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Scalar Agency

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Scalar Agency: Ambiguity, Potentials, and Challenges in Design Thinking

Introduction

Our institution aims to educate good designers through a ten-semester studio sequence that proceeds from the fundamentals of architectural design, through the technical aspects of building and comprehensive design, to investigations of the urban conditions. This framework requires students to negotiate scales at both the macro and micro levels. Learning to be a good designer begins with developing the foundations of architectural design and understanding the relationship between space and the body, in which the understanding of scale is crucial. As students move through the program, they zoom-in on details and out to the city, to understand more extensive relationships and infrastructures. Our research evaluates these ideas as they move through our curriculum. We look at the beginning design studio exercises and the end of our program with fifth-year projects and thesis explorations. Scale is a factor through which designers comprehend their designs. However, it does not come naturally as it is an acquired sense and knowledge. Thus, as one learns to become an architect, scale is a part of the fundamentals in design to be cultivated. In this line of thought, this paper explores the relationship between developing an understanding of scale and cultivating design skills and design thinking in architectural pedagogy. Conceptually, they also relate to the issues of representation and thinking. How does the development of the sense of scale inform the growth of skills in architectural design? What would be a proper methodology to integrate both aspects?

Method of the paper

The paper will assess and analyze studio outputs from our program across different years. It will study drawings and models from these studios, documentation of design processes, and final designs of the design projects. In particular, it will focus on the relationship between scalar changes and developments of design by analyzing drawings, models, and documentation of design processes. It will also analyze the relationship between the spatial and formal qualities of the final designs with the development of the understanding of scale through different media and techniques. Along with these analyses, the paper intends to assess the development of the understanding of scales as students build their aptitudes in various manual and digital media and techniques. The paper will review the literature on design thinking to establish connections between existing knowledge in design thinking and the findings from the analyses. Through these findings, this study would reflect on our pedagogical methods and approaches to continue refining our design teaching. It also intends to contribute to knowledge in architectural design pedagogy.

Literature: Scalar changes and design thinking

In *Visual Thinking*, Arnheim discussed the development of human cognitive ability, in which seeing or visual perception is not a passive process, simply reading, collecting, and storing information from the environment as stimuli, but an active process, forming concepts (Arnheim, 1997 (1967)). It is based on the mind's ability to read the environment, on which mind receives and perceives stimuli from the world around us through visual means. In this sense, it is about seeing. Seeing relies on the readability of the information from the environment, which points to the clarity of form. In this process, reading the environment goes through the process of the selections and organization of stimuli. Further, the mind operates to the process of simplification and generalization. In this process, our mind search for the most basic and recognizable form from stimuli. The mind also seek to identify a complete basic form of visual stimuli. It also seeks to differentiate a stimuli from the context. Further, the mind would seek for relationship between forms. This relationship points to the notion of visual patterns. In this line of thought, the cognitions of visual stimuli or the readability of the environment lies not only on the geometric descriptions of the stimuli, but also on comparison between objects. Hence, scalar comparisons come into play. Ching mentions visual scale, which was about visual relationships between an object or building to another (Ching, 2014). However, these visual comparisons are more than visual perceptions. He argues that we have expectations of the comparisons between objects or scalar preconceptions. In this vein, he emphasizes the notion of human scale, in which we tend to use human bodies as the base of our sense of scale. Indeed, Rasmussen argues that humans tend to quantify our perceptions of the environment through mathematical ratios (Rasmussen, 1964). This notion of ratios connects the concepts of scale to that of proportions.

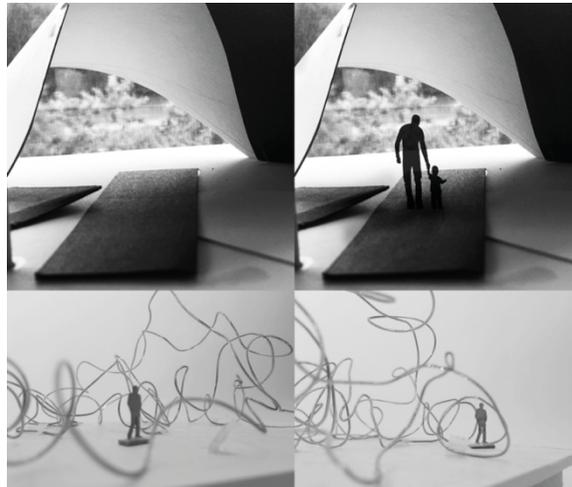


Fig. 01. First year studio explorations, student: Ferdinand Walden.

