Collaborative Learning in Design Build Studio Culture

Sara Codarin, Karl Daubmann, Scott Shall, Masataka Yoshikawa
Lawrence Technological University, College of Architecture and Design

Abstract

The Design Build Studio discussed in this contribution is an online graduate summer course where students design and build a full-scale, inhabitable structure over the duration of a semester, culminating in a final week dedicated to construction. The studio bridges the divide between architectural design and its physical realization through collaborative, hands-on construction. The course integrates conceptual design ideas with practical application, engaging students in design-build practices that closely reflect professional experience. Since 2019, six pavilions have been completed across campus, each showcasing unique design goals and constraints. The projects address challenges such as budgeting, logistics, material selection, and site-specific problem-solving, with budgets ranging from fifteen to twenty thousand dollars funded by local municipal programs. Students interact with the complexities of scale, planning, and construction through active participation in design, fabrication, and assembly. As part of the online master's program at Lawrence Technological University's College of Architecture and Design, the studio includes an eight-week virtual design phase followed by a one-week on-campus residency. Students work in teams, managing the complexities of remote collaboration and decision-making across different locations, while aiming to experiment in the physical world with materials and methods such as timber framing, metalwork, and robotic 3D printing. Each built project functions as a case study, using iterative processes and integrating material understanding with digital workflows, navigating architectural ideas as a critical design practice.

Introduction

This contribution explores the results of the Design Build Studio, a graduate summer course that concludes with the collaborative construction of a full-scale inhabitable structure built in one week. In *Translations from Drawing to Building*, Robin Evans mentions a fundamental challenge in architecture: the disconnect between design conception and the physical realization of that design (Evans, 1997). Unlike painters and sculptors, who engage directly with their medium, architects must contend with a separation imposed by the scale and cost of their projects, relying on others to fund, construct, and assemble their designs. Architecture is inherently shaped by circumstance and situation, subject to material constraints and real-world contingencies. The emergence of ideas is realized through applied methods, transforming reality by producing new objects. By adopting a theoretically driven critical practice (Allen, 2000), architecture can take advantage of emerging techniques and technologies, incorporating them into the evolving atlas of making procedures.

Within this framework, attention is addressed to the design and construction of artifacts at the scale of a small pavilion, viewed as a micro work of architecture holding significance beyond its function (Richardson, 2001). These structures inspire enduring fascination, tied closely to the human scale, encouraging direct interaction and engagement. Small constructions possess a tactile quality, an inherent accessibility, and an intimate connection with the senses. Experimenting with space at a full-small scale allows for a conscious exploration of

construction details, materiality, and formal expression. The built outcome becomes a distilled manifestation of the design vision, where every decision is heightened in clarity and intent.

Equally important is the celebration of process; drawings, models, and full-scale construction are not just preparatory steps toward a final product but hold intrinsic value as records of design exploration and inquiry. The emphasis extends beyond the physical results to the articulation of a methodology, reinforcing Louis Kahn's idea that form defines what something is, while design determines how it comes into being (Wickersham, 1985).

Elements of innovation

The Design Build Studio is a required summer course in the online Master of Architecture program at Lawrence Technological University, and includes the only residency requirement for the degree. This studio is a point of convergence that brings together a cohort of seventy to eighty students from the various program tracks to collectively conceptualize, design, and construct a full-scale project. Students in this group may have backgrounds in architecture, interior design, or could be pursuing their MArch degree after transitioning from other disciplines. Students meet twice a week for eight weeks, collaborating remotely in teams to assess and finalize the design proposal. This phase is followed by an intensive in-person Build Week dedicated to constructing the project. To manage the large cohort size, the studio uses a structured methodology for decision-making that blends hybrid online and in-person formats. The focus is on setting clear design objectives and encouraging solution-oriented problem-solving, guided by a team of three or four faculty members each year.

Throughout four assignments, the studio places its emphasis on student agency. During the online portion of the class, peer-to-peer evaluations are embedded into the coursework, enabling teams to exchange feedback and support a culture of continuous improvement, reflective learning, and shared responsibility for success. Once the design stage is finalized and onsite work begins, students take charge of structuring their teams, creating organizational charts, and establishing productive daily interactions to assess the progress of the project. Students actively shape their own Build Week experience with daily goals, learning to design and build physical objects while managing logistics and labor. During the Build Week residency, the cohort is divided into smaller groups of fifteen to seventeen students, each assigned specific tasks. Students designate roles to their peers, such as project managers, safety officers, communication specialists, and purchasing managers, to oversee various aspects of task delegation and execution. Roles are not static; students rotate responsibilities throughout the construction process, allowing everyone to participate directly in the building process and manage the logistics necessary for its success (Fig.1).

