw a distinction between structural and construction history. Structural history too often neglects the "unique circumstances, requirements, and inventions inherently attached to [case study] examples." When, in fact, "there are always many different correct structural solutions for a given problem." By their account, construction history, encompasses broader aspects of contemporary culture, including a tradition of "improvisations and attempts" that accompanies the development of tectonic systems.[2]

In similar fashion, Antoine Picon argues that there are unique influences on the development of construction history. These include the development of mathematical and technical knowledge, the development of machines, and the connection between construction and cultural history. Picon offers an example of the connection between construction and culture through Viollet-le-Duc's view of Gothic architecture as a response to the civic realities of medieval life—the high cost of materials and labor and a spirit of adaptation. Technologies related to the production of Gothic architecture, such as standardized stone-cutting methods, were also a response to these concerns of material conservation and labor. [3]

Structural engineering historian, Matthew Wells introduces the additional influence of political climate on the development of material culture. His comparison of ancient Egyptian and Greek political systems highlights very distinct attitudes toward technological development and the communication of ideas. For example, the nilometer was a large measuring device used to predict seasonal flooding, expected harvest quantities, and resulting tax rates. Access to this technology was restricted to high priests. According to Wells, the pyramids are additional supporting evidence of a closed and fixed society, resistant to the open exchange of ideas. There is very little evidence of testing or development in the pyramids. Only the partially collapsed pyramid at Meidum offers access to underlying techniques and subsequent adjustment. By contrast, Greek culture thrived on the exchange of ideas and open competition for innovation between political states. Wells attributes the rapid developments in technology and mathematical theory, such as contributions by Archimedes and Euclid, to flexible urbanism and Greek democracy. [4]

Many, if not most of these influences—politics, material availability, labor, microstructure, and construction traditions—are typically absent from the design studio. Time restrictions make it difficult for students to conduct in-depth research into economic, political, infrastructural forces. Full-scale testing of material properties and tool capabilities is limited by lack of fabrication expertise and budget restrictions. This, in turn, limits an attempt, analysis, and improvisation process grounded in material culture.

Strategy

By expanding the architectural design project to involve related disciplines and industry expertise, creative work in the design studio can be based on relevant opportunities while benefiting from a regular exchange of ideas. Two courses within the school of Architecture, a design studio and an economic development course share a common project focused on local material and manufacturing innovation. Urban and environmental planning students and business students research economic factors while architecture students explore new applications and functional expressions of material properties.

A local industry partner contributes feedback and expertise in addition to final prototype construction. Production efficiency is developed in student proposals through expert fabricator consultation and the realities of time and budget constraints. The repeated exchange between students focused on design and those examining economic / fabrication implications forces students to integrate a broad range of influences into their material system designs.

Project Methodology

Economic Potential

Economic research conducted by faculty partner, Suzanne Moomaw and her economic development students identified south and southwest Virginia (the former tobacco-production communities) as areas of opportunity for new manufacturing growth. In addition, several communities in central and southern Virginia have recently decommissioned furniture factories. Southern Yellow Pine is the primary species for the timber industry, and certification for a new Southern Yellow Pine cross-laminated timber product is in progress. Unskilled labor, agricultural land, and wood-manufacturing facilities (Fig 2, 3) are available assets in these regions.

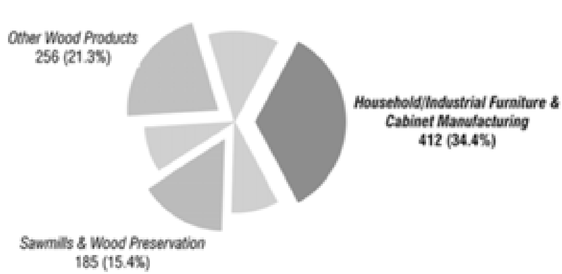


Fig. 2. Virginia wood production resources

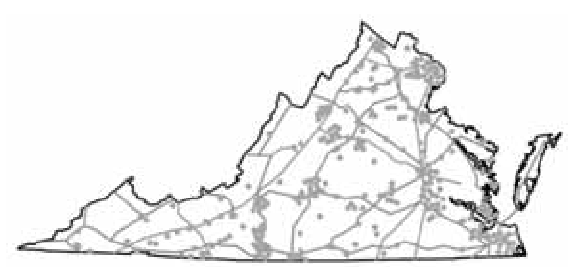


Fig. 3. Virginia industrial furniture and cabinet manufacturing locations.

Precedent Systems

Drawing upon known economic resources, architecture students were asked to focus on new potentials for the Virginia wood industry and reapplications of decommissioned furniture plants. Students were provided with precedents in three categories—structure, building function, mathematical inspiration—and asked to extract fundamental design principles based on material and structural behavior. They were then asked to translate the essential logic of their precedents to a new system, making specific use of (1) the material properties of wood (2) contemporary manufacturing processes and (3) structural analysis and design tools.

Skill Delivery

In the past three years, we have seen a proliferation of new performance analysis tools—developed by engineers, intended for designers and integrated with popular conceptual design software. Integration of these tools was important not only for the goals of the studio, but also to explore the potential of these relatively new tools in the design studio.

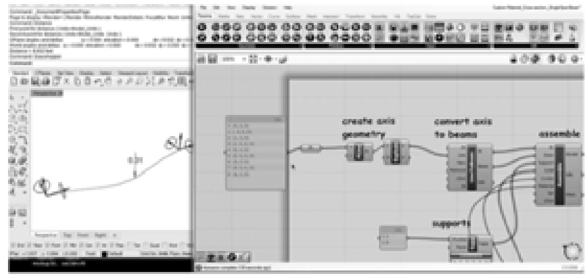


Fig. 4. Video tutorial for structural analysis

Video tutorials (Fig. 4) were created to introduce finite element structural analysis and material distribution optimization plugins for Rhino / Grasshopper. Students were required to integrate


Fig. 5. Students visited facilities of our industry partners, Gaston and Wyatt, fine furniture manufacturers.

performance analysis into the early stages of concept development to foreground the influence of material performance in their design decisions.

Knowledge Exchange

Frequent information exchange between the design studio and our project partners began with presentations by economic development students and a facilities tour of the industrial-scale manufacturing shop. This introduction provided a baseline focused on possibilities for future growth in the local economy and efficiency in manufacturing tools and processes.

A brainstorming workshop was conducted early in the semester to seek input from material scientists, mechanical engineers, biomedical engineers, architects, and our project partners. Students were asked to articulate the "design value" of their proposal related to the distinct material properties of wood.

Fig. 6. Brainstorming workshop

Project Execution

Students were required to develop material systems with dual- performance goals—for example, structural rain-screens, or light and sound diffusion panels. They were asked to find room for innovation within the limits of fabrication efficiency, local production opportunity, material properties, and performance.

Material Tools and Traditions

By experimenting with traditional wood-joinery techniques and equivalent CNC fabrication (Fig. 7), students produced a catalogue of efficient assembly options. Advanced techniques, like the CNC zip-joint developed for a five-axis router,

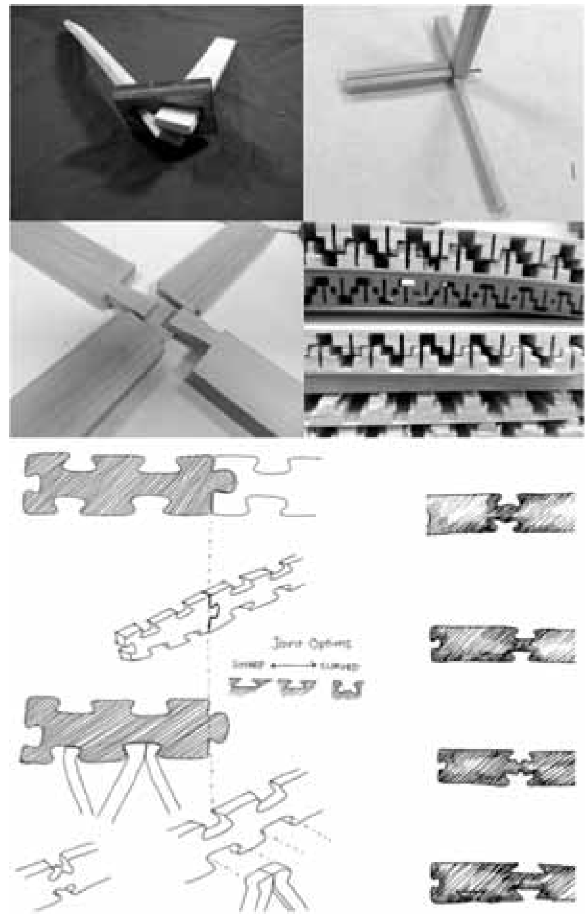


Fig. 7. Joint studies

were reinvented for production on local furniture manufacturing equipment.

Material Properties

Wood's unique inner structure, its grain or anisotropy, make its structural capacity dependent on direction and anticipated loads. Wood joints and members should ideally transfer load longitudinally. To reduce complex tensile connections, "timber framework members were [historically] arranged spatially in several layers letting them run continuously to produce a smaller number of connections." Student proposals built upon construction traditions with anisotropic behavior in mind.

Although our FEA structural analysis plugin (Karamba 3D) was not equipped to predict anisotropic behavior, student designs benefited from the digital analysis of member utilization, deflection, and overall equilibrium optimization.

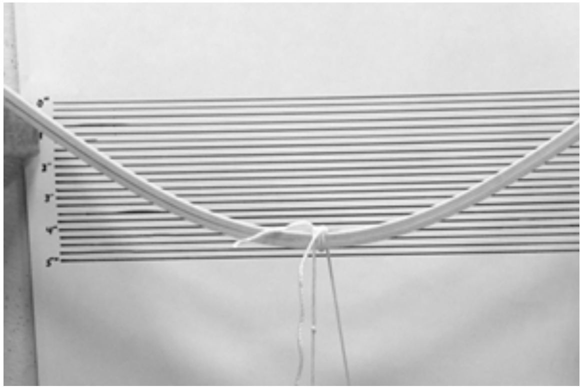


Fig. 8. Load tests were used to check digital model performance predictions and material properties.

Attempt and Improvisation

Three student projects highlight the potential of this studio methodology. The first, "Isostatic Network" (Fig. 9) is a slab reinforcing system designed to optimize support along isostactic tension lines. This project required that the students balance structural analysis and resulting isostatic patterns with the potential for member repetition and production efficiency.

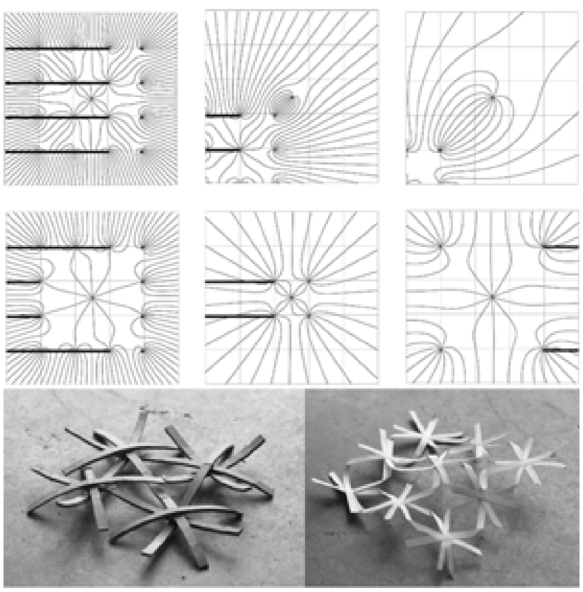


Fig. 9. Reinforcing matrix based on isostatic force lines

The next project used a Weaire–Phelan mathematical system to design a honeycomb façade screen with geometric stability (Fig. 10), evenly distributed support, and minimal material. Three-dimensional CNC joints were developed to streamline the otherwise complex production and joining system.

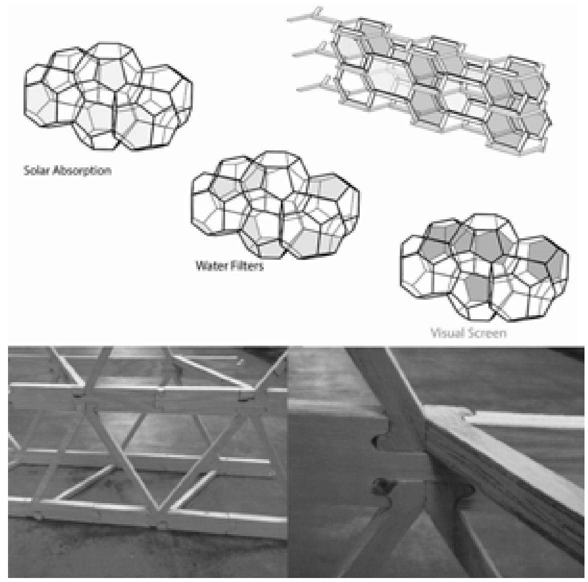


Fig. 10. Weire-Phailon honeycomb façade screen

Fig. 11. CNC Zip-joint and woven rain screen

Finally, a structural rain screen used an adaptation of the CNC zip-joint developed by Fabian Scheurer of design-to-production in 2007 (Fig. 11). Scheurer's method requires both a five-axis router and a veneer outer-layer to stabilize the final form. Students developed a script to step the zipper joint in a ziggurat fashion, enabling the use of a three-axis router more common to local manufacturing facilities. The prototypes were bent and stable without the need for steam heat or a veneer outer-layer.

Fig. 12. Final exhibition of student work, 2013.

Conclusions

The approach described above was developed based on methodology tested in the spring of 2013, refined, and repeated in the current semester (spring 2014). Two critical changes were made based on the first attempt. (1) Students are now creating material “mockups” but relying on an expert fabricator for full-scale final prototyping. This will enable collaboration between students and our manufacturing partner. It places constraints on efficiency and budget, and avoids the tendency for full-scale fabrication demands to overtake design exploration as deadlines draw near. (2) Students have now been provided with more detailed direction in the form of precedent and selected building functions to begin their material explorations. Based on these adjustments, the timeline for our fabrication-scale project is shortened from the entire semester’s work in 2013, to the first half of the semester in 2014. This adjustment allows time to translate material system, performance-based design methodology to the scale of occupiable building design.

By asking students to consider material tectonics as a culture with interrelated influences and traditions, this course promotes creative, rational design toward a relevant and open field of possibilities.

Notes

[1] Leatherbarrow, David. "Studies in tectonic culture: the poetics of construction in nineteenth and twentieth century architecture [by] Kenneth Frampton." Journal Of The Society Of Architectural Historians 56, no. 1 (March 1997). 98-100.

[2] Mario Rinke, Joseph Schwartz. “Force material form – transferring historical construction concepts into contemporary architectural design.” Proceedings of the Second International Conference on Structures and Architecture, Guimaraes. 2013. 1255

[3] Picon, Antoine. “Construction History: Between Technological and Cultural History.” In *Building Systems: Design Technology and Society*, edited by Kiel Moe. Routledge, 2012. p. 17.

[4] Wells, Matthew. *Engineers: A History of Engineering and Structural Design.* London, New York: Routledge, 2010. p. 22.

Backpedaling via Upcycling:
Sustainable Material-Logics as Re-Instigator of Foundational Studies

Meredith Sattler

Louisiana State University

foundation, *n* vs. Foun-dation, *v*

Beginning design educators are the first point of contact, for most students, into the codified endeavor of design. Serving as mediators between students' former educational pedagogy, their raw experiences of space / form / performance, and the specific modes within which they will eventually construct realities as designers, beginning design pedagogies and methods metaphorically lay their operative design foundation much as the foundations of buildings operate. Because of this, it is not coincidental given our discipline, that we utilize the term *foundational studies* with such vigor.

With equal vigor, this paper, which is not written by a beginning design educator, puts forth a gentile critique of architectural foundational design from the perspective of the upper division. Hovering 4000 - 5000 levels above the building's foundation is a highly precarious position from which to reimagine foundational design pedagogies widely deployed in schools of architecture today. In advance, the author acknowledges her naiveté, as she has yet to experience the challenges of foundational design education first hand, and requests forgiveness for any misinterpretations, false assumptions, etc.

That said, this paper is born of alarming observations and experiences gained teaching an upper division sub-architecture scale design / build seminar based on sustainable (recycling) material flows and logics. Over the course of this three credit design / build course, a reinterpretation of an *Issues in Sustainability* seminar (which previously utilized historical and theoretical frameworks that facilitated student output predominantly in the forms of textual, oral, and drawn) the professor's expectations about students' basic abilities to engage full-scale three-dimensional material logics were severely challenged. In order to unpack the particularities of this breakdown in the relationship between materiality and foundational study, definitions of the noun *foundation* are useful:

6. a. A basis or groundwork on which something (immaterial) is raised or by which it is supported or confirmed; an underlying ground or principle; the basis on which a story, fiction, or the like is founded.[1]

Over the course of the term it became increasingly evident that the fourth and fifth year undergraduate students' studies up to this point did not include significant exposure to working with materials at 1:1 scale. They were lacking conceptual frameworks and *hands on* experience analyzing materials for their inherent structural, connective, and (by and large) formal potentials. Ultimately, they had little understanding of how to deploy the few tools they did possess in the development of sophisticated designed interventions through a rigorous modeling and prototyping processes. The emergent reality demonstrated that an (assumed) foundational pedagogy of material logics and intelligence—one of the basic underlying *principles / stories* of the discipline of architecture—had been lost somewhere.

6. b. A ground or reason upon which men act; an understanding, basis of agreement. Obs.[1]

Because this *foundation of materiality* was not present, students had little ability to work through a materially driven design / build process with any sophistication. This was evident in many of the students' individual work, and was compounded in their group work, as common languages, methodologies, and mechanisms to share understanding did not exist, and in some cases never developed during the process of actualizing the project.

6. c. pl. [translating German grundlagen, etc.] The underlying principles or logical basis (of a subject), esp. as a separate matter for study.[1]

In order to address this situation as contemporary educators, the author proposes calling out foundational studies in materiality as a distinct pedagogy in order to ensure it is adequately addressed, and not lost, within foundational curriculums.

During the last thirty years, in many architecture programs across the nation, this foundation of materiality has slowly eroded as architecture has increasingly transitioned into a discipline more consumed with the justification for making buildings, and the representation of the instructions necessary to build them, than the actual material building process / product. It is possible that reasons for this erosion include increasing pressure to incorporate diverse strategies, tactics, and tools from our ever expanding smorgasbord of disciplinary knowledge. These tactics and tools may have ultimately accomplished more distraction to the primary principles / stories of architecture that added value to their foundational study. The author also speculates that students who have grown up in a digital age where significant amounts of time are spent occupying virtual worlds where gravity and physicality are, for the most part, not present, may need more rigorous exposure to the physicality of materials than past generations of students.

That said, creating a separate sub-discipline of materiality must not occur at the exclusion or expense of other critical foundational studies (both analog and digital components of the smorgasbord) such as seeing / drawing, spatializing / modeling, analyzing / representing, critically thinking / communicating, etc. Instead, these contents and modalities would best be put into service of our disciplines' primary objective: to create physicalized objects that are embedded and responsive within their larger systemic environments through the construction of grounded realities, a task that is deeply material in disposition. Here the Oxford English Dictionary may provide a useful twist on the word foundation:

foun-dation v. Obs. To ground.[1]

A *Foun-dational* sub-discipline emphasizing the understanding of gravity and other physical forces / behaviors in relationship to material properties may counteract the unintentional consequences of growing up in the digital age. Ideally *Foun-dational* studies would incorporate mixed and hybrid modalities in order to unpack and mobilize the design of sophisticated built interventions via the development of modeling and prototyping processes. Further discussion and strategies for accomplishing this are subsequently detailed in the *Backpedaling* section of this paper.

