1:1 Scale Transformation

Meg Jackson, University of Houston
Weiling He, Texas A&M University

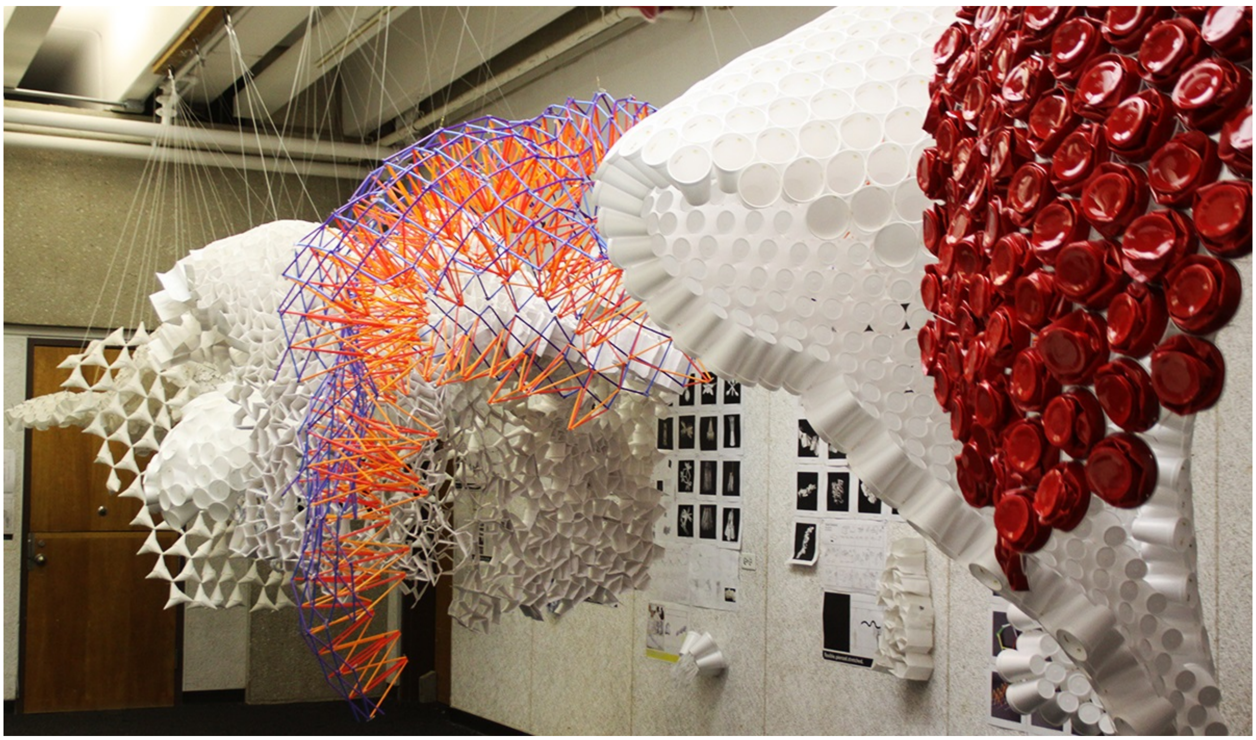

Figure 1_ 1:1 Installations (Student Work)

Introduction

Through iterative acts of making, the 1:1 case studies (1) presented in this paper explore teaching strategies that embrace intuitive, yet rule-based, active approaches to learning. Students are asked to investigate, elaborate and implement complex attitudes towards materials and objects in space, especially as they relate to the human scale. The projects demand intense material investigations and iterative problem solving. The projects require the students to negotiate between the scale of the material and a scale relative to the human body.

Introducing 1:1 Scale in Foundation Design

It is through direct contact – physical, emotional, and of memory – and through direct problem solving that learning / understanding is created. In these 1:1 projects, students are not learning through inherited ideas but learning through individual problem creation and solution seeking. The students have to engage intuitively with an abstract concept as well as investigate an idea through a physical medium.