Source: Image by Author.

Sennett has discussed humans predilections to changes that happened through metamorphosis (Sennett, 2008). This metamorphosis could occur through three different trajectories. The first is through evolution that yielded variants of a basic

type. The second emerged out of unexpected juxtapositions. The third changes happened through a domain-shift. In this line of thought, we intend to harness the potential of the effects of metamorphosis, especially the notion of the domain-shift. We relate the domain shift with the notion of the scalar changes, that is, that our perceptions change when an object is compared with another one. In another word, we are interested in the spectrum of changes from scale less to scaled. It also the changes of the same object, from perceived as a small to a large.



Fig. 02. First year studio explorations, student: Brandon Parker.
Source: Image by Author.

Smith and Warke point out that scale is essentially relative and fleeting. We can only comprehend the scale of an object only in the relationship with other things (Smith, Warke, 2014). In this sense, our sense of scale depends on position, including the positions between objects and between the observer and objects of observation. Thus, they differentiate physical and perceptual scales. The former is the understanding of scales based on actual differences in measures of objects on comparisons, while the latter refers to our visual perceptions of the environment. As Picon has pointed out, digital tools can zoom-in and zoom-out on screens (Picon, 2010). Through this faculty, they allow designers to miniaturize large-scale projects. In this line of thought, designers can manage the complexity of large-scale projects by moving through scalar transformations. However, this miniaturization is double-edged. On the one hand, it allows for formal explorations beyond Cartesian geometry. However, this formal potential has made structures and materiality less relevant. . In this line of thought, Latour points out that changes in scale is not similar to optical changes of lenses, as in zooming (Latour, 2014). Hence shifting from a small to a large scale is

different from zooming-in or zooming-out. The metaphor of zoom implies hierarchy of data, in which data in the smaller scale is nested within the larger scale; while in fact, is not always the case. Using Google Earth as an example, zoom-in led to extractions of different set of data. Although Picon's argument is rooted in the digital tools, these observations on the artificial capabilities are also relevant to other prosthetic to human eyes, both digital and mechanical, including cameras.

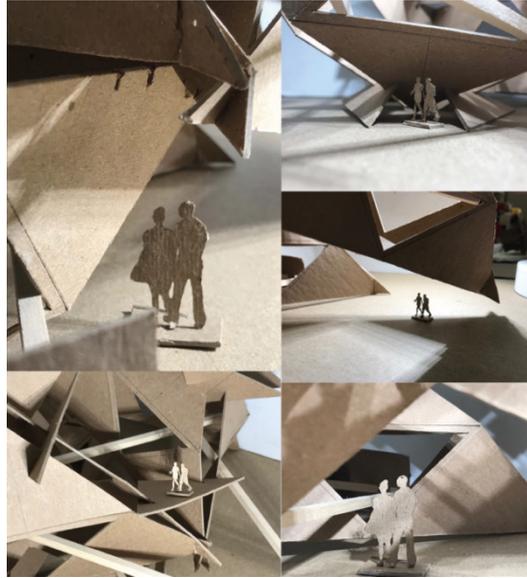


Fig. 03. First year studio explorations, student: Noah Stogner.

Source: Image by Author.