[UP]cycling > [down]cycling

In order to further detail the argument for *Foundational* studies, it is necessary to first contextualize the course from which the observations emerged. The seminar, titled *[UP]cycling > [down]cycling*, was constructed as an attempt to facilitate a design / build experience for an expanding group of upper division students who were becoming increasingly outspoken about the need for design / build within a curriculum not currently structured to accommodate it. The seminar hybridized design / build with sustainability through the lens of recycling (think architectures of a materially-limited future) to simultaneously fulfil the school's curricular requirements and the students' expressed needs. The theoretical underpinnings engaged to argue this hybridization employed dialogue about material reduction and efficiency: "...there is a miniaturization of matter and miniaturization of performance."[2] (Soleri's intent here is positive) which can initially be explored and understood at the more manageable sub-architecture scale, then later incorporated back into full architecture scale.

The course met once a week for three hours and was conducted as a seminar, in the original German fashion--to a certain extent the students took responsibility for generating much of the course content under the guidance of the professor. Seminar content included basic theoretical and practical application of general sustainability disciplinary knowledge, and advanced content specifically related to the processes of upcycling, recycling, design for disassembly, and downcycling. Explored through examinations of relationships between material life-cycles, formal, and operational dialogues of exchange, adaptation, access, agency, inclusion and phenomenon, the work of the Dutch firm *SUPERUSE Studios* was regularly engaged. Other critical influences came from Bill Addis, Benjamin Aranda, Nishat Awan, Adriaan Beukers, Michael Braungart, Gro Harlem Brundtland, Myron Guran, Ed van Hinte, IDEO, John Kolko, Chris Lasch, Kiel Moe, William McDonough, Peter Pierce, Tatjana Schneider, and Jeremy Till.

The seminar pedagogy, process, and production was illustrated in the syllabus as *Design, Recycle, Build, Recycle...*

Thinking - upcycle materials
Studying
Sourcing
Thinking – stakeholders
MAKING
Thinking – program
Thinking – site
MAKING
Sourcing
Dropping scale
MAKING
Thinking - material intelligence
Analyzing
Thinking - structural geometric logics
MAKING
Dropping scal e
MAKING
Thinking – connections
MAKING
Analyzing
Thinking - parts to whole
MAKING
Dropping scale
Analyzing
MAKING
Thinking – detail
Dropping scale
MAKING
Prototyping
Analyzing
MAKING
Representing
Installing
Documenting
UNMAKING
Recycling

Despite the professor's structuring of content, delivery, and design process, her preconceived notions of the manner in which the course would unfold were challenged throughout the design / build component. Relatively consistently the students would experience *a ha* moments of realization out of sequence with course structure, which forced the establishment of feedback loops requiring a delicate balance between informal re-sequencing / rescheduling and adherence to a more typical upper division regimented design process. This play between flexibility and adherence to the schedule proved critical in facilitating more sophisticated student work within the 12 weeks between the course start and the exhibition installation.

The course began with precedent analyses of upcycled pieces of architecture or sub-architectural scale components and examinations of material flow research and representational strategies. Students mapped material flows, created local harvest maps, sourced, and procured the materials they would eventually upcycle into their interventions. Then Belbin Team Role Questionnaires[3] were utilized to build four teams of four students each. Much of the remainder of the semester was organized around team work including several rounds of stakeholder research to inform the determination of siting and program and the design /build process. It is here that problematic issues related to the lack of *Foun-dation* emerged, which necessitated a shift from what was previously an upper division seminar course format into a beginning design studio.

Over the course of the next eight weeks, the students were to produce at least fourteen models and a 1:1 prototype, each week dropping in

Fig. 1. Seen as presented in class: successful 1:1 experimentation, and less successful ½" and ¼" scale models of possible water bottle / newspaper configurations and joints. Image credit: Carolina Rodriguez.

scale. They were also required to continue to experiment formally and performatively with their sourced materials at 1:1 scale throughout the eight week design phase.

The first weeks were focused on resolving issues of site and programming. After two weeks of surprisingly poorly informed model production at 1/16" and 1/8" scale, the professor required the students to build a 1/8" scale model of the whole site and to model within the site. Strategies for extracting critical material properties from their source materials at 1/8" scale were also discussed, as were methods for translating these into the selection of appropriately performative model making materials. In most instances, this translation was never successfully actualized, and in two cases, siting was not resolved until the students reached the 1:1 prototype scale.

The simultaneous 1:1 experiments initially facilitated critical understandings of material properties and behaviors. But as time went on, these experiments remained relatively unsophisticated; therefore, students were required to draw analytical diagrams of their experimental material configurations and to photograph their results. These documents were discussed in class, and students were continually encouraged push the material into new directions based on interesting results obtained from their experimentation.

Next the students dropped to ¼" scale while simultaneously reading and discussing texts by Peter Pierce and Myron Guran on the inherent structural and organizational properties of geometries. The professor strongly encouraged the students to model their materials digitally or to produce measured / constructed drawings by hand in order to better understand inherent geometries and their structural, organizational, and connective potentials. The students did not put significant effort into these models / drawings to a large extend because they did not understand the importance of the information they would glean from the process. For two teams, the realization of the value of these drawings came one month later as they were working at half and full scale. The ¼" scale model material selections showed significant improvement over the 1/8" scale, but in most cases were still lacking in critical material translation. Because of this, the models were not able to effectively develop structural and organizational strategies relating to siting and program.

The drop to ½" and 1" scales was designed to initiate explorations into potential joint locations and configurations. The students were designing for disassembly, and therefore were not permitted to utilize any adhesives or fasteners that were not native to their material. This proved particularly challenging, but in the end, the joinery was the component of exploration that the students gained the most sophisticated understanding of the process / product relationship. Much of this is attributed to the fact that the joints are literally the *make or break* critical component of the structure. Here, the students were starting to realize the distinct possibility of failure, which was a highly motivating factor.

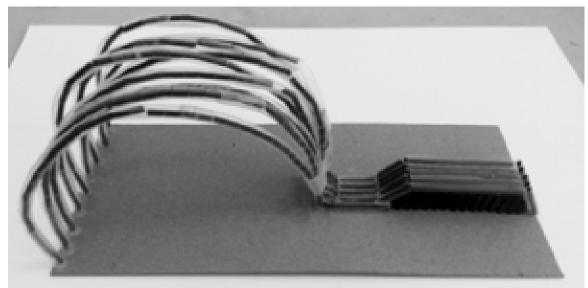


Fig. 2. ½" scale water bottle and newspaper structure / form model. The material properties and construction techniques utilized to make the model are not performative facsimiles of the team's component detailed in Fig. 3. Image credit: Tyler Detiveaux.

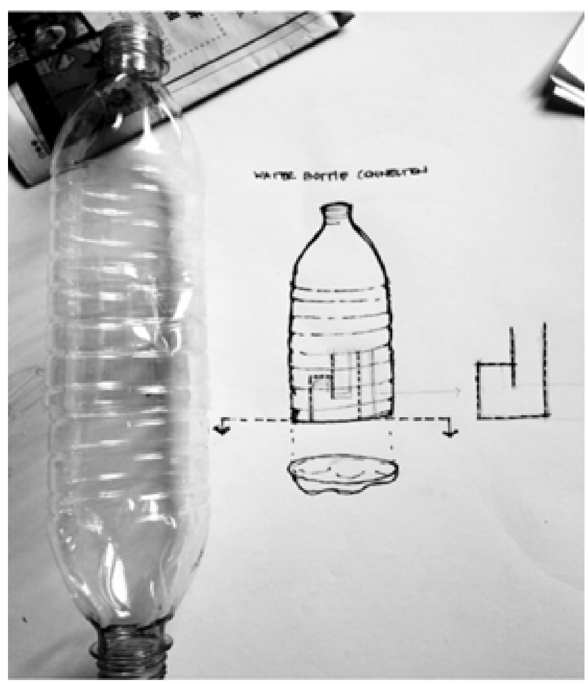


Fig. 3. Water bottle tab joint system in development. Image credit: Carolina Rodriguez.

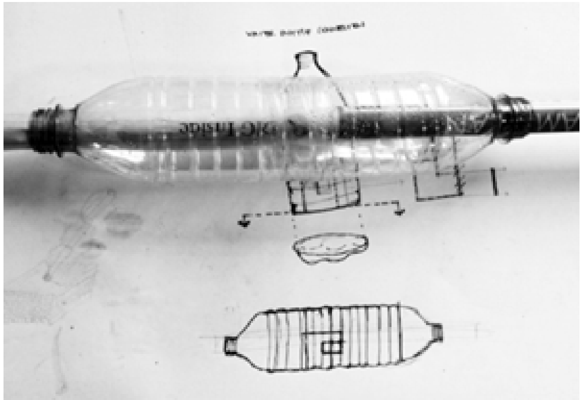


Fig. 4. Water bottle tab joint system with newspaper structural element inserted. Image credit: Carolina Rodriguez.

The drop to ½ scale was one of the least successful across the board; most teams did not actually produce any models at ½ scale, instead they went tentatively into 1:1. Teams were concerned about utilizing too much of their sourced material in these final modeling exercises, which led them to building very small mock-up components of their final interventions.

1:1 prototyping similarly took on a somewhat fearful stance about material usage. Most of the prototypes became the final installed works in the exhibition despite the fact that the students were briefed on the necessity of being able to obtain enough material for 1:1 experimentation throughout the term, prototyping, and final production. Lectures, precedents, and discussions on the prototyping process addressing the difference between industrial design prototyping and architectural scale prototyping (highlighting Renzo Piano's full scale mock-ups) proved to be informative, but had little effect on the final stages of production. This lack of iteration was an issue throughout the deign process, and contributed to unresolved issues in the final work.

Ultimately, each team completed and installed an end design / build product: a structural intervention composed of only upcycled materials that complied with IBC, state, and local code that was exhibited in the University's Recreational Facility for three weeks. Each team also developed an exhibition document from their material and stakeholder research which discussed the larger upcycling / recycling implications of their product, their design process, and any attributes of their intervention they chose to highlight.

The students spent the remainder of the term working as individuals on documentation and developing final portfolios of the semester's work. They participated in a lighting workshop and professional photography lighting was made available for their use. They produced as-built drawings detailing assembly and performance, and had group and one on one portfolio spread reviews.

Backpedaling

Despite the fact that *[UP]cycling > [down]cycling* was an upper division course, components of what became the primary content, particularly the previously identified *beginning design studio* component, might be highly appropriate for *Foun-dational* studies. Through the process of re-tooling a sustainability course to deliver both design / build and sustainability content, it became clear that sustainability is an excellent lens through which to explore design / build. Not only were several practical barriers to facilitating design / build education overcome, additionally unique opportunities for framing *Foun-dational* design were discovered:

Supplying materials with no budget:

Students were required to source and utilize only recycled materials; they had to ensure that their sources would yield enough material to complete design and construction within twelve weeks of the semester. This ensured that material needs would be met in a context where there was no budget.

Manpower:

Because the course was a professional elective worth three credits, half the amount of a typical studio, the students time commitment, and their studio schedule, had to be deeply respected. The exhibition was installed approximately four weeks before the end of the term, well in advance of studio final reviews. All of the stakeholder research and design / build components of the course were done in teams of four students in order to mitigate the workload. Teams of four were ideal: there were enough bodies to get the work done but not so many that it was easy for the workload to be unevenly distributed (students couldn't *hide* easily in groups of four). One team lost a member half way through the design / build component, and proved to be a bit short-handed during production.

Assessment:

Each student was assessed based on both their team work (55%) and the work they did as individuals at the beginning and end of the semester (45%). The team work assessment was a combination of both the professor's assessment, and results from blind peer-review surveys distributed within each team.

Safety and code regulations:

Students were required to adhere to all code and safety requirements imposed by the state, the city, and the university applicable in the Student Recreational Facility that their interventions were designed / installed into; additionally, they were explicitly required to avoid any Fire Marshal investigation / intervention. This ensured that the scale of each project was reasonably accomplishable by four person teams, that all projects were robust enough to hold up over the course of the three week exhibition, and they were able to be installed and de-installed utilizing only small equipment and within reasonable amounts of time.

Fig. 5. Strength testing seating mock-up. Image credit: Meredith Sattler.

Ensuring material intelligence is engaged:

Students had to upcycle these recycled materials into their final design / build interventions, then recycle the interventions at the end of the term; therefore, they were not allowed to utilize any adhesives, fasteners, or other connections that would hinder the disassembly and recycling of their interventions. If their interventions took the form of seating, they had to support multiple individuals that weigh up to 300 pounds for the entire three week exhibition duration. This ensured that students had to grapple with logics of structure and the conceptualization and construction of joinery that corresponded to the material logics of their chosen material(s).

As previously mentioned, ideally *Foun-dational* studies would incorporate mixed and hybrid modalities in order to unpack and mobilize the design of sophisticated built interventions via the development of modeling and prototyping processes. Digital tools, particularly three dimensional modeling software, can effectively facilitate understandings of relationships between form and spatial organization, which ultimately lead to insights about connection placement, form, and appropriate connection performance. Because these softwares often require the utilization of platonic geometries in the modeling process, students are forced to locate and map geometries within the raw materials they are working with. This knowledge can then effectively be leveraged in conversations about inherent structural and organizational properties.

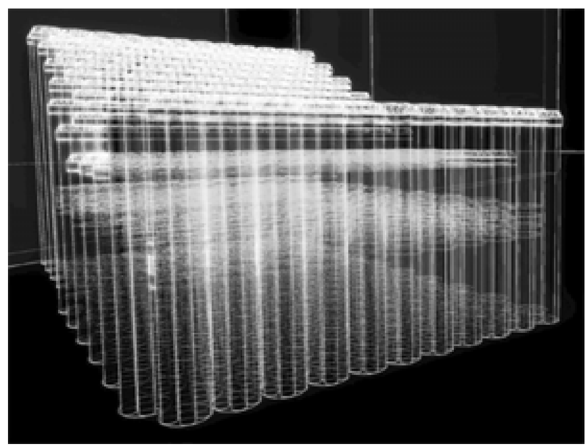


Fig. 6. Water bottle / newspaper lounger seat surface contour was developed utilizing grasshopper 3DM. Close-packing strategies were also analyzed both digitally and physically. Image credit: Tyler Detiveaux.

Both digital and hand drawing can also be leveraged as excellent tools for seeing, analyzing, and communicating performative characteristics of materials and whole interventions at multiple scales. These can be deployed particularly effectively at times when students are *blocked* in their design process. Final documentation drawing sets can also illuminate additional discovery post-design process, and greatly assist students in transitioning from *physical making* (1:1) design methodologies into more contemporary methodologies that rely heavily on drawing and modeling to scale.

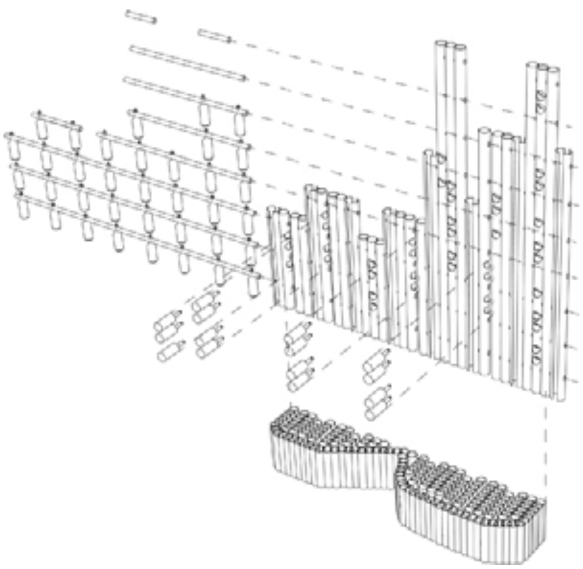


Fig. 7. Plotter paper tubes / tequila bottle assembly diagram. Image credit: Andrew Layman.

In the End…Which Constitutes the Beginning

Design process occurs predominantly via modes of representation which are inherently abstracted from materiality at 1:1. Most beginning design students enter their study with little prior knowledge of material or tectonic logics; hence, are ill-equipt to begin designing in abstracted representational modes without first gaining exposure to material intelligence at full scale. Often this disconnect between representational strategies and the reality of built form persists into upper division. Here, we have argued that 1:1 design / build is a critical component of formative design education and have proposed a methodology fusing sustainability ethos and material intelligence with "learning by doing" (*Foun-dation*).

Sustainability is a critical component of this *Foun-dational* study, providing a critical lens through which to explore design / build both theoretically and pragmatically. Beginning design students arrive in studio armed with enough knowledge and experience to engage meaningfully with topics and activities such as basic analysis of material flows within urban ecosystems and stakeholder guerilla research. These, combined with guided instruction in analysis of theoretical readings, material intelligence, and methodologies for incorporating the former to inform the design of architectural responses to a materially-limited future render *Foun-dational* studies not only plausible, but necessary. It is only through the direct engagement with materiality that full scale design / build facilitates: tactile experience of relationships between formal logics and material properties, structural integrity, logics of connection, and crafting intentional haptic experience within existing contexts, that we will once again ground architectural education, and propel it into the sustainable design paradigm of the twenty-first century.

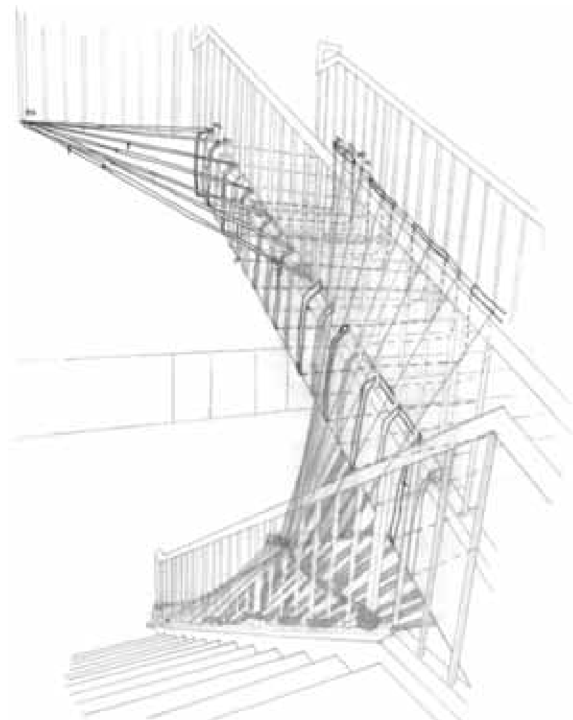


Fig. 8. Bike innertube tire installation drawing detailing structure, form, and weaving order (top right of drawing). Image credit: Lindsay Boley.

Acknowledgements

The author gratefully acknowledges the support of the State of Louisiana Board of Regents and the Louisiana State University School of Architecture. The authors wish to thank Carolina Rodriguez and Eric Weber. This paper was presented at the 2014 NCBDS 30 : IIT Conference. The contribution of the current and previous NCBDS conference organizers and committees is hereby gratefully acknowledged.