It is important to engage with traditional and emerging ways of making and material expression in a foundation curriculum. These 1:1 projects intimately connect students to materiality and gravity and the sensorial physical phenomena of the discipline. The projects challenge the students to transfer a complex, even abstract, idea into a full-scale design.

These projects operate on the premise 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 as a representation of ideas but the physical consequence of them.[1]

The 1:1 approach to iterative, generative processes exposes beginning design students to methods of making, complex organizations, diverse materiality, alternative ordering systems, and construction tectonics.

The final installations, which uniquely reveal both process and idea, are an opportunity for the students to directly experience the process of making. The crafting of scalable materials reconnects the hands to the mind. By directly engaging with physical methods of making, students must 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."*[2]

The case studies presented reveal teaching methods that increase a beginning design student's ability to think critically using rigorous generative processes. The work illustrated here emphasizes research, communication, evaluation, and problem-solving.

Scale Inquires

All projects begin with a 1:1 material and end with making a 1:1 space. The project brief is minimal. The students are to select an everyday, disposable object such as plastic ware, milk jugs, coffee sleeves, egg cartons, or boxes (2). They are to create a modular, aggregated surface at the scale of the human body that responds to the given site context.

Process is evaluated on the strength of the experimentation, intensity of the investigation, material manipulation, and innovation. Students document their process through sketching, diagramming, scale models, photography, and axonometric sequence drawings. Projects are evaluated relative to structural controls and formal assemblies, as well as the potential for spatial expression and creative problem-solving within the given constraints.

The final result is a 1:1 installation relative to the scale of the human body and the context of its site. The design investigations are 1:1 relative to the scale of the component object and the module. The design process operates within the dialogue between these scales.

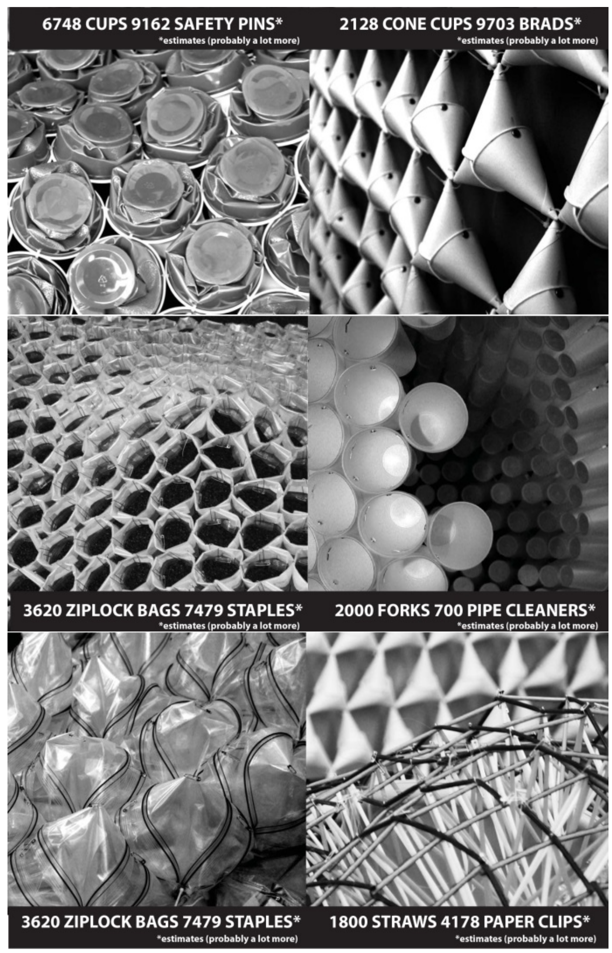

Figure 2_Common Object Assemblies

At the Scale of the Component

The project begins with rigorous iterative experiments that are expressions of 1:1 material investigation and material performance. The final systematic assemblies explore 1:1 tectonic relationships and operate simultaneously at the scale of the object, at the scale of the module, and at the scale of the assembly.

These projects require that the students define a methodology and a systematic approach to the design process (3). Students are asked to develop rules, or strategies, which guide and organize their process of material transformation -- from the initial selected object to a structural module.