Case study - First-year zooming-in, Fifth-year zooming-out

The first set of exercises in the First-year studio or the beginning design studios intends to introduce students to skills in space-making intuitively. The exercises introduce students to basic hand-drawing skills, including contour lines, gesture, and tonal drawings. Each technique forms a set of exercises that ask students to draw from observations of the built and natural environment. However, these exercises do more than just develop skills in drawing. Instead, the drawings serve as the basis of a sequence of inquiry into space-making and spatiality. After each exercise in a specific drawing technique, the exercise asked students to develop a three-dimensional construct based on the drawing they produced. In the beginning, students tended to recreate the object they drew as they built their models. However, the brief guided students to develop models that create space based on lines or planes from their drawings. Hence, it directs students to construct spatial enclosures rather than objects. The models emphasize fluid lines and irregular shapes. After students finished their models, the brief asked them to take photographs, zooming into cavities inside the model. These procedures initiate the student to learn to see space using a camera as a prosthetic tool. The exercise asked students to cut figures and insert them into their models' cavities. The brief directed students to create cutout figures in different sizes.

In this way, the project directed students to compare and contrast the different proportional relationships between the space and the cutout figures. It intended to introduce students to the notion of scales, developing their sensibilities to the aspects of scale. In the subsequent exercises, the brief introduced students to some basic commands in Adobe Photoshop, in which they inserted human figures into their photos. These montages offered a way to imagine inhabiting space and conceptually transform a scaleless cavity into a habitable space. This sequence of exercises introduced and developed basic skills in hand drawing, model making, and digital. Pedagogically, they cultivate students in learning to see and observe, to document through drawing, to make space, and go back to see and analyze space in small objects. The notion of scale is developed through comparisons with human bodies.

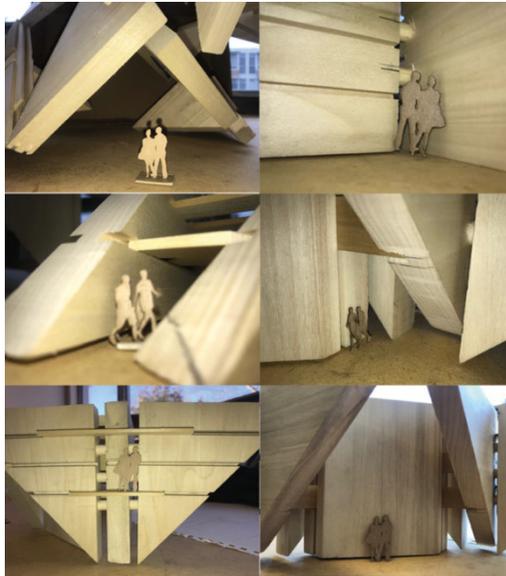


Fig. 04. First year studio explorations, student: Noah Stogner.

Source: Image by Author.

The next project in the First-year is based on the cube exercise. The brief for the project provided a gridded cube as the constraint for students. Students divide the cube into smaller spaces using basic geometric elements of lines and planes. These spaces juxtaposed and intersected with each other. They started with small study models to explore initial ideas. It intends to introduce formal and spatial order. As they refined their understanding of a three-dimensional organization that exemplified developing skills in formal and spatial order, they developed larger models based on these study models. In developing the project, the brief asked students to sketch out the sectional cuts of models, both in the horizontal and vertical directions. Eventually, as students produced large models, the project asked students to develop sectional drawings of the model. Spatially, the project intends to continue cultivating the ability in space making, turning cavities inside the cubic organization into habitable space.

It intends to introduce and develop fundamental skills in measured drawings and orthographic projections. In a way, it introduced basic plans and sections. In this

manner, the project introduces the notion of scale based on conventions in architectural representations. The project also tasked students to construct axonometric drawings. Crucial in this set is the notion of precision that guides the construction of drawings. By calibrating the scales of drawings and photographs, students reimagined these cavities into architectural space through changes in scales and measurements. This methodology explores the capabilities of graphic representations to introduce the understanding of space and form, which then feed into the subsequent design iterations.