Notes

[1] Oxford English Dictionary, accessed February 5, 2014.

[2] Paolo Soleri. Arcology: The City in the Image of Man. (Arcosanti: Cosanti Press, 2006) 12.

[3] http://www.belbin.com/, accessed August, 2013.

Spiritual Tectonics:
Exploring Dualities in the Design Studio

Chad Schwartz

Southern Illinois University – Carbondale

Introduction

Systemic thinking is the process of understanding how systems or components influence one another within a whole. It is a way of thinking that "emphasizes connectedness,"[1] enabling the thinker to see beyond discrete elements to the relationships these elements have with each other. The practice of architecture requires a systemic mindset. Even the simplest constructions are composed of myriad integrated systems at the scale of the site, the building, and the detail. While navigating the design process, architects must understand the complex interactions of these systems within a given project.

So, how is systemic thinking introduced in academia? The traditional bifurcation of architectural education does not always provide an integrative philosophy. The separation of the curriculum into design and technical courses is, in many ways, a significant deterrent to the examination of architecture systemically. This deterrent is especially prevalent in lower level courses, which tend to have more focused learning objectives and a far less comprehensive character than upper division and graduate coursework.

The study of architectural tectonics, on the other hand, is a systemic endeavor. From Kenneth Frampton's statement that tectonics is "the formal amplification of the structural presence in relation to the assembly of which it is a part;"[2] to Gottfried Semper's claim that the origin of architecture is not construction, but the visible representation of closed space originating from human dress;[3] to Karl Botticher's theory of the ontological kernform (work form) and its cladding of the representational kunstform (art form);[4] the view of architecture through a tectonic lens depicts the poetic integration of assembly, materiality, representation, space, and environment.

Though the potential for studying architecture as a series of systems exists in any curricular construct, without strategies in place to discuss the dialogue between the systems, systemic thinking cannot occur. Tectonics provides an opportunity to create links between systems that may otherwise be held separate for a novice architecture student. In a recent studio, a group of architecture students was asked to approach design from a tectonic point of view. Through a series of linked studio exercises centered on the design of spiritual space, these students were given the opportunity to systemically explore architectural design. For these individuals, tectonics provided the opportunity for new avenues of insight into the design and construction of the built environment.

Tectonics and Sacred Space

At the beginning of the semester, the students were given a 'tectonic primer' that served as a conceptual outline for the class. This primer contained a series of quotes or passages taken from a wide variety of sources and was organized into topical sections (the four elements, the ontological and the representational, the joint, etc.). Although the full gambit of tectonic theories were presented and open for exploration in the studio, the students were asked to specifically consider one particular aspect of architectural tectonics during their time in the course: the pairing of tectonic assembly and the stereotomic mass.

There are two distinct material procedures in the realm of tectonics. First, the tectonics of frame in which members of varying lengths are conjoined to encompass a spatial field. And, second, the stereotomics of compressive mass in which identical mass units are piled and stacked. These two systems are cosmological opposites (earth vs. sky, solidity vs. dematerialization, dark vs. light, rough vs. smooth) and there are ontological consequences in choosing to build with one over the other. Typically the framework tends toward the aerial and the dematerialization of mass, whereas the mass is telluric, embedding itself ever deeper into the earth.[5]

Here, Frampton positions the tectonic as dualistic. This same sentiment is echoed by Emilie

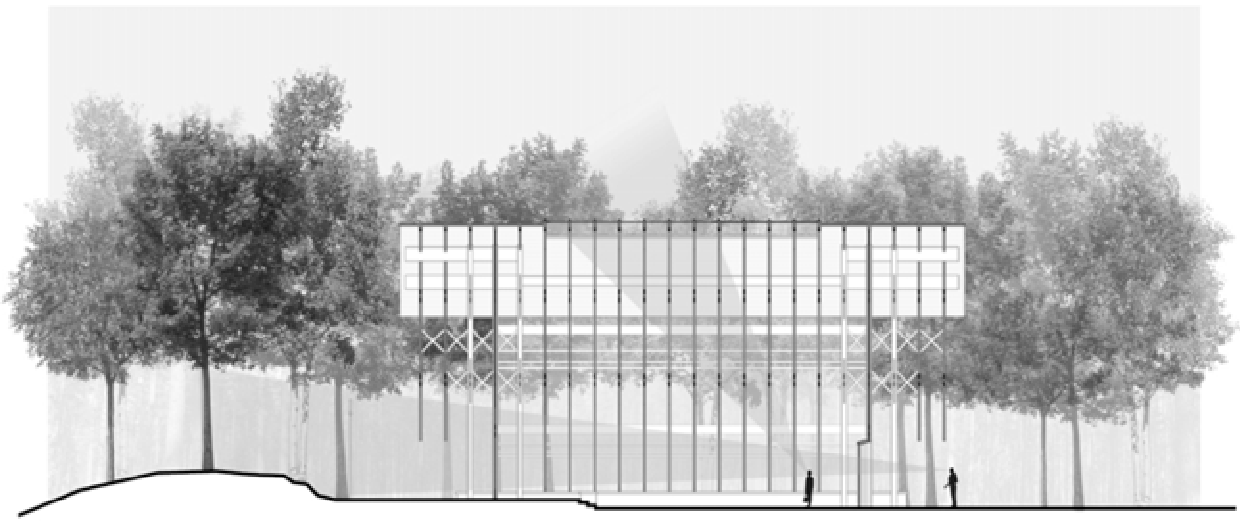


Fig. 1. Sectional Diagram of Thorncrown Chapel (by author)

Townes in "Constructing the Immaterial," but with respect to the sacred. Townes posits that the power of the sacred "radiates from the center with centrifugal force, but it also returns centripetally."[6] She continues by stating that sacred architecture must recognize its position at this center, "an axis between earth and sky."[7] Duality provides a link between the tectonic assembly of space and the immateriality of the spiritual.

Townes notion of the sacred center is also embedded in Gottfried Semper's analysis of the Caribbean hut. In this analysis, Semper classifies the four elements of architecture as the framework, the enclosing membrane, the earthwork, and the hearth. This classification system gave significant importance to a non-spatial element - the hearth - which is considered a component of the stereotomic mass. For Semper, the hearth, as a designation, "incorporated in a single element the public and spiritual nexus of the built domain."[8] The hearth is at once material and immaterial. It is the center of place, with its origins in the marking of the earth to signify occupation or settlement.

A third connection between the sacred and the tectonic stems from our ability to develop empathy with static form. Robert Vischer provides the example of a looming cliff face, which stands proudly at attention and seemingly in defiance; its outward projection instills the feeling of a lunging forward, perhaps in curiosity, perhaps in anger.[9] The ability to empathize with the physical forms of the world around us comes from our own physical embodiment. We have an innate understanding of gravity and strength, of pressure and release.[10] This understanding also allows for architecture to manipulate our empathetic reactions to achieve a heightening of immaterial experience like spirituality.

This effect is evident in a plethora of sacred structures, including Fay Jones' Thorncrown Chapel. The transparency of Thorncrown Chapel draws your eyes first through and out to the forest. But, upon entering the structure, your gaze turns upwards towards the sky and the heavens, guided by the rising slender columns and eventually trapped within the latticed canopy suspended overhead (Figure 1). As Daniel Willis has claimed, "Not since the roof vaults of the Gothic cathedrals had an interior architecture so willfully drawn our imaginations skyward."[11] An analysis of this project reveals a significant intersection of the tectonic and the spiritual; and it is with this analysis that the studio commenced.

The Studio

This third year studio was structured as a series of five interlinked problems, each building on and connected to those preceding it. The problems were choreographed with the hopes of providing a meaningful learning experience for the students. As they progressed through the series, the students were asked to work at different scales (the site, the building, the section, the detail) and in different mediums (sketching, modeling, digital drawing and production, full scale construction), encouraging a varied working perspective in addressing issues of tectonics, constructability, spirituality, and context (the primary focus of this semester's studio sequence).

Each problem also began with a reading related to its topic. These essays ranged from Frampton's "Botticher, Semper, and the Tectonic: Core Form and Art Form," to Juhani Pallasmaa's *The Eyes of the Skin*, to Moshe Safdie's "The Architecture of Memory: Seeking the Sacred." For each reading the students wrote a 300+ word statement illuminating the author's critical idea(s) that could be used in the development of the problem. These writing samples were then discussed in a student-led dialogue about the reading.

The first problem provided the foundation for the studio. In this problem, each student selected a case study project (via lottery) from a provided lot. Each case study was a small, but meaningful chapel or other religious structure (referred to from this point as chapels). They encompassed a variety of different religions and were scattered across the globe; some were well known and others somewhat obscure. Instead of choosing from of a written list, the students were presented with an image of the primary spiritual space (sanctuary) of each chapel. After a quick examination, the case studies were chosen based on the images. The students were then given time to do preliminary research, having until the end of the first class period to keep their selection or exchange it for one of the remaining unclaimed images.

In this problem, the students were responsible for a thorough analysis of the case study chapel, but with a focus on the expression of the tectonic and stereotomic. The analysis work was accomplished through diagramming, but the students were also responsible for creating original drawings of the space (plan and section) and building a model of a critical section of the work (Figure 2).

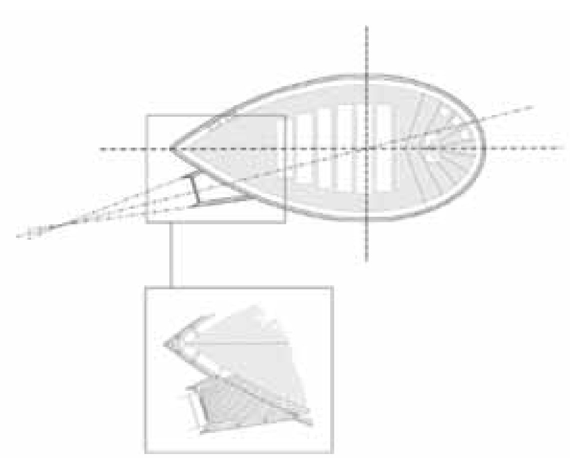


Fig. 2. Entry sequence analysis of Peter Zumthor's St. Benedict chapel (B. Beckman)

In the second problem, the students were asked to design a device which would, at a minimum, allow a visitor to pause and rest while at their case study chapel. This intervention could be located anywhere in or around the chapel, but had to respond directly to the tectonic conditions and other characteristics of the building they found through their analysis in problem 1. Most of the students, not surprisingly, interpreted this assignment as a bench or chair with the notable exceptions of a lectern and a portable, rolling mat for sitting on a grassy slope outside the sanctuary.

This problem shifted the scale of investigation from that of the building in the first problem to that of the detail in this problem. The impact of 'zooming in' was magnified by the requirements for presentation: the designed interventions were required to be built at full scale (Figure 3). Having to not only resolve the design of the whole, but fully construct it required an attention to detail that promoted a more thorough examination of the assembly and detail of the case study project. Contextually, the students also not only needed to consider the existing building as a

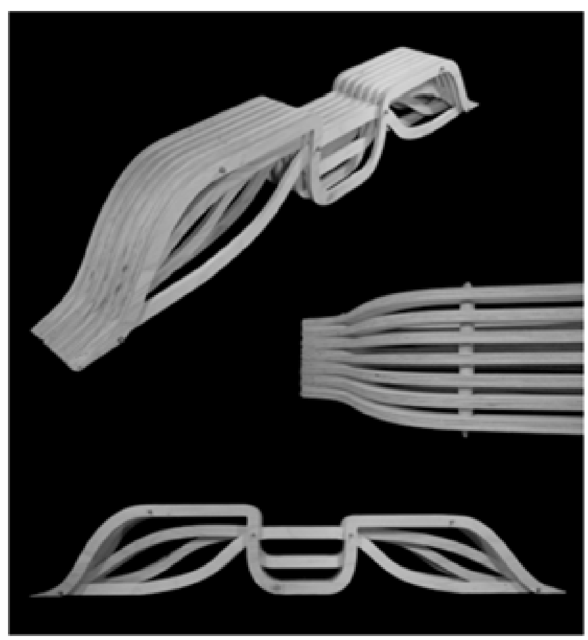


Fig. 3. New bench for Sanaksenaho Architects' St. Henry's Ecumenical Art Chapel (S. Abell; images by author)

context for inspiration, but they also had to consider their own bodily interaction with the piece as a driver of the tectonic assembly of the whole. Despite a lack of precision craft skills, the class admirably took on the challenge of problem 2 and most of the students were able to design and build interventions that appropriately inhabited the case study chapels.

The transition from problem 2 to problem 3 was the least structured in the course. In problem 3, the students were told that the governing board of their case study chapel had decided to establish a new chapel, temple, synagogue, etc. in the town of Carbondale, IL. For this exercise, each student had been fictitiously hired by this group to locate a new site for the facility within the city limits of Carbondale. For the first half of the problem, the students were divided into groups, each analyzing the region through the lens of the sacred, infrastructure, socio-political, or environmental context. Then, in the second half of the problem, each student selected a particular site in Carbondale that would best suit the needs of the client as interpreted from the earlier analysis of the case study project. Once again, the scale of investigation changed as well as the perspective on the project.

With a site selected, the class moved on to problem 4. This problem brought together all of the elements from the first three problems, had the longest working timeframe, and served as the course's apex. On the chosen site, each student was required to design a small religious building; a rudimentary program was provided to build upon. Inspiration for the design of this place was to be drawn from the analysis of the case study project in problem 1, from the construction of the intervention in problem 2, and from the context of the site chosen in problem 3. The problem statement posed several questions to the students: What is the purpose of a chapel? What is the narrative of the place? How does the tectonic expression of the building reflect its purpose? And, how is it contextually driven?

This problem asked the students to work both at the scale of the site and of the building with the students producing traditional scaled drawings and models of their work. The primary difficulty for the group centered on interpretation. Most of these students had never relied so heavily on the study of an existing project in their past courses. In this studio they were cautioned early and often to not copy the existing architecture, but to be inspired by the lessons it had to teach. This line of thinking proved to be a struggle for some of the students. Many, however, were able to use the lessons of the case study project to inspire their own designs; the student's work built on central tectonic and religious themes, massing strategies, lighting qualities, relationships to the context, and circulation patterns (amongst many others) (Figures 4 and 5).

Problem 5 continued the design of the project started in problem 4, but zoomed back in to more closely examine a small part of it. First, each student was required to select a specific section of his or her project in which the tectonic and experiential qualities of the design could be felt the strongest (for instance, a prominent corner of the building) (Figure 6). The objective was then to figure out how to build this small piece of the previously schematically designed project. Using the critique from the review of problem 4, the students were encouraged to continue designing this area of the building, albeit in relative isolation from the whole, in order to more carefully examine the relationship between design and construction.

Fig. 4. Chapel interior inspired by Studio Tamassociati's Meditation Pavilion (B. Macander)

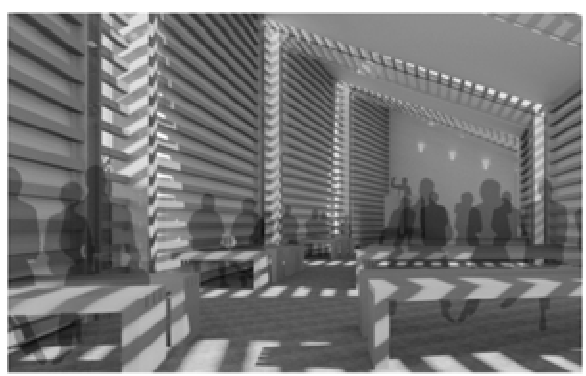


Fig. 5. Chapel interior inspired by the Rural Studio's Yancey Chapel (P. Mckissack)

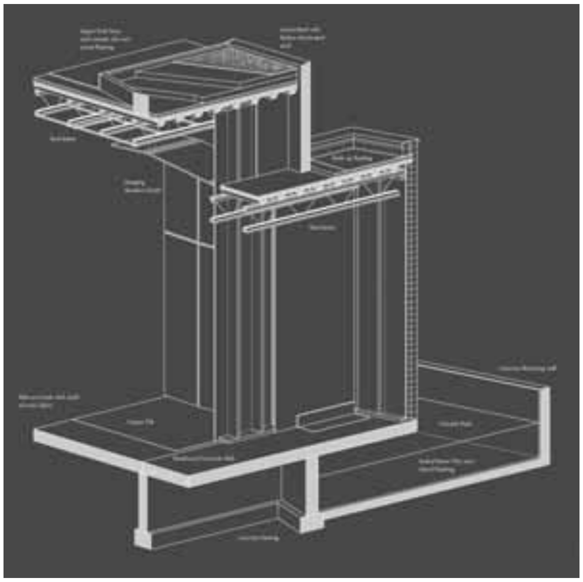


Fig. 6. Chapel building section isometric (A. Neal)

After this section was developed the students chose a detail from within that area and built it at full scale. The detail was required to express the aesthetic and tectonic qualities of the whole and contain the intersection of multiple systems. Once again, the shift in scale inward to the section and to the detail provided the opportunity for a more insightful learning experience for the class. Unlike problem 2 in which the students built a fully realized, free-standing piece, in problem 5 they were creating a very small part of a larger whole (Figure 7). The contextual relationship between part and whole, expressed thoughtfully in the problem's key reading from Marco Frascari, provided the terminal learning experience for the course. This problem provided the capstone for the semester's experience, illuminating the connectivity illuminated through the examination of architecture through a tectonic lens (Figure 8).

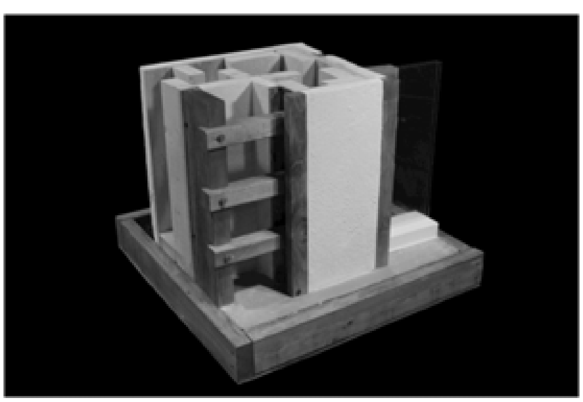


Fig. 7. Building detail - Corner of wall at window (P. Mckissack)

Reflections

This course was a first attempt at thoroughly integrating tectonic investigation into the pedagogical construct of a design studio. The hope now is to build on the lessons learned here in future courses and further this early success. In general, the student response to this avenue of learning was excellent. On the course evaluations, the students rated the educational experience and overall quality of the course as 4.84 out of 5.0 (96.8%). The statistical data was reinforced with written responses that praised the rigorous nature of the course, the linked problems that provided continuity through the semester, and the integration of theory and practicality in the design of the work.

Each student in the class found moments of success with the interpretation and translation of tectonic constructs. For many of the students, these connections were most successfully made in the transition between the case study analysis and the intervention problems (1 and 2). This transition was conceptually accessible and, coupled with the student's eagerness to build at full scale, provided a clear high point in the semester. Where thinking and making intersected engagement peaked, enhancing the dialogue about the work in the process.