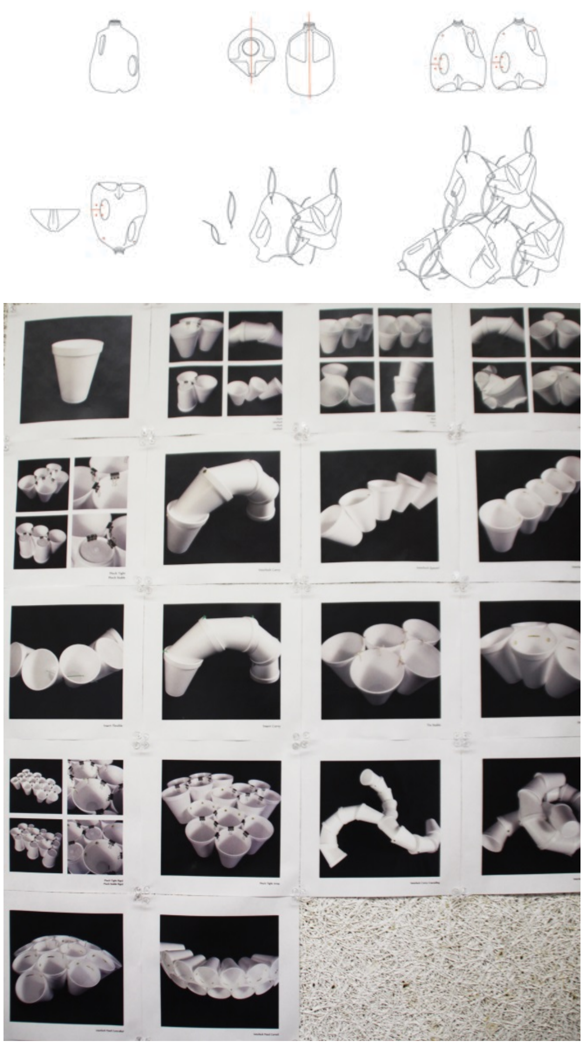

Figure 3_Systematic Approach (Student Work)

Material Scale

Each common object has a clear original scale. Its function determines its construction, material properties, form, scale and identity. Students may transform the geometry of the component using measured, intentional, and precise operational techniques. The project challenges the logic, construction, materiality, identity, scale, and geometries of the found object, while revealing and extending its architectonic potentialities.

The component, a material with definitive limitations, offered an opportunity to unexpectedly manipulate an anthropomorphic, architectural research object at the scale of the human body to determine topological and functional potentialities.

During the investigation of a module's performance, many factors affect the resulting material scale including the material potential of the common object, the overall scale of the design, and production efficiency.

Each of the un-manipulated components have inherent structural integrity, however through the manipulation and accumulation of the component, its properties can be weakened or strengthened. Physical factors, such as strength and weight, are taken into account in the evaluation of the module. The structural potential of the module will determine the resolution of the final surface.

Besides physical factors and material potentials and effects, human factors, such as production efficiency, play a determining role in material scale. For example, in transforming water bottles, a student simply used the tying technique, utilizing the gradual shifting angles between bottles and the resulting overall curvature but avoiding the tedious cutting process. Material scale does not change in this case. However, the overall effect of the design is magnified (4).

Perception Scale

Transformation happens both in reality and in perception. Between reality and perception, contrasting attributes exist in the same material, such as soft and hard, light and heavy, and flat and volumetric. In transforming common objects into modules and emphasizing their materiality, we discovered the important role that resolution of perception plays.

Figure 4_Transforming material scale of paper cups (Student Work)

The geometry of common objects is tied to their functional meaning. For example, a milk jug has a distinct cap, a neck, a handle, and a body. We understand what they are and what they are for. Increasing the amount, pattern, and repetition of common objects may change our perceptive resolution. Thousands of milk jugs together may resemble a pile of snow. The handles, from a distance, may create the appearance of softness in the eye. When a material is perceived in a new scale its resolution is re-defined and its appearance changes.