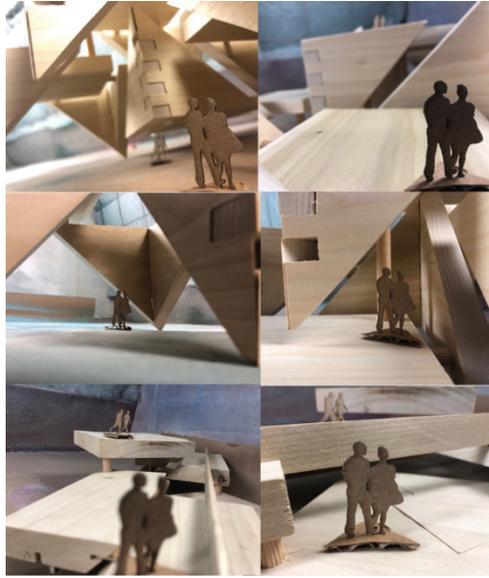


Fig. 05. First year studio explorations, student: Tim Gatto.

Source: Image by Author.

The semester's final project aims to integrate the learning and lessons from these two modules. The brief tasked students to design a small structure, which includes an entrance, a passageway, and a personal space. The latter is within the confine of twelve by twelve by twelve feet maximum. The project asked students to use their cubic project as the starting point for their design iterations. In this line of thought, their orthographic and axonometric drawings were crucial. Students explored possibilities of transforming their drawings; in a way, they explored changes and transformations of proportions of their drawings. In a way, the brief directed students to the possibility of transforming scales in order to change a scaleless construct into a scaled, habitable entity. It combines the scalar transformation from their first exercise and the measurable procedure in the second project. The precisions in the second project guide the scalar transformations. In this line of thought, the scalar transformations inform the formal and spatial features and organizations.

The second semester of the design foundation studios focuses on making, fabricating, and constructing. In the first project of the semester, students explored precedents of wood architectural details. These details were collected from the work of prominent architects in modern architecture, such as Alvar Aalto. Students

gathered the orthographic drawings and analyzed these details to identify their formal features and organizational principles. Based on these findings of the design rules, the project asked students to develop their design of three-dimensional constructs. They should develop their artifacts based on the design principles of their precedent. Next, students moved to the wood shop. In this stage, the project tasked students to fabricate and construct wood artifacts based on their precedent. The project did not intend to recreate the original detail. Instead, it asked students to use lessons from the precedent, and the formal organizational principles from the details, to develop their arrangement. The project provided a set of constraints for the wood artifact, including using linear elements and wood tiles with specific dimensions. Besides introducing students to the notion of working with limitations and potentials of materials and techniques, that is, wood and wood joinery. Design-wise, this project intends to bring formal organizational principles across scales. In a way, this project moved from scaled information of the precedent into a scaleless wooden artifact.

The final project of the semester and the first year asked students to design a pavilion for students to study. The project called for a design to accommodate a large space for group study, four to six small spaces for individual study, entrances, and circulation space. Further, the project specified that the design should integrate the wood artifact into the design. The iterations should transform the artifact's design as a thematic part of the design. These could range from the assembly of structure and enclosure of the building based on the formal organization of the artifact to the organization of space following similar organizational principles.

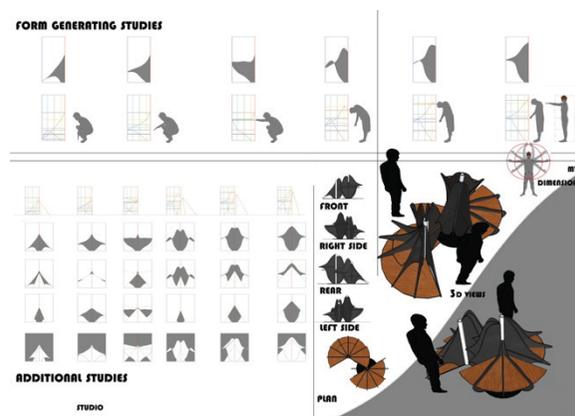


Fig. 06. Focus Studio anthropometric study and analysis of the body, student: Robert Bochenek.

Source: Image by Author.