There were, however, many challenges throughout the semester. The most significant of those was the translation of the case study to the problem 4 chapel. This studio marked the first time that the majority of the group had been asked to design with such a strong relationship to both a theoretical construct and a case study project. Problem 4 was the most complex problem of the semester and had a relatively tight timeframe. Although many of the students performed satisfactory on the project, the translation of the tectonic analysis of the case study projects was lacking in many situations. This deficiency could be alleviated in the future with a longer timeframe, which will require a restructuring of the other four projects. More time to contemplate the core ideas will allow for more significant connections between the theoretical ideas and the work.

Although unrelated to the tectonic analysis directly, the site selections made in problem 3 proved to be the weakest point of the course. The area from which to make the selections was too large and resulted in the selection of sites with little to no meaningful context from which to

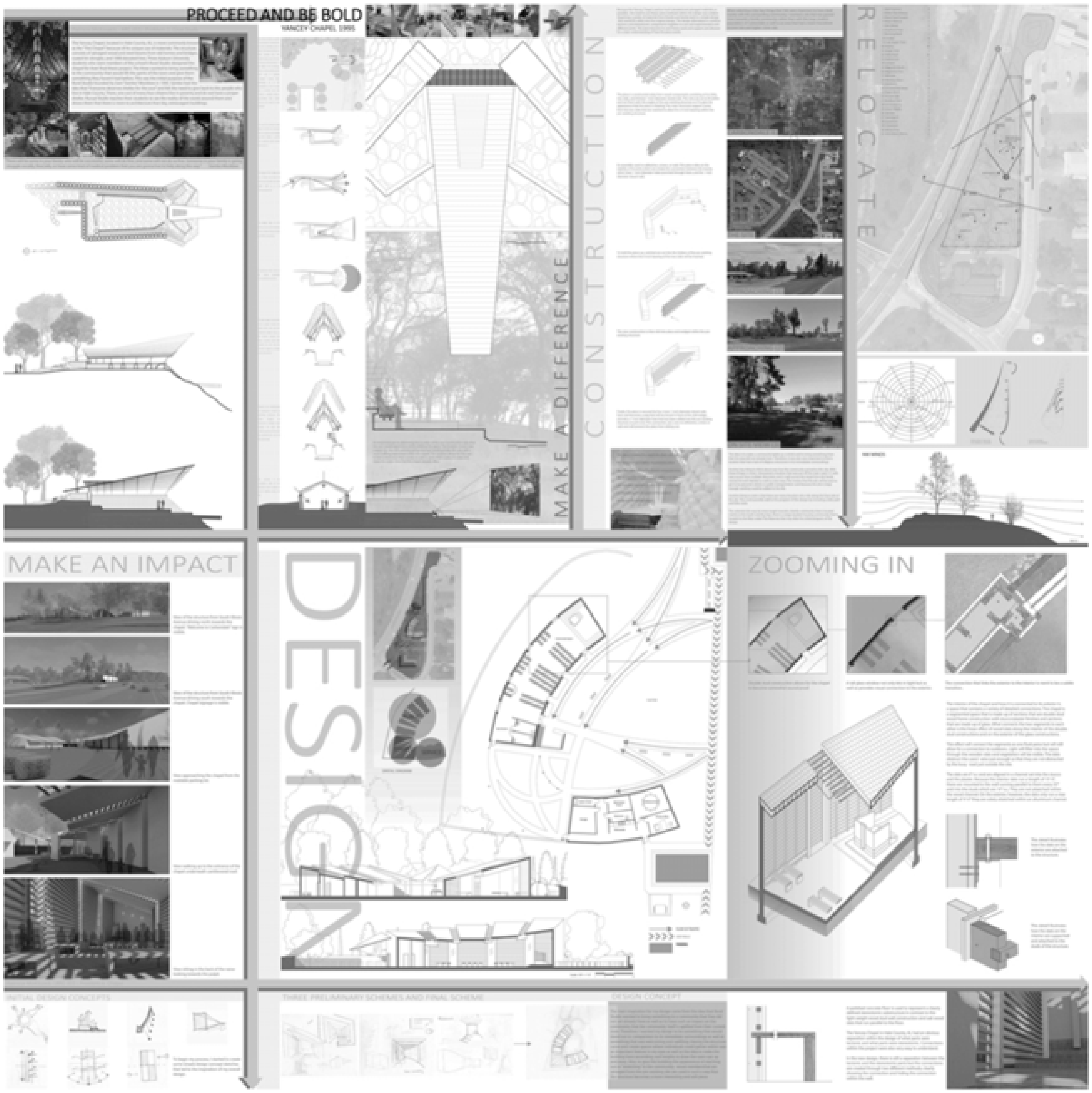


Fig. 8. Final presentation of all problems - Yancey Chapel case study (P. Mckissack)

draw a response. In some ways problem 3 also acted as a fissure in the semester, disjointing the early problems from the later ones. This problem was already somewhat unconnected from the rest of the set. A more tightly controlled selection process should assist in providing a better conduit between the early problems and those that come later in the semester and in reconnecting it to the pedagogical objectives of the course.

“Sacred architecture...helps people find meaning in the everyday experiences of their sufferings and joys, of their defeats and triumphs.”[12] But, how does it do this? That is the question this group of students was asked to explore for sixteen weeks. Through the lens of the tectonic, the students took on the challenge of understanding the relationships between the varieties of elements that make up the practice of architecture. Tectonics depends on the fundamental aspects of the world: gravity, the structure of the materials we use, and the ways in which we put these materials together.13 The learning experience in this class sought to build upon the nature of tectonics and help students understand the way we put architecture together and its impact on our experience of space. Through this process, the students were afforded the opportunity to not just understand the project type and theoretical model, but also the myriad contributors needed to create architecture with substance and, perhaps, soul.

Notes

[1] John Boardman and Brian Sauser, *Systemic Thinking: Building Maps for Worlds of Systems* (Hoboken: John Wiley, 2013), http://www.myilibrary.com?ID=504485 (accessed January 8, 2014), 5.

[2] Kenneth Frampton, “Rappel a L’Ordre: The Case for the Tectonic,” in *Theorizing a New Agenda for Architecture:* An *Anthology of Architectural Theory 1965-1995*, ed. Kate Nesbitt (New York: Princeton Architectural Press, 1996), 520.

[3] Caroline van Eyck, “Figuration, Tectonics and Animism in Semper’s Der Stil,” *The Journal of Architecture* 14, no. 3 (2009): 325.

[4] Kenneth Frampton, “Botticher, Semper and the Tectonic: Core Form and Art Form,” in *What is Architecture?*, ed. Andrew Ballantyne (New York: Routledge, 2002), 139.

[5] Frampton, “Rappel a L’Ordre,” 521-522.

[6] Emilie M. Townes, “Constructing the Immaterial: In Spaces Large and Small,” in *Constructing the Ineffable: Contemporary Sacred Architecture*, ed. Karla Cavarra Britton (New Haven: Yale University Press, 2010), 79.

[7] Townes, “Constructing the Immaterial,” 79.

[8] Frampton, “Botticher, Semper and the Tectonic,” 144.

[9] Robert Visher, “On the Optical Sense of Form: A Contribution to Aesthetics,” in *Empathy, Form, and Space: Problems in German Aesthetics, 1873-1893*, trans. Harry Francis Mallgrave and Eleftherios Ikonomou (Santa Monica: The Getty Center Publications, 1994), 105.

[10] Heinrich Wolfflin, “Prolegomena to a Psychology of Architecture,” in *Empathy, Form, and Space: Problems in German Aesthetics, 1873-1893*, trans. Harry Francis Mallgrave and Eleftherios Ikonomou (Santa Monica: The Getty Center Publications, 1994), 151.

[11] Daniel Willis, *The Emerald City and Other Essays on the Architectural Imagination* (New York: Princeton Architectural Press, 1999), 211.

[12] Miroslav Volf, “Architecture, Memory, and the Sacred,” in *Constructing the Ineffable: Contemporary Sacred Architecture*, ed. Karla Cavarra Britton (New Haven: Yale University Press, 2010), 65.

[13] Carles Vallhonrat, “Tectonics Considered: Between the Presence and the Absence of Artifice,” Perspecta 24 (1988): 123.

Between Isolation and Integration:

Systems, Materials, and the Beginning Design Student

Jerry L. Stivers

Oklahoma State University

Introduction

The practice of architecture is rapidly being transformed by changes in technology, a renewed commitment to the environment and a more integrated process for building design and construction. For young architects to effectively lead and coordinate the design and construction of buildings in an ever more complex future, they must develop an ability for integrated thinking when considering building systems, materials, and design.

Because most secondary schools' curricula are structured and compartmentalized to "teach to the test", a great number of students entering architecture school have limited ability(ies) for critical or integrative thinking. How do you begin the process for migrating students' analytic (isolated) thinking to a more synthetic (integrated) thinking? To what degree should traditional curriculum paradigms for beginning design students follow professional precedent and move towards a more integrated curriculum? Should they remain separate and focused to effectively educate today's student for tomorrow's profession? Or, is there a place in between?

Teaching an introductory course for building systems to beginning architecture and architectural engineering students has its challenges, primarily developing a mindset and building a case for tectonics and materiality as a catalyst for design .... not simply a response to the pragmatic needs for shelter and comfort. One the other hand, one of the biggest challenges in teaching beginning design studio is the integration of tectonics and materiality for fear of overburdening the students with technical issues and inhibiting their burgeoning creativity. This paper is based on a coordinated dialogue between two introductory courses: sophomore level building systems class and its parallel design studio.

Present Curriculum

Our present curriculum has two fully accredited (NAAB, ABET) five year professional programs leading to a Bachelor of Architecture and Bachelor of Architectural Engineering. Both programs' curricula have been purposefully woven together throughout the studio sequence to develop an understanding and empathy for the problems faced by their fellow A and AE classmates with whom they will potentially work with closely in professional practice. The beginning curricula for the design studio is team taught and focused on basic compositional and formal principles for buildings as well as various methods for their design communication. The technology courses are separated from the design studio and each other. They include: statics, building systems, strengths of materials, building materials, steel structures, timbers structures, concrete structures, and two environmental systems courses. Although there are purposed intersections between technology and design in the present curricula, the question remains in light of the students we teach and changes within the profession, is it enough or is it too much to provide the right educational experience for our students?

Between Isolation and Integration

As an architectural design critic teaching building systems for the first time, I had a desire to make the class as supportive and relative to the students' design studio by developing a mindset and building a case for technology as a design catalyst. I also didn't want to overburden them with a second project outside of their design studio potentially creating more stress or worse yet, a "meltdown". It became evident (and is the case for most technical support classes), there needed to be a conduit between technology and design that allows for conceptual thought to be conceived in equality and in light of the other. Through an informal discussion with my colleague (who was coordinating the parallel design studio for the first time), we both discovered an alignment of our teaching content and objectives for the courses as well as the potential for our semester calendars. We both were concerned with our students' ability to think more deeply and holistically about their projects so that their projects weren't just well considered at the spatial and conceptual level, but also in terms of materials, structure and technical systems. It was our belief that conceptual thought no matter how compelling at the spatial and / or functional level does not develop into "architecture" without the understanding of materials, structures and environmental systems.

A collaborative teaching strategy emerged and was structured around the common premise of exploring both "isolation" and "integration" of the architectural design and technology curriculum content. Beginning design students are transitioning from a very "rational" correct / incorrect secondary education in high school. When asked to consider or "integrate" too many design relationships at once without first fully understanding them individually, students can become "overwhelmed". On the other, integrated thinking needs time and repetition to develop the logic for design relationships (so you might as well start as soon as possible)! An integrative approach early in the curriculum helps students to consider design and technology as inclusive within each other. There is a delicate balance between the two, either way; it's not going to be pretty!

Semester calendars and course content for both the systems class and design studio were organized around isolated modules / projects which focused on foundational building systems for design and construction. The following is a list of the modules: site systems, spatial systems, structural systems, enclosure systems, and systems Synthesis (final studio project).

Strategies for Integrating "Design" into the Building Systems Classroom

Architecture 2263 - Building Systems introduces and establishes a foundational understanding of the following building systems: site, structures, enclosure, special construction, and mechanical / electrical / plumbing. Beyond a simple introduction, ARCH 2263 was designed to create linkages between the "understanding" and the "application" of how these systems inform or are informed by design.

The delivery of the technical content was accomplished through traditional lecture /note/exam format. The integration and application of the technical content was also supported by these additional strategies: systems precedent studies, guest practitioner lectures, construction observation visits, and a technical resource notebook.

Systems Precedent Studies

The systems precedent studies went beyond analyzing compositional and formal qualities of the buildings, rather, the students are asked to look at the site, structural, spatial, enclosure, and environmental systems and asked to consider how these systems help contribute to the building's overall design intent. By dissecting individual building systems and studying their interactions and influences on building performance and architectural form, students were able to explore by both isolation and integration. Precedent submissions (typically three-four pages) contained the following information: documentation of each project by collecting basic project information such as the building location, function, cost, design date, construction date, architect, owner, engineers, and contractor (the who, what, where, when, etc.), and written summaries, images, and / or drawings of the basic building systems such as site, spatial, structure, enclosure, environmental choices and their appropriateness in use (the why).

Guest Practitioner Lectures

Guest practitioners relevant to each teaching module were invited to speak to the students to help cast a vision of how and why each of their particular area of expertise was important to the overall design process and the integration of technology into design practice. After each lecture students were asked to write a short two-page response which addressed the summarized content of the lecture as well as how it could be applied to their present studio project. They were also asked to develop questions for further research. Student responses to the guest practitioners lectures were positive suggesting that it was very interesting see and hear stories about "real" projects and experiences which in turn helped them to visualize their own practice future. Many students commented that it was great to simply have the opportunity to "talk with an architect" which for many beginning students, has never occurred.

Construction Observation Visits

Construction observation visits were scheduled during each module to reinforce a tectonic understanding of material and fabrication processes. Writing assignments were given to the students after each construction observation visit. This assignment was meant to frame an experiential conversation about the technical and performative issues affecting architecture and the design process. Four years ago, our school moved into a new "state of the art" facility which purposefully showcases building systems as a teaching tool. Many lectures during the semester ended in the hallway or on the roof to see "first hand" a particular system or building material.

Fig. 1. Construction Observation Visit

Technical Resource Notebook

Students were required to assemble a cumulative technical resource notebook that summarized their semester experience in building systems. The intent was to provide a technical resource / design catalyst that could be used in future design studios and their journey towards licensure. The content of the notebook included: class notes/sketches/diagrams/drawings, field trip reports, guest lecture summaries, precedent assignments, quizzes, and exams. Emphasis was placed on its organization and information management so that they could easily find past data related to their "isolation / integration" experience during the semester.

Strategies for Integrating "Building Systems" into the Design Studio

Specific studio projects were developed to link the more carefully defined technical modules of the building systems class and the conceptually based studio projects. Five studio projects were formulated beginning with the site, followed by space, structure, enclosure, and culminating with the integration of the prior into a cohesive final project. Students worked in both drawing and model formats with special emphasis given to physical modeling to increase their experiential and tactile learning. Drawings were also used to refine and validate their propositions depending on the project. Technology issues were given special emphasis and made relevant through the project based learning and applied through experience in the design studio, whereas building systems became a more integral part of the students personal design approach.

Site Systems

The first teaching module focused on the design and development of the ground plane. Specific emphasis was given to the architect's ability to shape the earth within an architectural context. Specific areas considered were: landscape, movement systems, programmatic uses, users, environmental context, and specific man-made objects. Students, working in teams of three were asked to design a multifunctional environment for students, alumni, university personnel, and visitors to experience. There were three primary components to the design project: organize a collection of outdoor sculptures that were donated to the university, thoughtful placement of the sculptures in the landscape according to specific prescriptions, and to artfully design and accommodate the sculpture and other activities on the site in context.(8)

Supporting technical lectures given in the building systems class covered site systems topics related to sustainability and green buildings, soil mechanics and topography, vegetation, climatic response, regulatory requirements, and site circulation. A guest practitioner (landscape ar-

Figure 2: Site Systems Project: Student Team – Nick Freese, Minwoo Hahm, and Jennifer Lane

chitect) was brought in to discuss and expand the students' knowledge of different landscape precedent that could be incorporated into their own projects. Students also visited a local project under construction where they learned about different soil types and their potential for movement, as well as the effects of site drainage, and the regulatory constraints and their effect on site and building form.

Spatial Systems

The second teaching module focused on shaping space for a diverse set of outdoor activities. Among the principle activities are circulation and gathering for events and performances in music, film, art, and literature. Objectives for the project were to explore, respond to, and express the meeting and market-based places as well as develop an understanding of human behavior, activities, interaction, and relationship to their environment. Additional explorations included the ways in which space is captured, configured and otherwise defined. In response to their team site project, each individual team member was asked to design their own "agora" or market space for the OSU campus which was adjacent to the new sculpture garden. The multi-functional environment will serve as a gathering space for intellectual exchanges of both an academic and amusement variety. The two primary programmatic elements to the design included a main assembly space as well as several smaller interactive alcove spaces.(9)

Supporting technical lectures given in the building systems class covered a broad overview of topics that introduced the physical systems which define and organize the conceptual and spatial ordering of a building such as: the structural system, the enclosure system, and the environmental systems. Also discussed was the rational for selection and integration of a particular system which could include: performance, aesthetics, code regulations, cost, sustainability, and constructability. To bridge between modules two and three, emphasis was given to helping the students understand the key role "structure has to play as a spatial generator or seeing structural forms as an integral part of architecture."(10)

Structural Systems

The third module focused on the use of structure as a spatially defining device and as an ordering system for architectural design. Project objectives were to develop an understanding of structural systems and their integration into the design process. Again as individuals, each student was asked to develop a two part project: an open-air campus transportation hub in an area presently occupied by a parking lot and an underground parking garage to be located below the transportation hub. The open-air transportation structure was to accommodate and shelter both buses and those people who are arriving and departing by bus. The underground parking structure was to be accessed by ramp and accommodate 90 parking spaces as well as provide ample vertical clearance, ventilation, daylight, and vertical movement for pedestrians.(11)

Supporting technical lectures given in the building systems class covered structural topics related to the types of foundation systems (deep / shallow), types of floors systems (concrete / steel / timber), types of wall systems (concrete / masonry / stone / adobe / steel / wood), and types of roof systems (sloped / flat / concrete / steel / wood). Precedents assignments were given specifically to address unique structural systems and their generative possibilities in the design process. A practicing architectural engineer was brought in to discuss and show examples of how structure

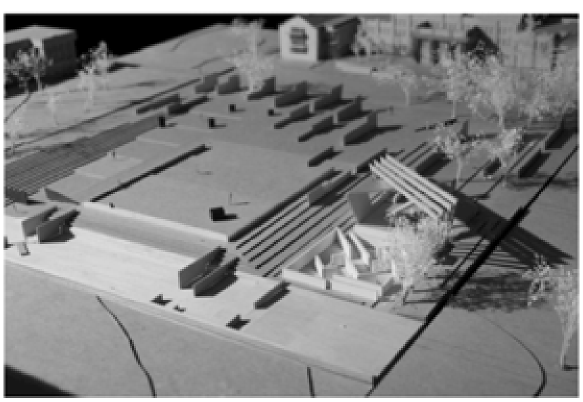


Figure 3: Spatial Systems Project: Student – Minwoo Hahm

Figure 4: Structural Systems Project: Student – Nick Freese

can be used as a design catalyst. Also students visited a new parking garage project under construction where they learned about both cast-in-place and precast floor and wall construction, as well as their effect on the site / building form and overall construction schedule.