Through manipulating the component, one reinforces or weakens its original scale. For example, operations that expose the previously hidden interior space of an object reveal new qualities of that object. Repetitive systems that create equilateral, geometric modules, such as triangles and hexagons, cause the geometry of the module to dominate while the reading of the original unit of the object weakens (5).

Figure 5_Perception of Modularity and its geometric aggregation (Student Work)

Pre - Parametric Thinking

These 1:1 modular investigations introduce beginning design students to not only traditional design processes, but also to parametric thinking, tectonics, and generative techniques. The investigations introduce concepts of tectonics, modularity, assembly, texture, and the manipulation of surface, pattern, and field. The design and performance of the surfaces are ultimately controlled and calibrated within the logic and geometry of the component's geometric parameters. Strategically layering and controlling primitives generate the installations; therefore, they have both rigorous order and parametric potential.

The simplicity of the common objects provides necessary constraints while at the same time their flexibility provides a potential for individual exploration. A system-based approach anticipates the need for beginning design students to connect with digital methods of making. These analogue projects are precedents for further exploration into complex computational geometries, parametric design, and digital fabrication methods.

In the 1:1 projects presented here, the 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. 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 (6).

Figure 6_Student assembling modules.

Module Systems

Most of the material investigations focus on the connection details (7). These connections operate at two relative scales: at the scale of the designed module and at the scale of the surface assembly.

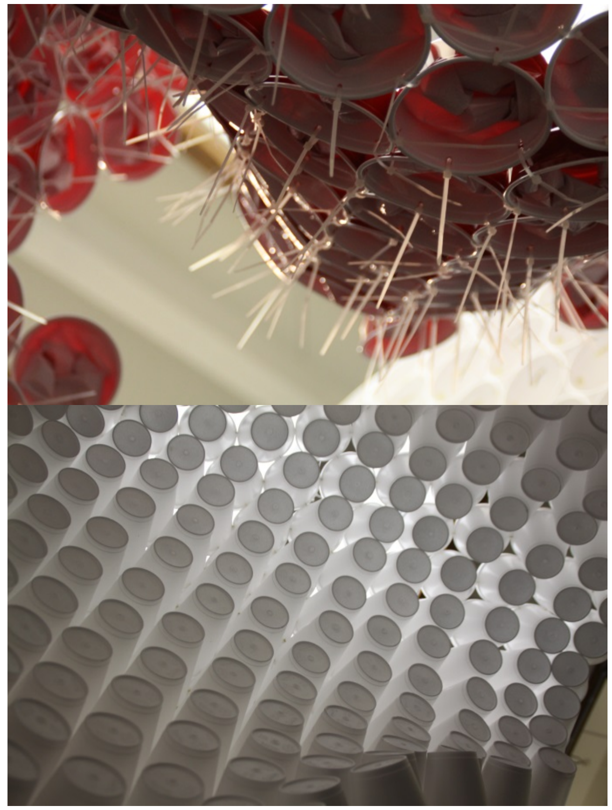

Figure 7_ Tectonic Details | Figure 7_Surface (Student Work)

These system-based explorations reveal the power of modulation as a space-making operation. Final installations, made by hand, even as a scale model, reveal the architectural implication of surface, as well as the ability of aggregated 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.

Once a module has been established, the focus turns to the performance of that module in an aggregated state and the system of joinery that creates the surface (7). The surface operates at the scale of the human body.

At the Scale of the Body

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. These 1:1 case studies provide alternative strategies to engage the students directly and actively with the complexities of spatial dynamics as related to human scale (8).

Figure 8_ Surface enclosing the body (Student Work)

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. The projects are in scale relative to the body that encourages the students to understand how the body is a measurement in relation to itself, other people, objects and surfaces affecting the environment: *"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."*[3]

The Dynamic Human Factor

In order to address issues of scale relative to the human body, students were required to do a series of diagrams during the design process (9). Diagrams have the unique capacity to dissect, layer, and process complexity that makes them a successful generative tool. The medium of drawing serves 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 drawing 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.