In a fifth-year project devoted to materiality and making, building on the long heritage of design build at our institution, the project centered on the design and construction of a moveable kiosk for the school's chapter for AIAS. The kiosk was envisioned to support the Freedom by Design program and act as the home for their bake sale fund raising events. The exploration began with two smaller studies investigating recycled materials searching for ways to repurpose the discarded and understand the relationship between the body and space by analyzing anthropomorphic data and how the human body gets integrated into the design process as it relates

to issues of aesthetics, function, structure, economics, and construction technology. The first studio exercises started with an open-ended experiment into materials and materiality. The agenda for the experiment was to develop a tectonic object focusing on an architectural construct, such as surface, skin, enclosure, tactility, structure, and fabrication.

The criteria for material selection was quite open and extremely flexible though the tectonic object had to be developed out of an object or series of objects that have been discarded or basically forgotten. The student explored the flexibility of their media engaging its possibilities through a series of mutations and transformations. Scalar transformations required the creation of a larger framework for replication. The tectonic object was investigated through the use of physical study models and documented through drawing and representation. Students documented the performative and experiential qualities of the artifact and illustrated the aesthetic and technical aspects of the design. In every instance the relationship back to making and experience was highlighted.

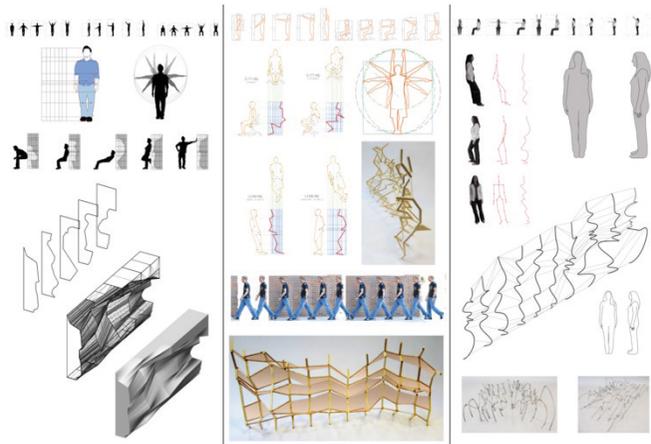


Fig. 07. Focus Studio anthropometric study and analysis of the body, students: Kevin Chong, Jonathan Davis, Sarah Roland.

Source: Image by Author.

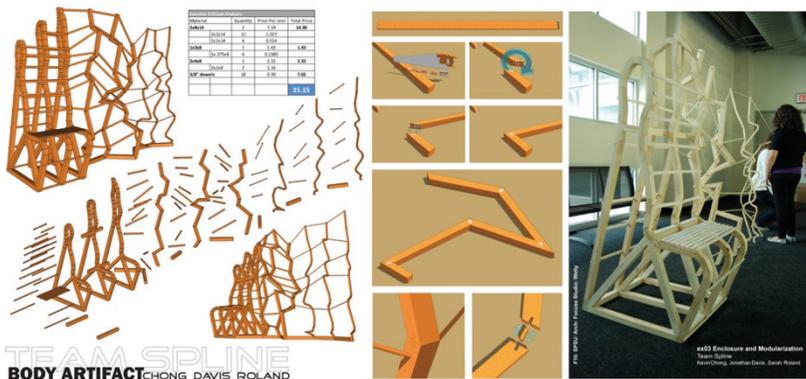


Fig. 08. Focus Studio anthropometric study and analysis of the body, students: Kevin Chong, Jonathan Davis, Sarah Roland.

Source: Image by Author.

The body provided the starting point for the second project with an exercise centered on anthropometric study and analysis of the body. The human body is viewed as the design agent, bringing critical issues of scalar relationships, ergonomics, cognitive and sensory perception. The investigation begins with documentation of the body. Catalog and map the body to develop a studio module inspired by le Corbusier's le modulator. Students developed a series of graphical diagrams that described spatial relationships of space, activities, and spatial requirements. They started with static poses documenting limits and extends. Then created a graphic avatar representing themselves, scaled to their body proportions. From here a series of drawings were produced similar to the anthropometric charts found in Graphic Standards. The goal was to create a catalog of the dimensions of their body and its parts. Combining these diagrams and spatial studies was used to develop an ordering system or module for the studio. We are attempting to develop some rules for spatial organization. The body postures and movement were documented through static poses. Include in this investigation social situations that might be encountered in our kiosk, such as interacting with a patron, sitting with friends, reading alone, moving through the space, lounging, or discussing. These studies recall exercises from the first year to understand the relationship between body and space by analyzing anthropometric data and the human body related to issues of aesthetics, function, structure, economics, and construction technology integrated into the design process. Through these first two exercises the notion of scale was engaged through the physical with analog artifacts providing a direct connection from mind to hand. Scaler transformation that were not possible to material or size constraints were explored and represented by digital means.