Enclosure Systems

The fourth module focused on the design and development of the enclosure for a diverse set of educational spaces and activities with particular emphasis on a variety of design issues and contextual forces such as light, precipitation, temperature, views, and access. Students were asked to investigate the fundamental design principles that govern façade design. Working in groups of three, students were asked to individually choose one of the three expanded (or replaced) buildings and design the façade facing the campus quadrangle that had recently been redesigned in the first project of the semester. For all buildings involved, the new main entries will face the recently designed sculpture park in the quadrangle.(12)

Supporting technical lectures given in the building systems class covered enclosure systems topics related to: building orientation, solar control, fenestration, relationships to interior spaces, ground / corner / sky transitions, surface / material manipulation, roof systems / materials / drainage, wall systems / materials / drainage, thermal resistance / transmittance / insulation, moisture control, ventilation and building expansion. Precedents assignments were given specifically to address unique skin systems and their generative possibilities in the design process. A practicing architect made a presentation specifically addressing various types of skin systems with special emphasis on rain-screen systems and moisture control. In addition, students visited two different construction sites which were in the final stages of building skin enclosure.

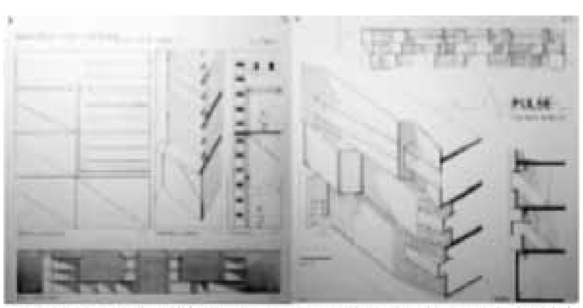


Figure 5: Enclosure Systems Project: Project Team – Nick Freese, Minwoo Hahm, and Jennifer Lane

Integration

The final project was principally focused on synthesizing (integrating) the issues and systems covered during the first four project modules. The 8,000SF library project was set in an engaging context with diverse spatial, structural, and environmental requirement and required the full application of the student's architectural education and experience to date.(13) In retrospect, faculty for both studio and classroom benefited from the isolation and final integration methodology, stating that students were much more "at ease" with a technical vocabulary which could be considered design generative. As can be seen from the example shown, students began to see the importance of the relationships between site, space, structure and skin and their successful integration.

Most of the technical lectures in the building systems class during this time were in review of the semester's overall content with much of the time in class devoted to application towards the student's projects.

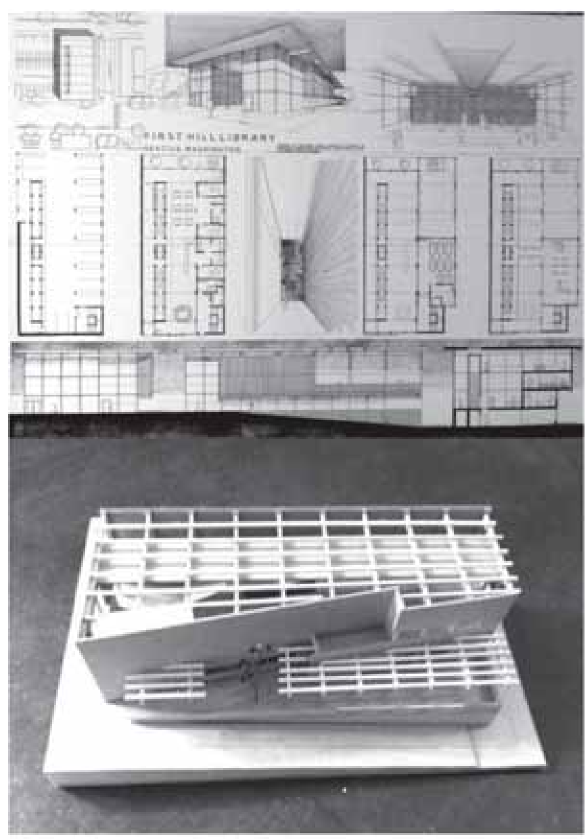


Figure 6: Synthesis Project: Student – Jennifer Lane

Observations for Pedagogical Change

- *Architecture students should be exposed to technical aspects of building design in the foundational years of the curriculum.* By developing a technical "vocabulary" early in their design education, students begin the architectural conversation where design is inclusive and conceived from both the abstract and the concrete working together.
- Beginning design students need to "experience" the relationship between design, technology, and construction. Construction observation bridges the gap between conceptual thought and integrated thought.
- *The classroom and studio are nothing more than environments and methods for teaching architecture.* Both have their place in the educational experience of an architect and should be taken advantage of for their differences as well as integrated together to create a more collaborative curriculum.
- *Encourage collaboration between studio professors and technology professors at each level of the curriculum.* Simply calendaring design studio projects and technology content, allows teaching objectives for both to be reinforced and considered in light of the other.
- *Architecture involves both design and construction.* Beginning design students need to develop a mindset and process for design in which the complete design / construction cycle is considered.
- *Integrative thinking about design and technology takes time.* The beginning years of a curriculum should establish a foundational understanding and develop a synergy to be built upon in subsequent years through iterative project based learning in both the classroom and studio.
- *Isolated thinking about design and technology provides clarity.* The beginning years of a curriculum should provide focused study about the individual building systems for design and construction.
- *A comprehensive curriculum should be conceived and designed to acknowledge both its individual and collaborative parts.* It is vital to provide a learning environment for future architects and architectural engineers that embrace the "whole problem" which equally lies at the intersection of design, technology and construction.

Notes

[1] Neil Howe and William Strauss, Millennials Rising: The Next Great Generation (New York: Vintage Books, a division of Random House, Inc., 2000).

[2] Douglas Coupland, Generation X: Tales for an Accelerated Culture, (New York: St. Martin's Press, 1991).

[3] Neil Howe and Reena Nadler, "Managing Millennials: How to Cope With a Generation of Multitaskers," http://www.tlnt.com/2010/08/25/managing-millennials-how-to-cope-with-a-generation-of-multitaskers/ (accessed 2 May 2013)

[4] Elizabeth Evitts Dickenson, What's Next: Children of the Revolution, Architect, January 2013, 110.

[5] Oklahoma State University, School of Architecture, Programs, Mission Statement, http://archceat.okstate.edu/content/mission-statement (accessed 15 Apr. 2013).

[6] Oklahoma State University, School of Architecture, Programs, Architecture Program, http://archceat.okstate.edu/content/architecture-program (accessed 15 Apr. 2013).

[7] Oklahoma State University, School of Architecture, Programs, Architectural Engineering Program, http://archceat.okstate.edu/content/architectural engineering-program (accessed 15 Apr. 2013).

[8] Nathan Richardson, Project 1: Site, (Oklahoma State University, ARCH 2216, Spring 2013).

[9] Seung Ra, Project 2: Space, (Oklahoma State University, ARCH 2216, Spring 2013).

[10] Bjorn N. Sandaker, Arne P. Eggen, Mark R. Cruvellier, The Structural Basis of Architecture, (London: Routledge, Taylor & Francis Group, 2011).

[11] John Womack, Project 3: Structure, (Oklahoma State University, ARCH 2216, Spring 2013).

[12] Awilda Rodriguez, Project 4: Skin, (Oklahoma State University, ARCH 2216, Spring 2013).

[13] Nathan Richardson, Project 5: Synthesis, (Oklahoma State University, ARCH 2216, Spring 2013).

Digital Pneumatics:

New Possibilities for an Old Paradigm

Lance Walters, Assistant Professor

University of Hawaii, Manoa

Introduction

The introduction of digital design and fabrication mediums is a critical point in contemporary architectural education. The proliferation of digital means, not just in architecture but in everyday life, only emphasizes the importance of its early integration into a broader design pedagogy. However care should be taken to understand that the growth and agency of digital technology comes from a strive for accessibility, rather than a layered application of advanced and technical means. Instead of increasing power and complexity, the popularity and availability of these tools requires openness. In this way it can be understood as a tool instrumental to the early development of critical design thinking skills.

Digital and fabrication technology in the early stages of design education are most effectively used a tool to develop critical thinking skills in young designers rather than a technical skill set supplementary to design. To help understand the implications of digital tools as early as possible it is important for students to undergo interactive design projects that engage ideas of how they work. This is opposed to a specific and technical approach towards the machine and software.

The use of pneumatic design projects in intro-design phases can significantly enhance the beginning design students understanding of the design process and their own design work. Its design process can provide an opportunity to engage directly with material, machine and design. The architectonic objects it produces are engaging spatial creations that students can rapidly design, realize and interact with. Pedagogically, objectives of this project are tied to the course as well as its position in and relationship to the curriculum. Pneumatics have a substantial architectural history; though this work as a class project is not about any physical architectural presidents it does look to many of the theoretical aspects of 60s inflatable design paradigm.

Through the digital-pneumatic project series students are able to understand and implement digital design thinking skills very quickly. The digital-pneumatic scope has evolved over three semesters with each iteration emphasizing a cohesive and exploratory design approach. This paper and study of the project (digital pneumatics) evolved out of the ongoing development of the curriculum at the University of Hawaii, Manoa School of Architecture and specifically the development of the second year design course charged with introducing digital concepts and fabrication methods.

Background:

While this contemporary version lacks the socially provocative message from the early pneumatic works it continues to build on other ideas many of the 1960s and 70's work espoused. As originally intended with their inception in the 1970s, these 'inflatable' projects continue to question certain tenets of architecture, though this is more through inward reflection- something more for the (student) designers to think about- than it is for those whom we might spread a message to. These notions of possibility and intractability lend themselves well to a dynamic and engaging set of tangible design projects.

Inflatable objects have a long history before it came to the architectural world, but its design roots began in the 1960s as certain designers began reacting to modern architecture and materials. Groups such as Ant Farm and Jersey Devil, among many others, linked strong social messages to architecture through their inflatable design projects. Their work is most often understood as a reaction to other architecture movements at the time, with provocative messages about social equality, approachability and even sustainability.

Radical or idealized pneumatic work has since faded though pneumatics have still found their way into other aspects of architecture and engi-


Fig. 1. Students work on a pneumatic while it inflates

neering today, including high profile pavilions, disaster relief shelters and engineering projects. There is an interesting history that comes with this work, which can be incorporated into the class room discussion, however the value as a project is not in this history. Though the examples are numerous and come with broad intentions, the focus of this studio project is less about case studies but in many ways remains linked to the ideals associated with early pneumatic work.

The project portion of the course is modeled after a typical design studio but utilizes the project type and scope to differentiate itself. It focus on four aspects of design which included how perceptual design meets physical objects, material and assembly, and digital/manual iteration. The final pneumatics merge CNC (Computer Numerical Control) machines, digital assembly and nesting methods, and detail oriented hands-on craftsmanship on a large scale.

There are numerous books and blogs on making inflatable structures, perhaps most notable is Ant Farms 'Inflatable Cookbook'. Construction of them is quite simple and highly flexible. In its most basic form, a closed volume is created with plastic- either melting the ends together with an iron or taping it closed- and an opening is made for a fan to blow air in (Figure 1). No special or expensive equipment is needed. Regular box fans provide plenty of air, and the plastic can be from trash bags or in rolls of painters polyethylene drop cloth. There are many tips and tricks that can be incorporated, a few of which are discussed here alongside the academic structure of the class.


Fig. 2. A student moves through a large scale pneumatic structure.

Project design observations

One of the best ways to start a project like this is to inflate a project in the classroom for the students. Witnessing the heavy flat plastic rise into a three dimensional structure for the first time and then realizing one can go inside and interact with this space can be very inspiring. The students are able to inspect it, see its simplicity, and touch it all without giving to much of the project away (Figure 2).

The actual design begins with simple computer based modeling exercises paired with a series of analog material investigations of the polymer material. This is an opportunity to not only get a feel for what one is working with and experiment with general techniques but it is also, unknowingly to the student, a lead in to larger design challenges that they will face again when developing the final projects.

One of the primary lessons is for the students to work through how perceptual ideas meet with the physical, architectonic objects. To the limited extent that these young students have built or physically constructed designs in the past it is typically creating architectural models comprised of representational materials whose behavior is, at least generally, understood. This could mean balsa for a certain scaled down 'wall' or plexi for a glass 'window'. In pneumatic projects there are no materials in between their design and the final creation.

Something the students face over and over again is how the built work challenges their initial, formal notions of what to design. This is largely due to the material and the air that helps define

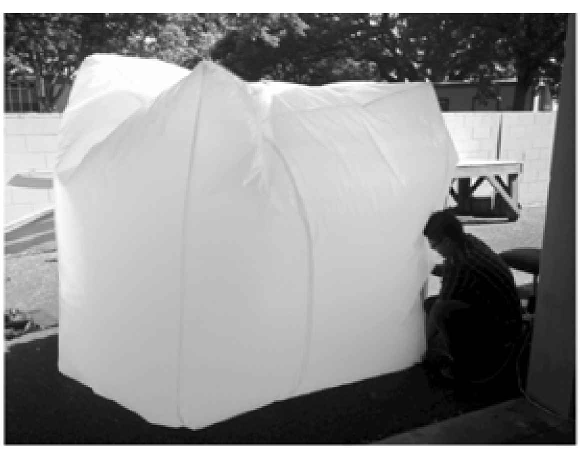


Fig. 3. Students attempt to inflate a rectilinear volume that inevitably distorts and pillows.

its shape. These projects are inflated through large volumes of air, not high air pressure as in a balloon. Students tend to have ideas about form, shape and space that the material ultimately will not conform to. The resulting forms that the material takes is largely unexpected and requires the students to understand, very tangibly, how the inflation process causes the material to behave. As they do it begins to inform their initial design visions. One reoccurring discovery by almost all students is that linear or planar faces, something in nearly all students first design schemes, is not possibly in the inflated objects (Figure 3). This is mainly due to the fact that the inflated objects are supported by air, but worked on and constructed in an unsupported environment. For the students this means two things. Firstly, they must rethink their preconceived notions of what their designs will be and integrate material and process to achieve a desired design. Secondly, it means that mock-ups rather than representative models must be built, tested and then retranslated back into the computer.

These design studies involve structural or spatial ideas that are fabricated, constructed and observed. These studies can be brought back into the initial digital model via 3d scanners and digitizers for comparison. Being able to reflect and study what they have made against what they wanted to make is in invaluable opportunity for the student to reflect on their design work, one that may only come a few times a semester during later studios.

The lessons learned from this cross referencing feeds the final design and creation of large pneumatic structures. Often made in groups, some completed works can hold more than 60 occupants inside. The students are asked to respond to a relativity simple design directive, usually changing or relating their work to an assigned space in the building or classroom.

The structure and form of these works are more easily described and anticipated with today's architectural representation and design tools. This remains true even while using the plan and section drawing modes the early inflatable projects pushed back on. This is beneficial to an early design studio in that it allows us to teach important design drawing skills while also directly highlighting their usefulness.

Promoting a simplified and creative use of the digital tools is one of the most important aspects of this project. Students are required to use a wide array of digital software and fabrication equipment repeatedly in the creation of the inflatables. The substantial hands on time with these tools makes them very comfortable and understanding, promoting accessibility a hopefully a willingness to continue working with them in later studios.

Construction observations:

Students take their digital design forms and deconstruct them into panels or pieces, which are then transferred to the poly sheeting. Throughout the duration of the project, students are encouraged to try different techniques and tools and to learn about each process. Projecting and then tracing (by hand) is a very low tech approach to getting design from the computer onto the poly. This can be a slow process, especially when there is a large variety of patterns that need to be made, but students may also find that is accommodates larger patterns very easily. This method also instills a direct sense of scale, and highlights perspective/projection distortion depending on where the projector is located in reference to the plastic material.

CNC routers are the most common tool used for making the physical patterns (Figure 4). The router itself is only used in a 2d capacity, and no milling takes place. This reduces the time needed to make each part, and the lack of actual milling eases the less shop-comfortable students into working with what can be an intimidating machine. To do this, the router bit may be replaced with a felt marker, or in some cases even a hobby knife. The main point here is to reduce the complications of the equipment and just get the students using it comfortably and repeatedly. If they feel they can easily use the machine and it speeds up their work they are more willing to use

Fig. 4 CNC router used to draw or cut patterns.

Fig. 5. Student uses a hair flat iron to seal a seam.

it in the future in more advanced ways.

The equipment provides the only size restrictions for the project. Early on students may see the equipment such as the router bed size as a limitation, but as they begin to understand how the machines fit into the process they quickly develop ways to deal with it. For example nearly all students find at some point that folding or stacking layers of material in particular ways under the CNC machine can duplicate or array a particular mark or guideline to create a larger panel.

Because the construction process is so highly transferable to the digital fabrication environment the work employed in the creation of these projects directly reinforces important design-process knowledge. Both hand tools and digital tools must be used together and is a great chance for students to experiment with what works best where.

Because there is only one material, it is tightly connected to the design and assembly process. Once the students know that their work will inflate, most of their time is spent between designing in the computer and building the projects.

Fig. 6. Final pneumatics review

As students get a feel for the construction process they improvise tools and techniques as well. Hand tool creativity is also observed (Figure 5). Reference material discussing sewing techniques can be invaluable. Studying the details of clothing seams and general patterns of stuffed animals or dolls can provide insight and inspiration not only for the project designs but for construction drawings and presentation materials.

Conclusions

The sheer amount of material that needs to be covered when introducing digital mediums presents a major challenge in how a design course is shaped. When this material is combined with a very detailed and technical approach it may not leave much room for design or critical design thinking. It may also lead to small, incremental lessons that cover only one or two minor aspects of design at a time such as assembly logic or form/geometry development. With this comes less opportunity to see how these aspects all come together in a design process.

Architecture studios, especially advanced design studios, are often forced to focus on just one or two supporting aspects of design work such as a technical element, construction detail or model making. This is due to the specificity and level of content that they are charged with. One advantage of early design studios have is that they can be more broad (Figure 6). Well balanced projects that help the student to incorporate a wide range of design aspects together will help students be better prepared for the more advanced and focused studios in their future.

Using pneumatic designs in intro-design phases can significantly enhance the students understanding of essential tools in their own design work and it translates into an engaging medium for young designers to rapidly design, realize and interact with. Because the construction process is highly transferable to the digital fabrication environment and the work employed in the creation of these projects directly reinforces important design-process knowledge, students are able to understand and implement digital design thinking more immediately in the design curriculum.

tinyTEDs

3-minute image-based presentations, tinyTEDs were presented in an informal setting one evening of the conference to encourage debate and discussion. The tinyTED portion of the conference was an opportunity to present an emerging idea, a course project, a rant, a rave, or just to test a concept. Topics related to the conference theme but not necessarily to the specific session topics.

tinyTEDs replaced the poster session and were intended as a mash-up of TEDtalks and PechaKucha 20x20 – technology-entertainment-design-ideas worth sharing + fast paced-meet-show your work-exchange ideas. The open call was intended for work that was not quite ready for a paper length presentation yet worthy of teasing the beginning design community with some great images and gauging the audience’s reaction.

peNUMBra...

a 180 second call to night

Brian Ambroziak, Andrew McLellan

University of Tennessee, University of North Carolina Charlotte

I cannot walk through the suburbs in the solitude of the night without thinking that the night pleases us because it suppresses idle details, just as our memory does...
- Jorge Luis Borges, "A New Refutation of Time" in *Labyrinths*

The paucity of architecture in thoughtful relationship to aspects of night becomes apparent when we acknowledge the existing prejudice towards architecture in sunlight.