The diagramming process promoted innovation—allowing each student to create an architectural

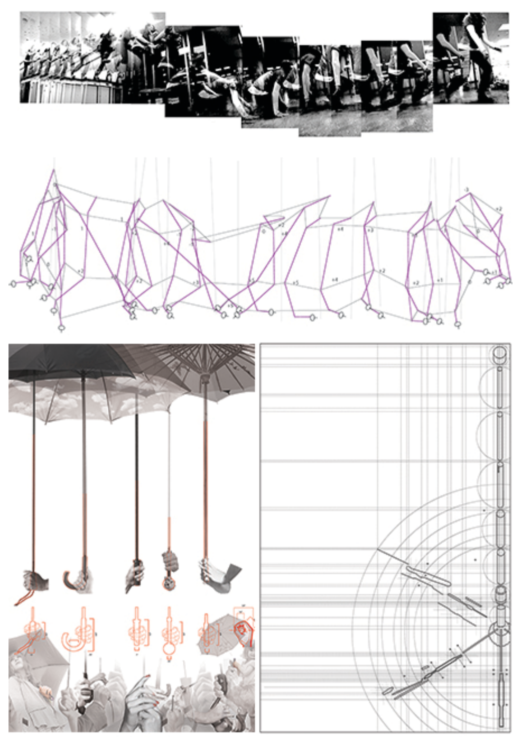

Figure 9_ Diagrams investigating the body (Student Work)

language to notate anthropomorphic measurements simultaneously communicating a complex spatial idea.

At the Scale of the Site

All of the projects must respond to the context and scale of site. The original scale is relative to the scale of the common object. The assembled surface needs to adjust to the scale of the site. Both the scale and the identity of the common object are transformed with the context of the site.

Different spatial contexts demand different scales. In the physical world, one cannot escape from resolution and gravity in design and making. Resolution is a demand from the body's tactile and visual perceptions, and movement in space. Gravity constrains the structural existence.

In past iterations of these projects, we have experimented with varied scales of sites, such as the human body as site, interior spaces, spaces between buildings, and open spaces in nature. Each of these surfaces is relative to the scale of the human body. However, the object's scale changes relative to the scale of the context (10).

Perception scale also affects site scale. A site is composed of a hierarchy of space relative to depth, from the close up and immediate space to the farthest extension. Within this space, the viewer not only moves and senses, but also constantly makes references of the design in its site. Therefore, when one is at the periphery of the site or at a close distance to the design, he/she may perceive in difference scales. When being afar, the perception may be the overall formal logic of the surface, such as axis, datum, and direction. When moving closer, the perception may be an edge condition or a ground condition. Moving even closer, the perception may be the geometry of the modules, and eventually the tactile qualities of the material when sight is replaced by touch.

Scale Models

Iterative scale models were required in order to address these factors of scale early in the design process. As part of the problem solving process, the students are required to do multiple iterative scale models of their full-scale designs (11).

These intense, hand-crafted, working models allow us to address issues in studio beyond the component manipulation early in the process. They allow the students to set a goal for their projects and serve as physical evidence of the design development and process. Since the projects often require the students to engage with the site-specific context and have a relationship with the neighboring installation, the scale models are useful in group studio discussions. Unlike drawings, which were also required, working models are easy to refer to and access projects quickly.

Figure 10_Project made from coffee sleeves in various contexts. (Student work)

Figure 11_Scale models with finished installs. (Student Work)

Perhaps the biggest consequence of the scale models, however, is their value in teaching a design process – a systematic approach to the development of an architectural idea. Problem solving exercises with no formal methodology for the design process may miss opportunities for learning. While simultaneously addressing 1:1 material investigations, the scale models are necessary design tools to develop and evaluate concepts. The working model helps the student visualize his intent and helps to actively reflect on that idea (12).