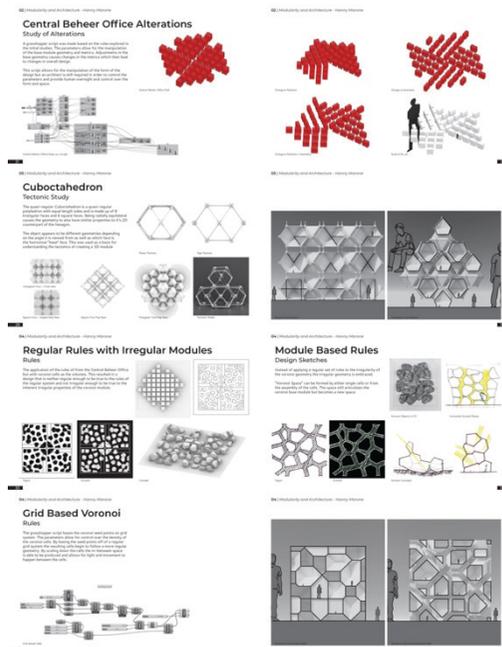


Fig. 09. Thesis Studio, Modularity and Architecture, student: Hanny Marone.

Source: Image by Author.

This documentation led to an ordering system and rules for the formal, spatial organization that guides a design/build project of a wooden kiosk. It also informed the method of construction of the kiosk. These projects develop the foundations of architectural design. More importantly, the methodology also informed projects in subsequent years through the final level. In a studio in the fifth year, the project directed students to trace human figures. However, these lines are only part of the complete outlines of the body. Instead, this step generates a series of line drawings that traces a series of the posture of the human body in a specific position. These lines, arrayed in vertical directions, formed the construction lines for an artifact. The project led students to transform this design into a structure that would fit a human body. However, the project continued as drawing. It continued into a built structure on a one-to-one scale.

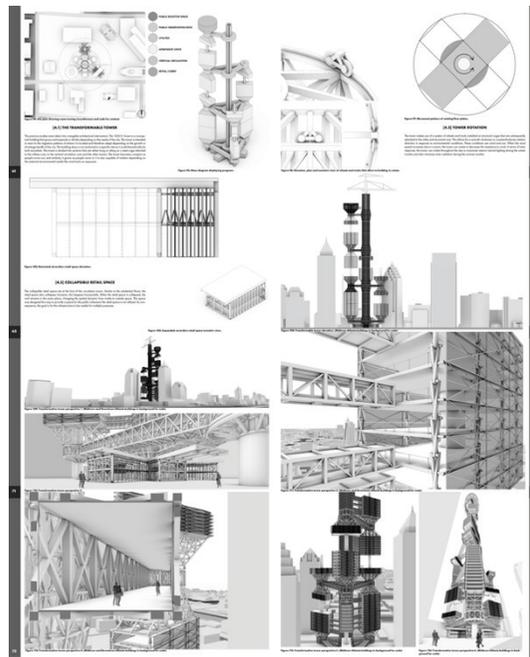


Fig. 10. Thesis Studio, Transformable Architecture Through Kinetic Mechanisms, student: David Feregino.

Source: Image by Author.