The arts outside of architecture are filled with inspiration taken from night that include Caravaggio and Whistler's moonlit *Battersea Bridge*, Debussy's and Bartok's evocative nocturnal compositions, and the shadows of Vienna's public squares and underground caverns in Reed's *The Third Man*, to name but a few.

These examples speak to the overwhelming greatness of night's solitude, its quietness, its illusiveness, its clarity. They describe voids of darkness breaking the scene, where space, object, and experience are redefined through an absence of detail and where context becomes perceptually fragmented. These night inscriptions provide fragments of a critical body of work for reclaiming the subtleties of dusk, moon-light, and darkness and their emotive and metaphorical potential, experiences much lost to inhabitants of the modern world.

Fig. 1. *The Lantern Parade*, Thomas Cooper Gotch, 1910

Fig. 2. Los Angeles, c.1998

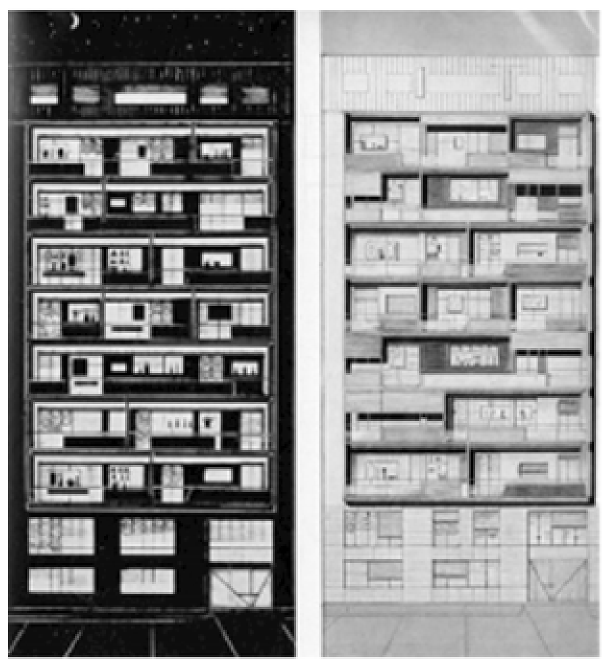


Fig. 3 Night and Day, Elevations, Gio Ponti,1956

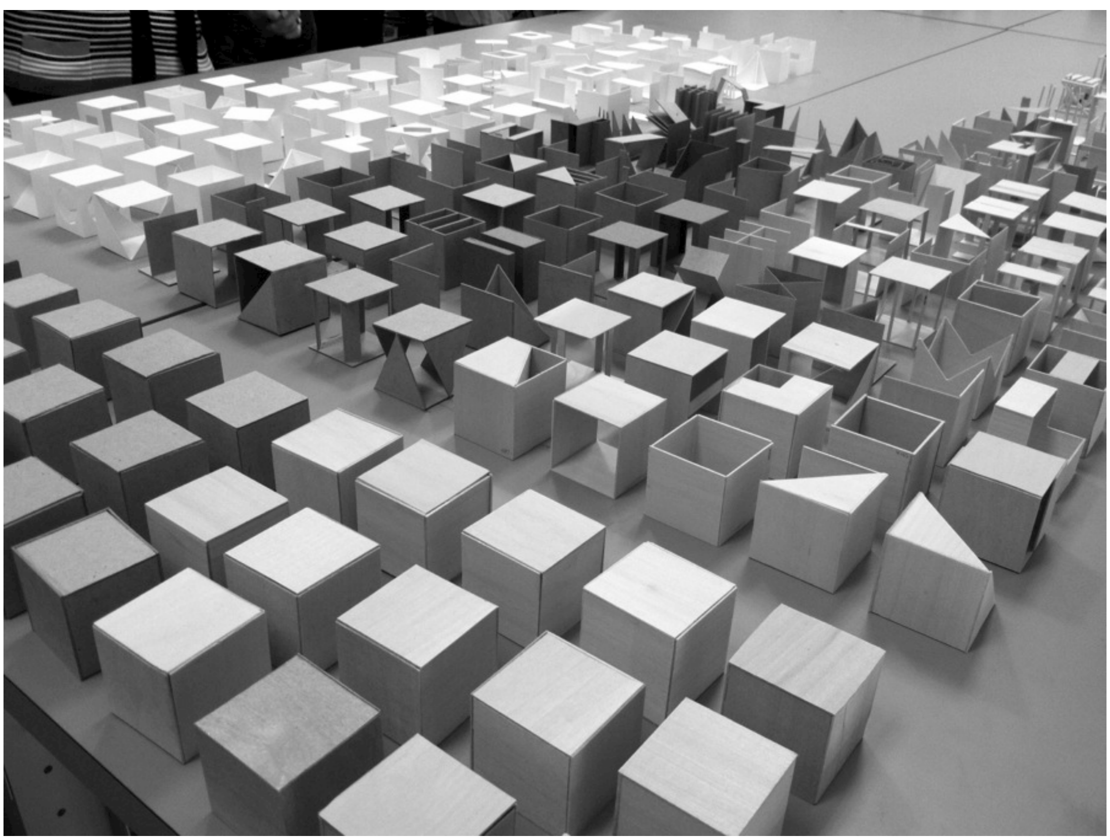
30 Cube Project:
Design Constraints + Iterations

Catherine K. Anderson

The George Washington University

From the inception of a concept to the final presentation – how do first semester design students learn to go beyond preconceived notions prevalent amongst fledging designers? How can the creative process lead them to fully comprehend design fundamentals so they may be deployed innovatively and not simply be replicated? How does the act of “making” or hands-on explorations through model making versus sketching support and encourage students to investigate solutions beyond collaged or recombined versions of what has been observed rather than analyzed? And how can this progression of assembling and discovery be facilitated by numerous iterations and severe constraints?

This presentation will focus on a specific project given to first-year interior design students in their initial studio (Foundations) in a first-professional degree program. Because of the extreme limitations or design parameters established by the instructors for this assignment, students were able to acquire essential design concepts versus learning them via drawing, reading, or lecture. This self-learning yielded a deeper and more permanent understanding of the concepts as well as a knowledge base that could be recalled in future studios as design problems became more complex.



Cubes arranged by materials and visual similarities; photo by C. Anderson.

Slump:
Form Factors & Material Misbehaviors

Kelly Bair

University of Illinois at Chicago

Slump examines the formal aesthetics and material sensibilities that result in the pairing of rudimentary form making methods (casting, carving, drape forming etc.) with the precision of computational-based machining (laser cutting/etching, cnc milling, 3d printing) in architectural design. Environmental influences such as surface area, heat, weight, loading, adjacencies (to other contextual figures) and viscosity act as agents for finding form. Tapping into a long history of figural objects and buildings “in the round”, a second course titled “Heavy Rotation” implemented the material experimentations mined from Slump with historical precedent analysis of revolved buildings in an effort to speculate on large scale model making and fabrication for beginning design students.

Heavy Rotation model. Student Team: Damian Babicz, Brian Schmidt, Nazifa Virano, & Kat Tran

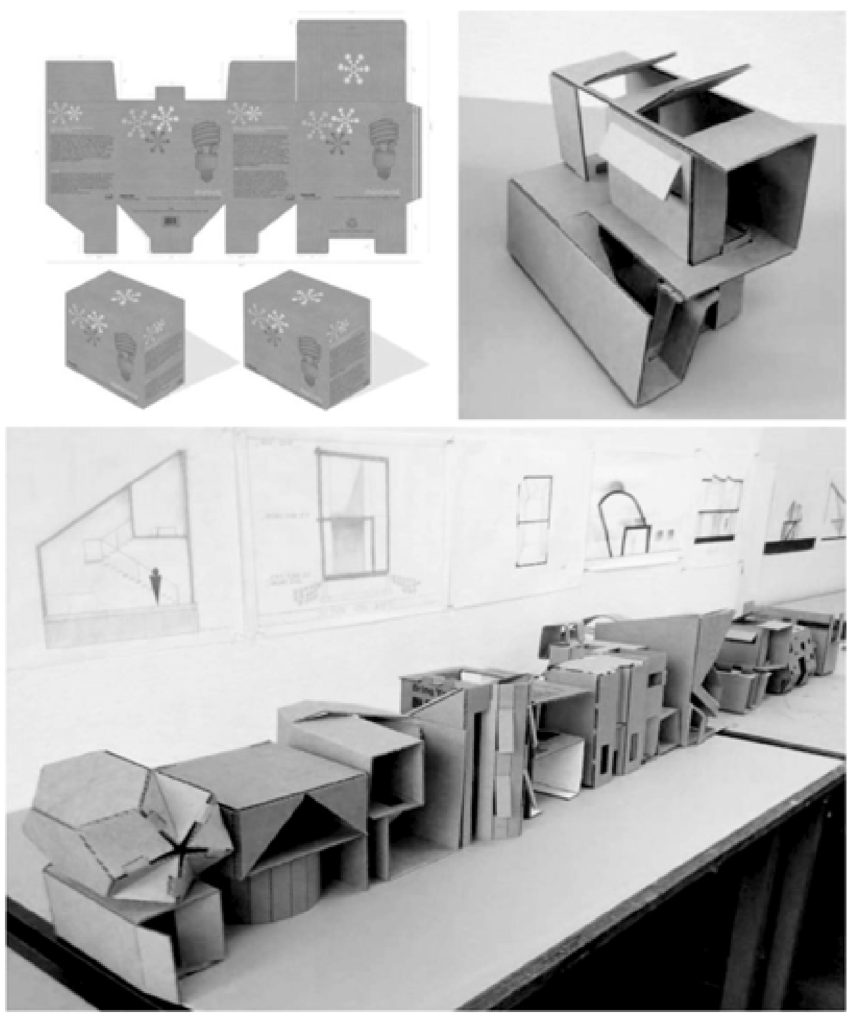
Folding a Row House

Warm-Up Project

Craig Griffen

Philadelphia University

This one-week initial project efficiently introduces second-year students to several ideas of prefabrication, modularity, materiality, joining and economy of means that they will use in their subsequent project. Using examples of innovative product packaging for inspiration, students transform a piece of 12” x 36” corrugated cardboard into a three-dimensional urban housing unit solely through the process of cutting, folding and joining. No glue is allowed and the entire sheet must be used. Students better discover the characteristics of the material and spaces of the building through iterative hands-on making rather than orthographic drawing.



Folding Row House, student work (photo by author)

Oneiric Hut:
Toward Architectural Embodiment

Gabriel Guy

University of Waterloo, Canada

I set out to learn something basic about architecture, something foundational on which to situate the conceptual and rhetorical exercises played within the studio. It seemed apparent that in order to *think* about architecture I should be involved in the *act* of architecture. My intentions, albeit naïve, were to engage architecture on its own terms, through its own medium, to return to first principles, if there ever were any, and to acquire a form of architectural knowledge inseparable from its material becoming. There was no amount of hypothesizing, theorizing, no amount of digital sophistication that could supplant the basic educational experience gained from involving myself with real materials, in a real place, with a fully engaged being. With this in mind, I journeyed to Ontario's North, to a great limestone island with little more than a hammer and saw and a desire for experience that most brutal of teachers. I would engage the myth, memory, and materiality of this *place* as a method of embodied architectural instruction.

I began by taking up residence in an abandoned farm house located on 200 acres of forest and farmland. The owner kindly allowed me access to the old house and acreage to carry out my building experiment. All materials for the project were harvested directly from the site, reclaimed from two dilapidated barns and sourced from two local sawmills within 20 miles of the site. Contextually, traditional agricultural buildings were used as points of departure in assessing climactically successful building practice. The Ojibway Cultural Centre and visits with local residents provided insight and dialogue into regional and traditional embodied knowledge specific to this *place*. There was no designing done beforehand and basic construction skills were lacking; building was a process of ad-hoc improvisation and resulted in a challenging process of trial and error. Prolonged isolation, a harsh winter, and building inexperience all contributed to a rich poetic encounter with the natural environment, the self, and the act of architecture. The act of architecture facilitated a kind of archetypal and sacred experience; a seven month pilgrimage toward architectural embodiment.

The final manifestation of the experiment, informed by traditions of the primitive hut, is a place that offers repose. It acts as a place to sleep and consequently dream. It is a place to access the creative unconsciousness, that great wellspring of poetic imagination, and resides as an argument for the reintroduction of embodied forms of learning into the current architectural paradigm.

Fig. 1. Construction of oculus (Photo: Rachel Novak)

Fig. 2. Interiior

Fig. 3. Entrance

C.A.D. :
Critique Aided Design

Thomas Kearns

Illinois Institute of Technology, College of Architecture

Teaching foundation digital media within the limits of 3 credit hour coursework presents a fundamental schism between technical training and sense training. Too often, digital media education is oriented towards tutorial delivery without time to effectively situate those tutorials within a productive discourse. This "Tiny Ted" will present the progress of new design communication curriculum changes in the CoA at IIT which are transforming coursework from tech training to critical discourse.

Jordan Kanter, Lukasz Kowalczyk, Carlo Parente, Karla Sierralta (course instructors)

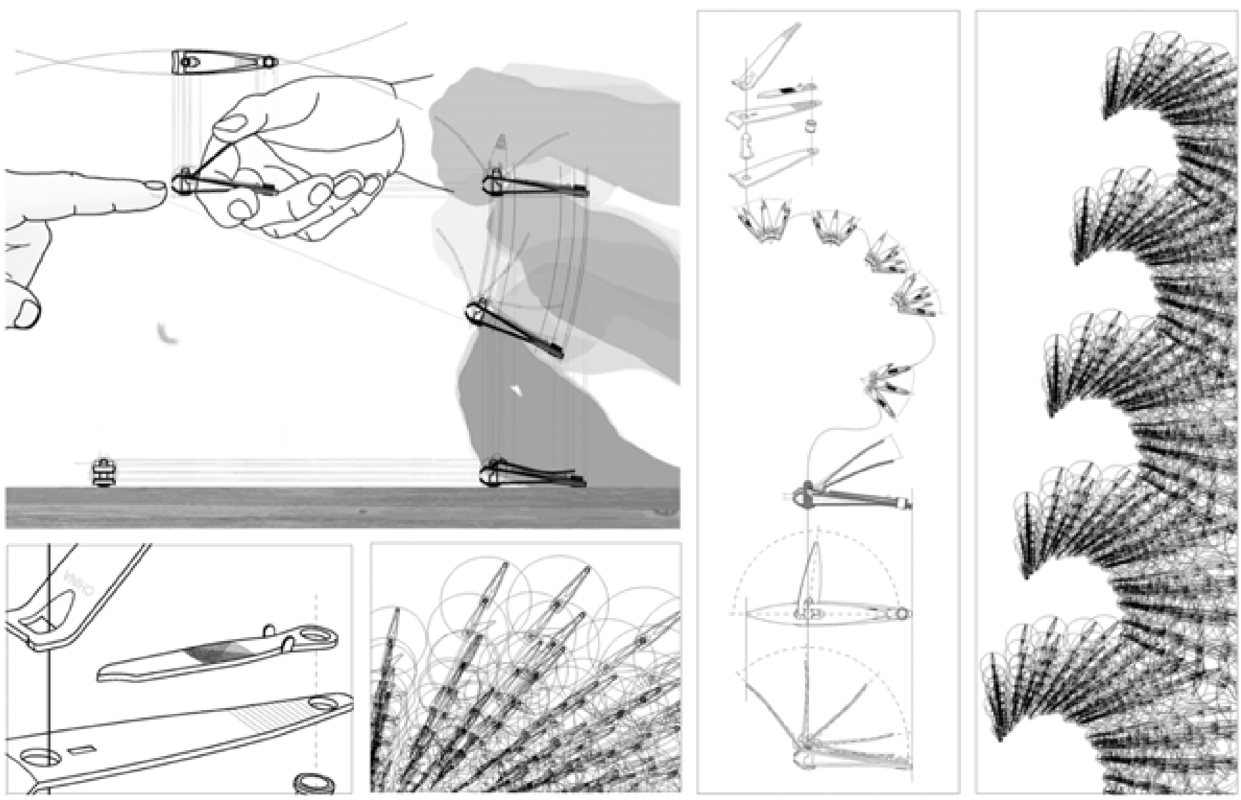


Fig. 1. Mixed Media drawings from computer model. Student: Kevin Kosciulek, Instructor: Jordan Kanter

Puzzles or Mysteries?

Brian M. Kelly, RA

University of Nebraska-Lincoln

Beginning design education, generally, endeavors to shift student mindsets from a generalist, consumer viewpoint of the world to an active participant and problem solver. This is most often achieved through design exercises where students are guided to generate a solution to a problem statement with varying degrees of abstraction. In the process of solving the problem, the student constructs knowledge and fills knowledge gaps. The Constructivist philosophy of learning is experiential, adaptive learning that integrates new knowledge with existing to construct relationships and revise existing cognitive structures. The teaching tool most often used in this development is problem-based learning (PBL).

Practice-based professions such as medicine and architecture require the practitioner to work from experience, construct knowledge, and respond with informed, professional judgment when faced with a new or divergent challenge. The educational environment for these disciplines is tasked with developing this ability establishing an emergent knowledge base. Problem-based learning originated in medical schools of the mid 20th century and has been instrumental in this regard. It is also the model on which the current studio format is based encouraging self-learning and establishing a mindset that embraces techniques of questioning and reframing design contexts and problems.

This presentation investigates the differences between problem statements that are end-focused yielding a narrow range of outputs (puzzles) versus those harvesting the essence of problem-based learning where students are guided through a process of not only finding viable solutions, but also participating in the problem definition (mystery). The solution to a puzzle offers a degree of latitude and authorship where the participant can choose their path to an endpoint, but the degree of variance in that endpoint is narrow. Metaphorically speaking, the puzzle packaging shows an image of the final piece, and the puzzler can start in the middle, the corners, or any other place that they believe will yield success. On the other hand, the solution to a mystery requires the participant to engage not only the generation of the solution to the mystery, but also the ways in which the mystery will be solved. Horst Rittel and Melvin Webber put forth the term "wicked problems"[1] to describe a problem which contains a trait of indeterminacy - one in which the answer can only be arrived at through abductive reasoning. The design problems which designers face today, and even more the problems which are in the foreseeable future, require a professional who has been trained not only to find answers to a question, but also to be able to formulate those questions.