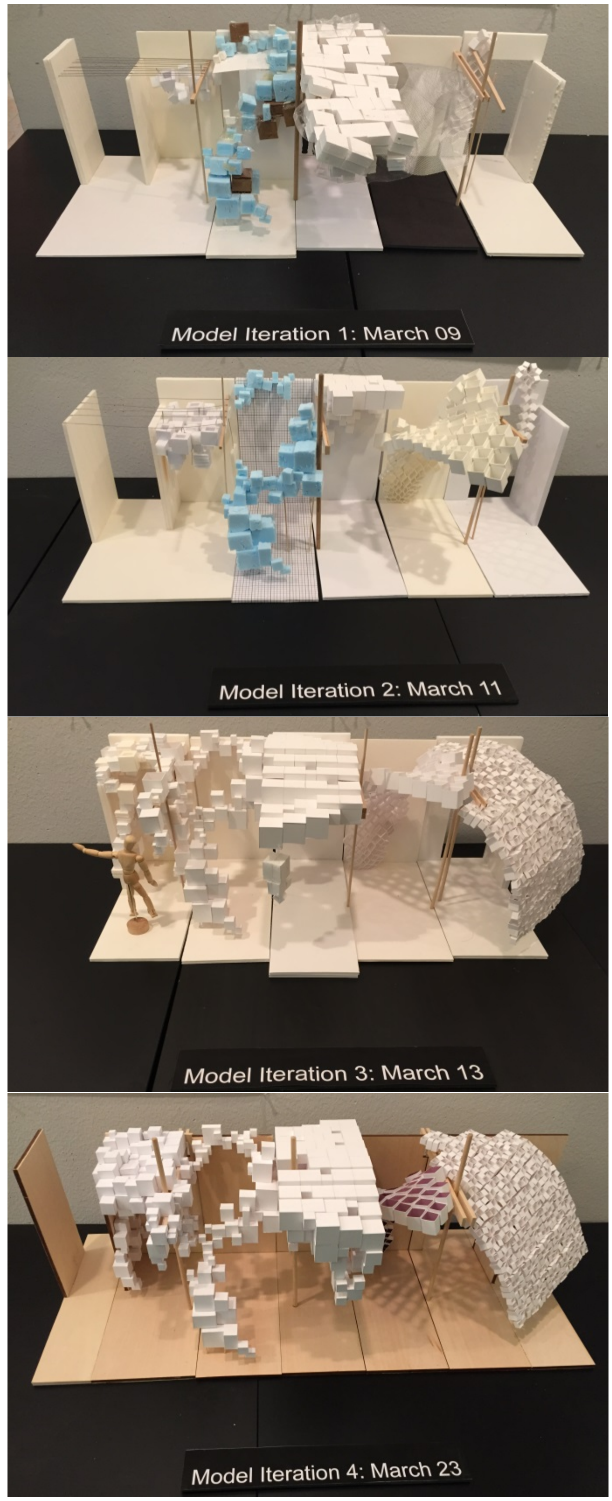

Figure 12_Iterative Scale models (Student Work)

Models force students to physically commit to the act of making. By organizing the design process and making it more transparent, the models helped the students visualize the potential of the abstracted architectural problem.

At the end of the project, the iterative scale models gave the students a clear look back at their design process. While the project outcomes were a source of pride, the rigorous process remained equally important in the evaluation and, more importantly, to the students.

The case studies presented are consciously full-scale at 1:1. During the design process the students were required to make scale reference models (1"= 1'). By working at both scales and having the unique opportunity to have their ideas "realized" at full-scale, the students perhaps understand the 1:1 scale more concretely and have a more intense appreciation for scale architectural models (13).

Figure 13_Scale Translation | Scale Models with the full-scale install. (Student Work)

The importance of Iterative Process and Generative Design

The ability to think critically is the means by which designers observe, learn, investigate, and innovate. Accordingly, the responsibility of the educator is not simply to teach design as a *product*, but rather as a complex *process*. To that end, exercises must be designed not to encourage a finite conclusion, but, rather, to establish a limitless territory for exploration through iterative process, evolution of thought, and individual expression.