Further, some projects from our thesis studio explored scalar transformations through digital means. A thesis revisited the notion of mat building to generate designs for tall structures in urban settings. It experimented with elements and configurational rules in the digital space without scale definitions. The findings led to basic modules for designing a tall, multi-story building. The thesis then translated scaleless modules into those appropriate for a tall building. One of our thesis students focuses his research on mat building. The students studied the literature on mat building as well as an analyzed precedent of mat buildings. This research allowed the student to extract the design principles of mat building. In this vein, it hinges on elements and a set of rules

that govern and organize the design of the mat building. The student brought these findings to focus on exploring elements and configurations. In this line of thought, the student explored various geometric shapes for the elements. In turn, the geometric shapes informed the formulations of possible rules for the configurations to form the mat organization. The research began with physical objects. However, the students then brought the findings to conduct explorations in the digital realm. It allowed the students to expand the range of formal explorations. In this vein, the studies offered the possibility to explore various geometric shapes, from regular to irregular geometry. It also provided opportunities to explore possibilities of varieties of shapes from the basic shape; in line with this, it also allowed for varieties of dimensions from a similar geometry set. Historically, mat building worked in a horizontal direction. This thesis intends to apply the principles of mat building in the vertical direction.

The design inquiries started from a series of plays and explorations that focused on defining basic elements and possible rules for configurations of these elements. The iterations tested different geometry of these elements, followed by possibilities to alter the proportion of these geometries. The next set of iterations explored these elements and configurations as three-dimensional elements and configurations. These explorations happened in the digital space without definitions of scale. The findings from these experimentations served as the basis to define a set of basic modules for designing a tall, multi-story building. As the design process progressed, the student refined the translation of the scaleless modules into modules appropriate for a tall building. This scalar transformation necessitates the student to apply and integrate knowledge learned throughout undergraduate education. Along this vein, another thesis project pursued the question of expanding kinetic architecture into generative design. Based on findings from literature and examples, the thesis studied a series of elements and connections in digital space that were fabricated through a three-dimensional printer. These artifacts allowed the student to experiment with different alternatives. These included horizontal and vertical directions and small, medium, and large. The thesis tested the possibilities of generating tall buildings based on these principles of kinetic architecture.

Discussions

Throughout our design sequence, students encounter a series of projects exploring various scalar transformations. This methodology also informs projects in subsequent years through the final level. The exercises aim to enhance creativity and possibility by exploring the unimagined. They empower the student to move beyond what they know and embrace the possibility of what they might find. Exploring scale through analog and digital means gives the student the basic tools for expanding their experiences and widening their design perspectives. The exercises follow a similar approach, whether analog or digital, in all studio years. They begin with seeing and then making. This artifact becomes the area of study where students investigate possibilities through scale transformations of small, medium, and large. The exercises challenge students to explore the potential of these findings, transforming the knowledge into the possible.

These scalar transformations necessitated the student to apply and integrate knowledge learned throughout undergraduate education. These studios explored the ambiguous nature of scale, moving from scaleless two-dimensional graphics and three-dimensional constructs into architectural space and structures, putting various design representation techniques and genres at the center of the process, including varieties of analog and digital media and techniques. In this vein, scale could act as analytical, measuring, and generative means in design processes. As an analytical tool, scale provides a framework for analyzing formal and spatial properties. As a measuring device, scale provides a base to achieve precision. The exercises stress the importance of scale in relationship to the body and our perception. Through a process of zooming in and out, the transformation is achieved in understanding possibilities. As a generative means, it lends to possibilities of spatial and formal transformations. Deciphering the structure, organization, or rules leads to a framework for design development.

By analog means, scale becomes a direct connection through the use of physical artifacts. It is a tactile event informed by the material, the process of making, and analyzing. In the virtual space of the computer, scale becomes much more ephemeral, almost scaleless in the limitless potential to zoom in and out. This freedom allows the design to be explored at many levels though it provides its danger with infinite scalar, often scaleless representations. This shift in scale requires students to suspend judgment on what they know until the investigation is complete and the series of representations or drawings is complete. Similar to design, teaching is a process of inquiry. The understanding of scale remains rooted in our design process through direct engagement with the tools, techniques, and procedures. These conditions provide constraints and opportunities to inform the development of generative principles. Scalar changes mine different sets of information embedded in the documentation of a project that feed into the design process.

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