[1] Horst WJ Rittel, Melvin M Webber. *"Dilemmas in a General Theory of Planning."* Policy Sciences 4 (Amsterdam: Elsevier Scientific Publishing Company, 1973)

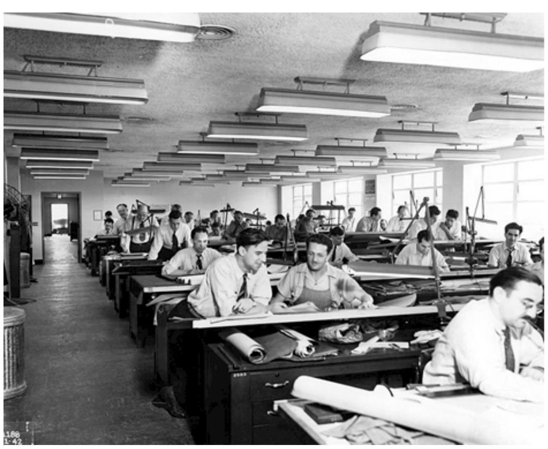


Fig. 1. Drafting room (via Wikimedia Commons), Fig. 2. The Anatomy Lesson of Dr. Tulp, Rembrandt (via Creative Commons)

Fabrications:
Graphic Speculations Spatial Tectonics Transformations

David Leary

College of DuPage

A drawing is an architectural reality.
A model is an architectural reality.
And a building, is an architectural reality!
- John Hejduk

The fourth of the five-quarter pre-architecture design sequence entitled '*FABRICATIONS*' focused upon '*precedent.*' The student teams, ranging in size from seven to fourteen individuals, scoured architectural journals and other publications searching for scaled drawings, photographic images and videos of their assigned investigations.

Wading through voluminous, often contradictory information on one hand, and theoretical, schematic or scant material on the other, precise scaled drawings were ultimately created. These graphic interpretations were transformed into exquisitely crafted bass wood models. The work of the studio was completed within an eleven week time period. The models included here, constructed without the use of CNC or digital printing technologies, are ordered in the sequence of their chronological FABRICATION.

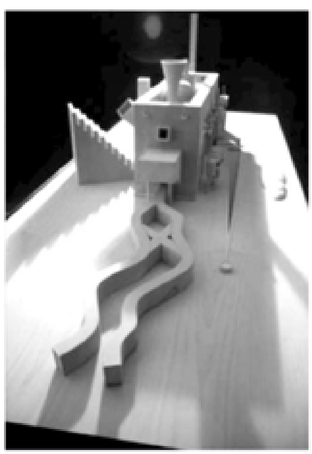




Fig. 1 Durer, Perspective Machine, Fig. 2 Hejduk, Theoretical Cathedral Fig. 3 Le Corbusier, La Tourette

The Weather Archive:
Material Models as Design Experiments

Sneha Patel

Tyler School of Art, Architecture Department, Temple University

The Weather Archive: Material Models as Design Experiments presents the work of an undergraduate studio in which materiality was presented as operating within a state of perpetual change, linked to the liminal states of temperature, atmosphere, air pressure, moisture, energy exchange, etc. Students developed dynamic models as experiments, analogs for observation (Fig. 1) rather than scaled simulations of previsioned static forms. These models prompted fundamental questions about the very nature of materiality and materially-related cultural stigmas; the values placed on permanence, the aesthetics of beauty, and optimized performance within architecture were challenged. This talk will elaborate upon these techniques of beginning-level model-making and drawing to argue for emphasis on material experimentation within design curricula as a means of engendering directed curiosity.

"Architecture is often defined by its opposition to weather, which represents a physical and psychological threat. But an alternative interpretation indicates the importance of weather to architecture...because weather both locates architecture and makes it more ambiguous, unpredictable and open to varied interpretation."[1] Drawing from this description from contemporary architect and architectural historian, Jonathan Hill, this talk will discuss how *weather* served as an instigator within this studio to question the paradigm of 'materials as products', selected in design based on their static characteristics. In contrast, Hill's reference to *variability* prompted students to consider the design possibilities present when examining and documenting changes in material behavior over time.

Purposely contradictory, weather's attendant forces of instability and unpredictability were played off of the hermetic tendencies of traditional architecture and the organizational desires of the archive typology in this studio. As a result, the students worked with ways to represent the dynamic qualities of their material models through cataloging techniques, such as taxonomies, iterative experiments, and observational logs. This tinyTED will provide visuals and descriptions of the both the material models themselves, and their associated forms of documentation and discovery.

[1] "Bartlett School of Architecture International Lecture Series: Weather Architecture: Submitting to the Seasons," Nature Network, accessed October 3, 2013, http://network.nature.com/hubs/london/events/3852.

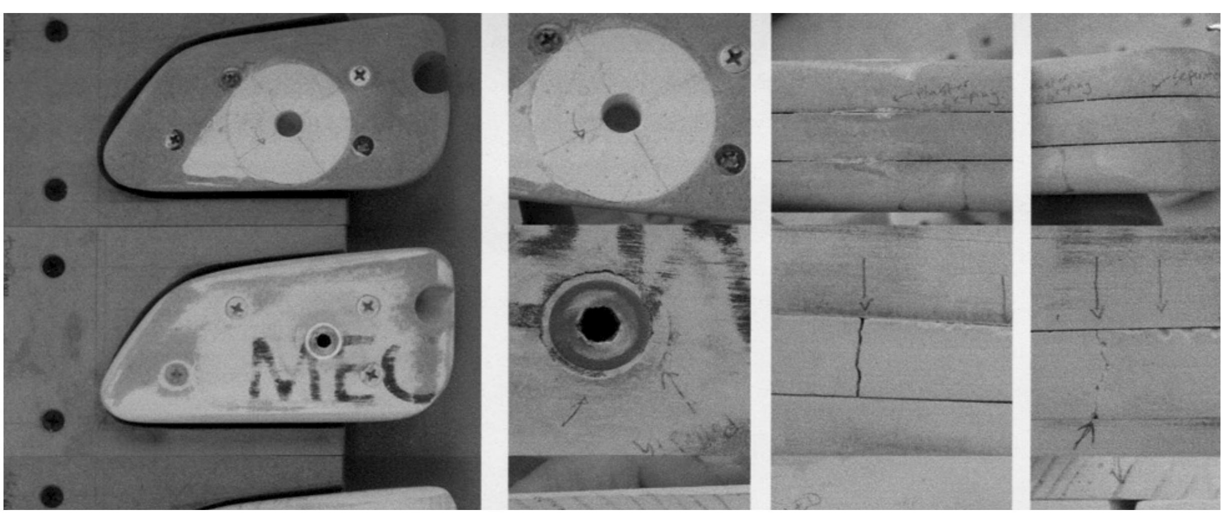


Fig. 1. Water-logged models by E. Mayer, produced for *The Weather Archive* studio.

Chalkboard LIVE

Anne Patterson

University of Kansas School of Architecture

There's nothing nostalgic about a chalkboard. Seeing live drawing captivates the beginning design student. Watching a drawing evolve before your eyes turns a skeptic into a believer and even a proponent. The chalkboard is this instructor's 'Moleskine'. Watching drawing systems and architectural ideas demonstrated live is a like watching sport... anything could happen: a stroke of genius or a heroic failure. The instructor is on the line, as it were, and the input of the students can impact the outcome of the image, making them participants, not mere observers.

The ephemeral nature of the chalk drawing makes it of the moment: belonging only to those who have witnessed its making after it turns to dust and becomes memory or legend. After I started teaching two studios, I started the habit of photographing the chalkboard so the drawings would last more than a day. In this tinyTED I share the secret images of a semester's worth of live drawing demonstrations, from drawing systems to outlandish ideas.

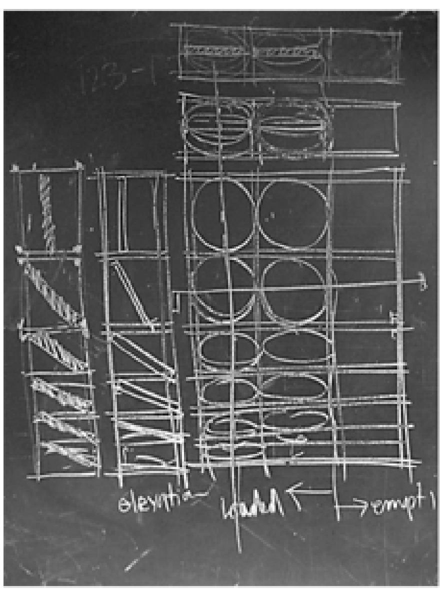


Fig. 1. Wall systems

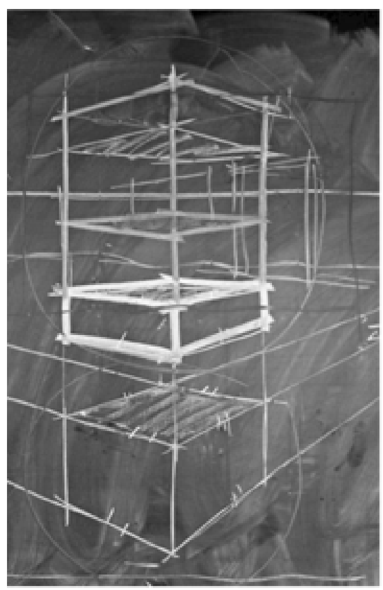


Fig. 2. Perspective

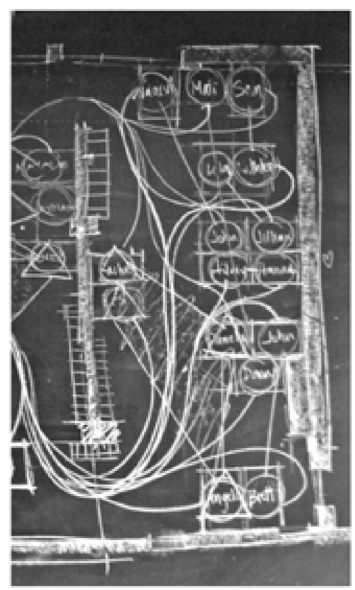


Fig. 3. Movement & Connection

Investigate the Essence of Architectonics

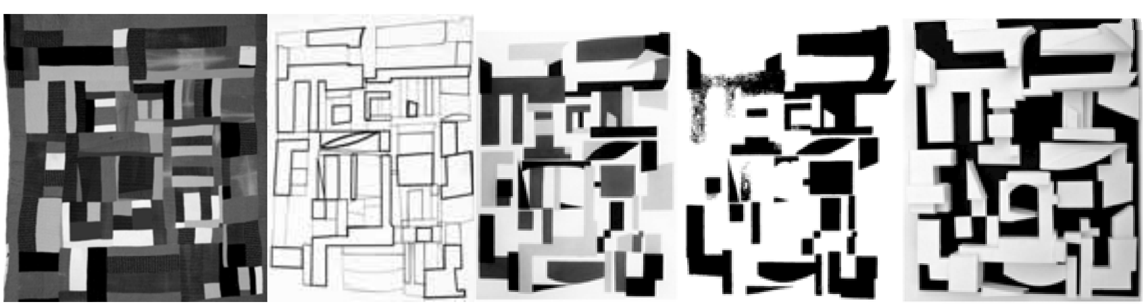
Through the Quilted Space of Material & Process, from Gee's Bend, Alabama to Detroit, Michigan

Allegra Pitera

University of Detroit Mercy

Infusing the design process with an investigation of materials, freshmen students begin the semester with an assigned quilt design (of the quilts of Gee's Bend, Alabama) from which to explore shape, form, color and materiality through a series of 2-D and 3-D design projects. Pulling a 'thread' of an idea through the semester, students photograph the architecture of Detroit, transforming design and materials through new conceptual integrations – ultimately in a trajectory of architectonic form in a site in Detroit: the Dequindre Cut. Materials ranging from canvas board and paint to ink on vellum, foam-core bas-reliefs and clay and wood models along with digital hybrid images – the process challenges the students to synthesize the evolution of form with the quilted space of materials.

Nichole Fricke, hybrid image of Dequindre Cut Greenway, Allegra Pitera Studio II, winter, 2013



Gee's Bend quilt *Blocks and Strips*, Mary Lee Bendolph Gee's Bend quilter, 2002,
Nichole Fricke, Quilt process projects, Allegra Pitera Studio II, winter, 2013

Simple Connections

Chad Schwartz

Southern Illinois University – Carbondale

In Thinking Architecture, Peter Zumthor states that "buildings are artificial constructions. They consist of single parts which must be joined together."[1] Within this discussion, Zumthor poses that the quality of a finished project is a direct resultant of the quality of the joints holding together the assembly. In an architectural building technology course, a seemingly simple question has been posed to a group of second year students: How do you join together two pieces of 2x4? The responses, inspired by typical connections we see every day, provided the students not only with ideas about the crafting of joints, but also about the crafting of the constructed environment.

[1] Peter Zumthor, *Thinking Architecture*. (Boston: Birkhauser, 2006), 13.

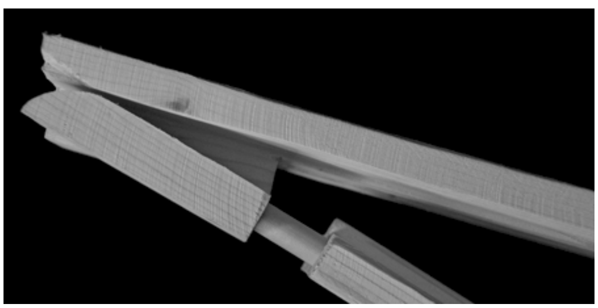


Fig. 1. A. Michael | Spring 2012 (photo by author)

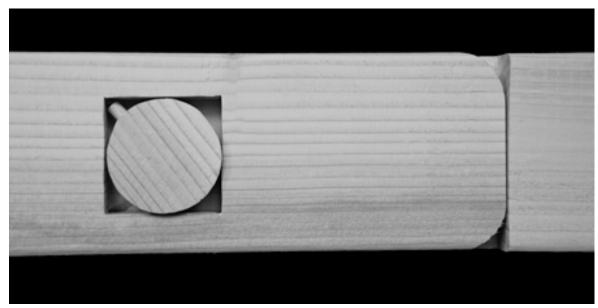


Fig. 2. N. Ouelette | Spring 2012 (photo by author)

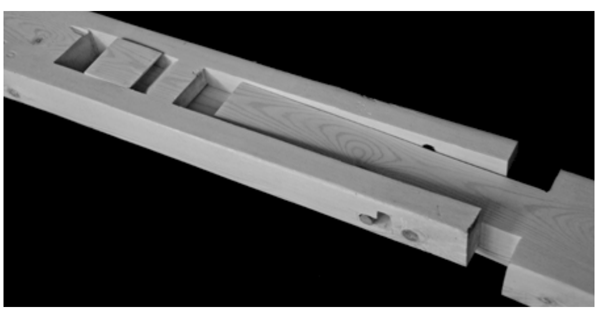


Fig. 3. R. Finn | Spring 2012 (photo by author)

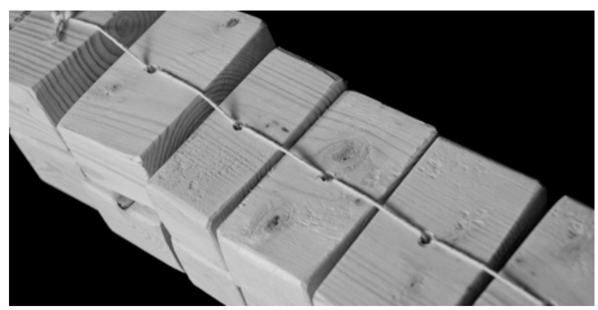


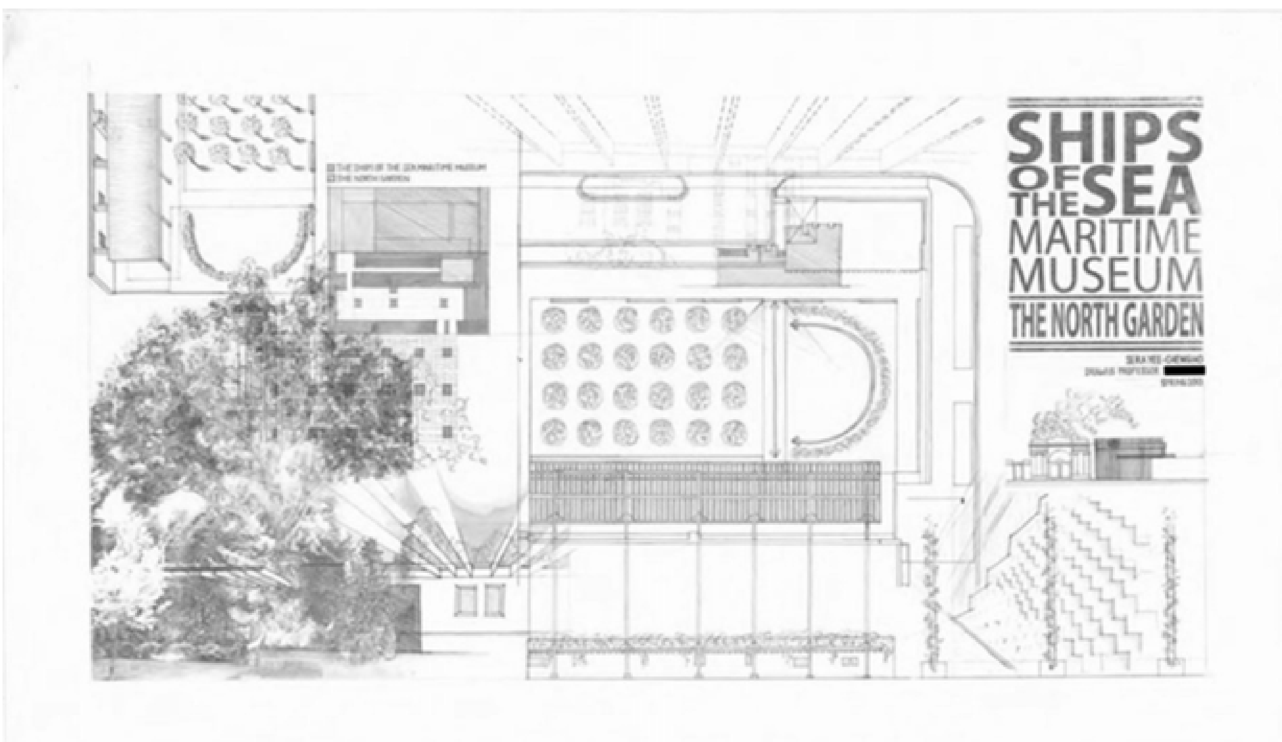
Fig. 4. S. Tutka | Spring 2012 (photo by author

The Role of the Analytique|Hybrid Drawing
in Beginning Design

Scott Singeisen

Savannah College of Art and Design

The analytique/hybrid drawing is a form of critique, a looking "after-the-fact" at the formal nature of an existing building through graphic representation. The analytique/hybrid drawing is not necessarily a diagnostic analysis, but rather, a method of interpretive analysis and alternatively, concerned with the method of finding "formal linkages" between various elements and paradigms in an architectural work. The analytique/hybrid drawing is essentially a tool for the investigation of "fragments." A case is made for ‘modern’ analytiques using work that is the result of a multi-disciplinary initial drawing course for students pursuing degree work in architecture, interior



Making:
Between Digital and the Hand

Tolya Stonorov

Norwich University

What becomes of the maker if the hand is no longer involved? How is the experimentation that comes from working a material through touch, translated and shifted when the process becomes automated and preconceived? There is feedback specific to working with materials, tools and methodologies that directly informs design, assembly, concept and built work. How is evolving feedback transformed when the relationship between hand and material is distanced?

As material tolerances approach zero with the use of digital fabrication methods, is there a richness lost in the presence of precision? Explorations between disparate materials suggest a reinvestigation of how they are joined, the relationship of material to ornament is reconsidered. Through a parallel exploration of digital and hand techniques, fabrication methods are challenging our generative means of making. Current research with plywood, felt and resin, examines the relationship between the materiality of process and production.