While the 1:1 case studies presented in this paper are somewhat abstracted from the realities of architectural construction, the projects define a systematic design process. Complex processes of translation are rigorously engaged through thinking and making. These acts are fluidly, freely, and independently advanced, moving between mediums in two- and three-dimensions. Likewise, thinking skills that prepare students for computational methodologies are embedded within the design process. Self-directed experimentation and innovation is encouraged to achieve a level of understanding beyond the familiar. Furthermore, the project begins and ends with the potentiality for discourse beyond both merely the original problem and the finite solution.

Conclusion

In conclusion, we believe 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. Using a 1:1 material to make a 1:1 space demands scale transformation as well as transition from one kind of realness to another. In such transformation and transition, students establish a new materiality in an expanded context (14).

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 understand the act of design and the process of making as a dynamic shifting field, rather than as an autonomous act.

The body's relative size in space derives the literal scale. However, the body is more than a relative measurement. The human body does not solely influence scale and geometry, but also is a dynamic factor. Movement, time, experience, and memory influence the design.

Material iteration and re-iteration lead to a sequence of transformations: of itself, the space, and spatial effects. Processes of material transformation present a dynamic between resistance and expression. Starting from the initial state of materials, the design process involves rethinking and testing architectonic potentials. Form making obeys material limitations and opportunities, weight and gravity. The accumulated consequence of the final assembly may not resemble the initial material, but is itself a new material effect.

In addition, although representation, technique, and medium are necessary tools for fluency in the design process, as educators, we are responsible for the development of a design approach. Design, whether considered a noun or a verb, is a process – the act of making. 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. We should actively and creatively engage students in ways of making while teaching ways of seeing.

Through iterative acts of making, the case studies presented here explore teaching strategies that embrace intuitive, yet rule-based, active approaches to learning.

Figure 14_Making

Notes

[1]Attributed to Jeffery Kipnis in Anthing Discussion 3, *Anything*, ed. Cynthia C. Davidson. The Anyone Corp.: New York, NY. 2001. p 129.

[2] Menges, Achim. "Integral Formation and Materialisation" In *Computational Design Thinking.* John Wiley & Sons. 2011

[3]Pallasmaa, Juhani. *The Eyes of the Skin,* Wiley-Academy: Great Britain. 2005. p 64.

Selected Bibliography

Bachelard, Gaston, and M. Jolas. The Poetics of Space. Boston: Beacon Press, 1994.

Bloomer, Kent C., and Charles Willard Moore. Body, Memory, and Architecture. New Haven: Yale University Press, 1977.

Caan, Shashi. Rethinking Design and Interiors: Human Beings in the Built Environment. London: Laurence King Pub., 2011.

Clayton, Martin, and Ronald Philo. Leonardo da Vinci: The Mechanics of Man. London: Royal Collection Enterprises, 2010.

Diller, Elizabeth, Ricardo Scofidio, and Georges Teyssot. Flesh: architectural probes. New York: Princeton Architectural Press, 1994.

Dodds, George, Robert Tavernor, and Joseph Rykwert. Body and Building Essays on the Changing Relation of Body and Architecture. Cambridge, Mass.: MIT Press, 2002.

Gropius, Walter and Arthur S. Wensinger. The Theater of the Bauhaus, The Johns Hopkins University Press (Reprint), 1996.

Holl, Steven, Juhani Pallasmaa, and Alberto Perez-Gomez. Questions of Perception: Phenomenology of Architecture. San Francisco: William Stout, 2007.

Kieran, Stephen and James Timberlake, Refabricating Architecture. McGraw-Hill, 2003.

Lavin, Sylvia. Kissing Architecture (POINT: Essays on Architecture). Princeton University Press, 2011.

Mori, Toshiko Immaterial/Ultramaterial (Boston, Harvard Design School, 2002)

Pallasmaa, Juhani. The Eyes of the Skin: Architecture and the Senses. Chichester: Wiley-Academy; 2005.

Pye, David, The Nature and Art of Workmanship (Cambridge, Cambridge University Press, 1968)

Tilley, Alvin R.. The Measure of Man and Woman: Human Factors in Design. New York: Wiley, 2002