Fig. 1. Digitally fabricated furniture studies, T. Stonorov

Rethinking Sketching

Stephanie Travis, Associate Professor + Director of Interior Architecture + Design

The George Washington University

Within the last 20 years, freehand drawing has come full circle. Once overshadowed by the newness of technology, it is now making a comeback as a meaningful and sought-after skill. But, how do academics rethink sketching so that it is presented within an inspiring context? This methodology for incorporating sketching into the beginning design curricula starts with small-scale objects (furniture), expands into more complex spaces (interiors), and finally focuses on larger-scale subjects (architecture). Innovative ideas and step-by-step exercises explore the concept of the *process* of sketching, and give faculty a progressive framework to use within their courses.

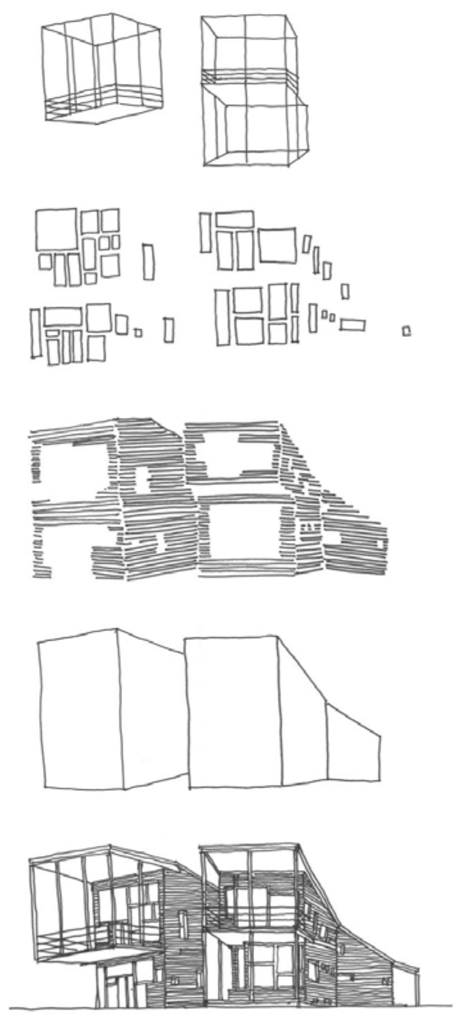


Fig. 1. Investigating Layers:
Sketches by Prof. Travis of Steven Holl's "Y" House.

Graphic Materiality:
Graphic Design as Building Element

Susie Tibbitts, Roberto Ventura

Utah State University, Virginia Commonwealth University

Foundation

A disconnect exists in design education between representation and building materiality. Targeting the physical and the tactile, however important, is only one component of materiality in design.

Materiality extends beyond the physical nature and assembly of building elements and engages the haptic and metaphysical. Material, Postell and Gesimondo[1] write, "possesses an inherent poetry that is interconnected with human experience and engages both the mind and the body." Pallasmaa[2] notes, "The quality of architecture...(lies) in architecture's capacity for awakening our imagination."

Through new digital processes and the rediscovery of interdisciplinary practice, graphic design exerts an exciting influence in the built environment. From Eva Maddox's branded environments to Rem Koolhaas's collaborations with Bruce Mau, practitioners are employing graphic design as building element and exploring a new hybrid.

Through artistic interplays of type and image, graphic design utilizes technology to evoke and inform.[3] If materiality is both physical substance and the state of being material, graphic materiality, this new hybrid, is the physical fusion of graphic design and building elements in service of artistic communication and spatial definition.

Graphic materiality shares much with traditional materiality. In addition to visual texture, fabrication technologies create physical surfaces via graphic design principles, resulting in unique hybrids. Unapologetically synthetic, graphic materiality expresses itself honestly, just as rough-hewn wood might. As in masonry, graphic materiality exhibits pattern and scale. The evocative power of graphics used as material illustrates its closest relationship to traditional materiality. No longer restricted to the canvas or cinema, image employed as a building element supports an immersive experience, one that "is tangible and appeals to the senses...(it) takes disparate elements and unifies them into whole systems."[4]

Beginning design students exhibit dexterity with graphic design technology, so the potential to integrate it into their design studies is great. Students can explore graphic materiality at full-scale with resources common to most design departments without the financial, spatial and temporal restrictions of building to understand traditional materiality.

Material Heterodoxy

Graphic materiality shares much with traditional materiality. It respects a module, honesty of expression, and metaphysical power. The graphic element is a fusion with the building material, and that characteristic, like the specific veining of soapstone, cannot be separated from the substance.

Module

Physical materiality implies construction, and in doing so, celebrates module. The repetition, the rhythm, and the scale of building material all influence the expression of space.

Module implies limit, in terms of assembly, system and fabrication. The brick suggests the ideal mass, volume and geometry for manual assembly. The proportion of a full sheet of plywood syncs with the accepted spacing and placement of wood framing, suggesting an integrated system of assembly. The size of an expanse of glass at the street level of a high-rise reaches a recognizable limit across similar buildings, suggesting an accepted limit for most applications of glazing; when one notices an overly large piece of glass, the contrasting scale is noteworthy.

Graphic materiality also respects module and scale. Examining common graphic design fundamentals, we notice principles like rhythm, balance and hierarchy, and fundamentals like transparency, layering, grids, and texture.[5] Graphic materiality must work within these modules, either because of its hybrid connection to traditional material, or by virtue of the assembly of the image. The basic building blocks of graphic compositions share metaphoric solidarity with basic building blocks.

Honesty

The origin of the materiality legacy in modern architecture can be traced back to the writings of Eugene Emmanuel Viollet-le-Duc[6] and the architects of the Industrial Revolution. The purity of expression, the articulation of order and the clarity of the rational all became the primary driver of beauty. The insistence on honesty put the integrity of material at the forefront structural and aesthetic expression.

However, Ruskin's "Lamp of Truth" in *The Seven Lamps* expresses the existence and potential delight of the non-authentic character, provided they made no attempt to falsely communicate an integrity. This explicit dishonesty permits the soul to engage the possibilities beyond the articulated expression. The imagination is activated once the parameters - e.g., "this is not real" - are established.[7]

Building elements exhibiting graphic materiality embody a priori honesty because their character is unmistakably manufactured. Image and text, the tools of the graphic designer, are man-made, and therefore impossible to interpret as anything other than that. Their synthesis with building materials, by default, create a hybrid unique in its genesis.

The ambiguity of some building materials like stone veneers or construction assemblies such as the Barcelona Pavilion column is absent in graphic materiality. Stone veneers may read as solid walls by the layperson, and the four L-angles comprising van der Rohe's cruciform column are camouflaged by their chrome wrapping. However, the expression of the illuminated panels on the facade of Henriquez Partners Architects' 60 West Cordova (Figure 1) development could not be read as anything other than sign. The synthesis of explicitly man-made elements in graphic materiality automatically conveys the honesty and truth of raw material, even if the actual assembly is obscured.

Figure 1: 60 West Cordova. Architect: Henriquez Partners Architects; Photographer: Colin Goldie

Metaphysical

My memory of my grandparents' house is infused with the scent of the cedar chest that sat at the foot of the bed in which I slept there. The haptic sensations of material bring with it associations and remembrances that add richness to the experience of place. As Pallasmaa writes, we process architecture through senses biased by our experience.[8] Design assuming a scheduled reaction is at best naive.

The architecture of the 1980s fetishized the visual, an impressive collection of aggressive, specific compositions which, despite their fantastic expression, left little on which the visitor could overlay their biography to establish a more intimate dialogue with space.[9] Richness occupies the space between object and past experience, and buildings and spaces that permit the grafting of the personal foster connection.

Although graphic materiality is heavily influenced by the visual, the power of it rests in its integration of image, text and space. Whereas the aggressive compositions of Deconstructivists established objects to be visually appreciated from afar, graphic materiality presents visual information for understanding.

If graphic design manipulates text and image, then the content providers include authors, poets, painters, photographers and cinematographers. Their currency is metaphor, and by virtue of this, invite introspection and metaphysical connection. Graphic materiality integrates this metaphoric language within the built environment. Whereas the design that Pallasmaa criticizes is segregated from the visitor,[10] graphic materiality engages the imaginations of the participant, resulting in multiple, muti-valanced interpretations and connections to space and place.

Professional Precedents

Design integrating graphic design and interior design demonstrates the conceptual, material and experiential power of such collaborations.

Branded Environments Studio at Perkins + Will: Richard E. Lindner Center, University of Cincinnati

Figure 2: Lindner Center. Designer: Perkins+Will; Photographer: Allison Buskirk

Eva Maddox's integration of graphic design in interior design characteristically imbues a materiality into neutral building surfaces. Instead of hanging images on a wall, the image and wall – or any building element – become one. The same characteristics an element built of wood might have can now be applied to a neutral material through the integration of graphic compositions. Color temperature, rhythm, pattern, visual texture all apply in a dissection of this graphic materiality.

The Lindner Center (Figure 2) weaves reflectivity and transparency with graphic information. The intensive use of graphics across these surfaces intensifies the environment and develops a complex spatial depth. Glass and graphics synthesize, transforming the two-dimensional surfaces into a three-dimensional architectural environment. A traditional material palette would work against this intensive three-dimensional composition, as would a more typical "hall of fame" arrangement, where information and honors are framed and contained. By endowing graphics with material qualities, the space transcends a mere trophy room; it becomes an environment that immerses one into the brand of UC athletics.

OMA/ Rem Koolhaas with Bruce Mau: Seattle Public Library

Rem Koolhaas and graphic designer Bruce Mau have collaborated on numerous projects since their book *S, M, L, XL*. The Seattle Central Public Library illustrates how they merge graphic design and interior design through graphic materiality in three important ways: signage; spatial definition; and conceptual expression. In each case, removing the graphic element diminishes the impact of the whole.

Figure 3: Seattle Public Library, circulation desk. Designer: OMA/ Rem Koolhaas with Bruce Mau; Photographer: Sarah Houghton

At the circulation desk (Figure 3) an object; instead, the sign is the object. Subtracting the graphic lessens the impact of the architecture. Integrating signage with building elements turns a graphic gesture into an architectural element.

Babble (2004, Figure 4), an installation by Ann Hamilton, translates graphic design into a physical texture, creating a three-dimensional surface. Instead of looking to material and construction to distinguish a space, the graphic intervention – in this case, text art -- defines the foreign languages area of the library. The relief of the text is a graphic layer atop the textural and color qualities of the flooring that articulates space.

Figure 4 (top): *Babble*, at the Seattle Public Library. Artist: Ann Hamilton; Photographer: Sarah Houghton

Figure 5 (bottom): Seattle Public Library, book spiral desk. Designer: OMA/ Rem Koolhaas with Bruce Mau; Photographer: Sarah Houghton

Finally, graphic design integrates with architecture to illustrate the conceptual thrust of the building. The building *parti* organizes the book stacks into a "book spiral," a progressively expanding core around which the library wraps. As the collection grows, the spiral expands. Instead of labeling the stacks by affixing placards to the ends of shelves, the sections are identified by floor treatments, articulating the expansion of the space and introducing a rhythm to its circulation, providing scale and wayfinding in one movement. Originating in the desire to establish the spiral as the focus of the building, the graphic gives emphasis to the singular gesture of the building, namely, the decision to locate the collection in a cohesive whole rather than in multiple segregated floor level.

Shigeru Ban: Camper SoHo

Figure 6: Camper SoHo. Designer: Shigeru Ban Architects; Photographer: Forgemind Archimedia

Ban exploits the three-dimensional potential of graphics in his SoHo storefront for the Camper shoe line (Figure 6). Understanding the pragmatic necessity of promoting the brand in a busy pedestrian and vehicular commercial intersection, Ban negotiates the twin requirements of signage and product through one gesture that simultaneously embodies both.

Clearly defining the space by dematerializing the facade and celebrating the activity of the inside, namely the display and purchase of footwear, Ban establishes the interior as the architecture of the space. Viewed from one approach, the interior is dominated by an elevation-wide Camper logo. This gesture responds graphically to the vehicular context of the site, defined by speed and traffic; in essence, the interior is a billboard.

From the opposite street, the logo is segmented, revealing shelving extending the same length, a detail gesture appropriate only for the slow, small-scale pedestrian-scaled investigations of window shopping.

The geometric necessities required to execute the gesture then determine the organization of building elements like lighting and furnishings. The designer uses graphics three-dimensionally in a way that cleverly and strategically exploits the project's programmatic, pragmatic and conceptual ends.

OMA/ Rem Koolhaas with 2x4: The McCormick Tribune Campus Center at the Illinois Institute of Technology

Figure 7: McCormick Tribune Campus Center. Designer: OMA/Rem Koolhaas with 2x4; Photographer: Eric Allix Rogers

The McCormick Tribune Campus Center by OMA/Rem Koolhaas showcases graphics by the design studio 2x4 (Figure 7). Small pictograms depicting various student activities combine to create large murals of Mies van der Rohe, one-time director of the school of architecture and master campus planner at IIT, on the glass entrance of the building. 2x4's micro to macro approach to this environmental graphic simultaneously provides insight into campus life and the unique history of IIT. The pictograms have formed a pseudo brand identity for the college and can be found on merchandise throughout the campus bookstore.

Ghislaine Viñas Interior Design, LLC, Warren Street Townhouse

Figure 8: Warren Street Townhouse. Designer: ghislaine viñas interior design; Photograph courtesy of: ghislaine viñas interior design

Unlike most interior designers, Ghislaine Viñas transforms basic interior design components into graphic elements (Figure 8). Viñas and her husband Jaime Viñas, a graphic designer, often collaborate on custom graphics for commissioned spaces. Her work includes a typical use of two-dimensional graphics such as wallcoverings, custom paint, rugs and artwork but the application is profound and purposeful. More unique is her layered use of three-dimensional pieces, like furniture, plate assemblages, light fixtures and accessories, which skillfully create complex, livable environments using graphic techniques.

Rockwell Group's LAB and Digital Kitchen Designs: Cosmopolitan Hotel

Kinetic spaces, like the lobby and registration area of the Cosmopolitan Hotel illustrate an innovative convergence of graphics and interiors (Figure 9). Characterized as digital architecture, the 384 LCD screens which wrap the columns and 26 screens located behind the registration desk allow for a dynamically changing environment.[11] The screens display synchronized graphic animations with mesmerizing movement. The graphic scenes alternate imagery which include but are not limited to, botanical specimen illustrations, dancing couples, bookcases, pathways and provocative human forms. The integration of kinetic images with building elements exhibits graphic materiality as the kaleidoscopic content of the video is supported by transparent and reflective surfaces. The conception of the image, material and space is holistically considered.

Figure 9: Cosmopolitan Hotel. Designer: Rockwell Group's LAB and Digital Kitchen. Photographer: Brandon Shigeta

This concept transcends that of any static space and yields endless design possibilities. Kinetic spaces have the ability to reinvent an environment thereby providing the user an assortment of sensory experiences without altering the interior architecture. This type of space is similar to the virtual environment of a video game but is more sophisticated when combining tangible people and objects. Maneuvering through a space such as this amplifies the relationship an occupant has to the graphics.

Pedagogical Opportunities

The exploration of graphic materiality in studio potentially benefits the beginning student in multiple ways.

As programs like Adobe Photoshop and Illustrator become increasingly accessible, students arrive at universities with technological awareness but limited design understanding.[12] Rather than segregate the computer from the design process, projects that develop awareness of design principles, strategies and fundamentals can be employed to bridge the technological and conceptual gaps.

Exploring graphic materiality as a pedagogical tool also enables the student to explore design concepts and executions at full-scale. Pattern studies, environmental graphics and building elements, from surface design to three dimensional mock-ups, can be explored at a one-to-one scale. Design aspects like production, assembly, scale and proportion can be directly explored using resources common to most any design program. Limits to production -- available space, insurance liability, tools, institutional obstructions, time and finances - are either easily overcome or smaller in magnitude when looking to work with graphic materiality. In many cases, not only is the graphic element developed at actual size, but the materials employed may also be real and not facsimile.

Figure 10: *Folding Forms*. Designer: Susie Tibbitts; Photograph courtesy of: Susie Tibbitts

Folding Forms (Figure 10) is an example of a full-scale prototyping research project that examined the process of converting two-dimensional graphics into three-dimensional forms for architectural and interior use. The preliminary models and prototypes were constructed using hand and laser-cut paper which allowed for a cost-effective exploration of the designs. This example of graphic materiality explores the impact of a graphic as shape rather than image or type. The project involved establishing a singular graphic element similar to a building unit. The units were then combined to create a building system. Access to large format printers, laser-cutters, rapid prototype and CNC machines can result in strong student outcomes regarding graphic materiality exploration.

Graphic materiality also provides an opportunity for disciplines at the foundation level to cross-pollinate. The opportunity for collaboration between interior design, graphic design, architecture, landscape and other disciplines is rich in terms of scale and content. Since graphic materiality is at its essence a hybrid, no discipline can claim dominion over it, and thus, many voices can be heard in the process.

Conclusion

Graphic materiality describes the class of hybrid design work that fuses graphic design with building elements. Like traditional building materials, graphic materiality embraces module, honesty and metaphysical connection. The practitioners exploring it develop spaces where the graphic quality of the environment is inseparable from the experience of place.

Graphic materiality provides opportunities for students to explore interdisciplinary design at full-scale. The logistical thresholds traditional building projects must overcome are potentially lower than for graphic materiality explorations.

Notes

1 Postell, J., & Gesimondo, N. (2011). *Materiality and Interior Construction*. Hoboken, NJ: John Wiley & Sons, Inc.

2 Pallasmaa, J. “The Geometry of Feeling: The Phenomenology of Architecture.” *The Architectural Reader: Essential Writings from Vitruvius to the Present*. Ed. A. Krista Sykes. New York: George Braziller Publishers, 2007. 245.

3 What is Graphic Design? (1993). Retrieved on 14 June, 2013 from http://www.aiga.org/guide-whatisgraphicdesign/

[4] Wheeler, A. (2009). *Designing Brand Identity: An Essential Guide for the Whole Branding Team*. Hoboken, NJ: John Wiley & Sons, Inc.

[5] Lupton, E. & J. C. Phillips (2008). *Graphic Design: The New Basics*. Princeton Architectural Press.

[6] Viollet-le-Duc, E. "Dictionnaire Raisonne." *The Architectural Reader: Essential Writings from Vitruvius to the Present*. Ed. A. Krista Sykes. New York: George Braziller Publishers, 2007. 241-245.

[7] Balhon, C. J. "Interpreting Ruskin: The Argument of *The Seven Lamps of Architecture and The Stones of Venice*." *The Journal of Aesthetics and Art Criticism*, 55 (4), 401-414.

[8]. Pallasmaa, 243.

[9]. Ibid.

[10]. Ibid.

[11]. The Cosmopolitan of Las Vegas. (2010). Retrieved May 22, 2013, from http://www.rockwellgroup.com/projects/entry/the-cosmopolitan-of-las-vegas

[12] Pan , R.,Kuo, S., & Strobel, J. "Interplay of computer and paper-based sketching in graphic design." *International Journal of Technology and Design* Education. 23 (3), 785-802.

ILLINOIS INSTITUTE
OF TECHNOLOGY