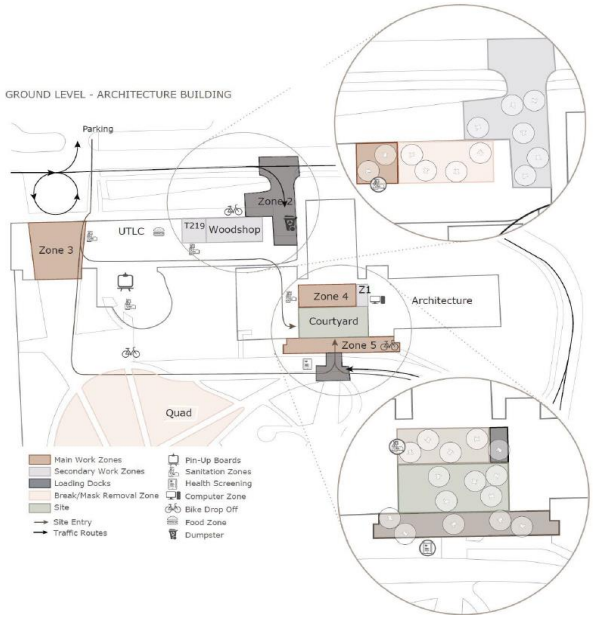

Fig. 1. Site organization in preparation for Build Week.

The Design Build Studio is based on learning-by-doing, where students engage with materials and construction techniques while collaborating across disciplines

(Nowacki and Wolfgang, 2009). This framework prepares students to envision their future practices by combining strategic planning and teamwork as well as grounding creative ambitions with architectural constraints and challenges. The interplay of virtual and physical collaboration highlights the studio's role as a hub for experiential learning, where students and faculty shape a process for achieving a comprehensive understanding of design, making, and practice management.

Objectives

The Design Build Studio focuses on learning-through-making at full scale with the objective of establishing immediacy between designers, design decisions, and built construction (Bernstein and Deamer, 2010) - integrating design, making, and process into a cohesive learning experience.

The pedagogical approach serves multiple purposes, articulated as follows: a) facilitating effective decision-making within remote collaboration; b) translating instructional notation into full-scale building execution; c) defining operational hierarchies between digital and physical labor; d) engaging with materials, their implementation, and tolerances; e) balancing prefabrication, customization, and on-site improvisation; f) assessing results and defining metrics for success.

Direct engagement with materials, tools, and design-to-fabrication processes simulates real-world design-build scenarios and dispels apprehension toward custom design and production. The ultimate goal is to challenge students to expand their capabilities, mindsets, and ingenuity through the complexities and struggles inherent in customized design-build processes. A key focus is on the distribution of authorship of a large group of creatives throughout the project, to properly own organization, logistics, on-site labor, and material competencies (Deplazes, 2008).

Studio Methodology

The studio is made possible through a partnership between the College and the local municipality. The public art program, which allows the College to construct installations, is based on a policy that allocates 1% of any real estate development's construction budget to public art. As a result, the final project proposed for construction requires approval from the City's public art commission.

The scope of the studio necessitates active faculty involvement. With the condensed ten-week summer semester and the inherent complexities of this type of project, faculty establish parameters by shaping the course's research agenda and defining a broad yet focused framework for the studio in advance, whether on assembly, prefabrication, or on-site customization (Kieran and Timberlake, 2003).

Assignment One

The studio begins by dividing the large group into teams of three or four students. Each team is tasked with proposing a schematic tectonic strategy for an outdoor pavilion that can be built on a relatively flat site. The proposal is based on the study of an assigned precedent selected by faculty based on material, size, and approach. Proposals should define the parameters of the system and illustrate how these parameters manifest across the processes and outcomes of design, fabrication, assembly, and installation. Teams analyze the system's tectonics, including its hierarchies and part-to-whole relationships, while speculating on the materials, components, and connections that form the system, along with potential adaptations or alternatives. Students are encouraged to consider programmatic, environmental, ecological, and contextual forces that might drive variations and adaptations in the project. Additionally, teams are asked to identify which elements of the system are modular or repetitive versus unique or distinct, as well as which are responsive or variable

versus constant or fixed. This exercise challenges teams to use precedents to accelerate the design process, adapting and modifying them to align with their own conditions and project goals.

Assignment Two

The second assignment builds on the outcomes of the previous exercise by consolidating teams that used similar or complementary design approaches. Paired teams engage in a new round of design, synthesizing multiple projects into a unified proposal. This stage introduces greater emphasis on the logistics of construction and assembly, pushing teams to address practical considerations more directly and learn more about the site. In this project, the class advances material/tectonic strategies to produce a proposal that is developable and implemented while also offering opportunities for human occupancy and spatial interactions with the site. Teams evaluate the limits of variability and differentiation in relation to feasibility, including cost, time, technical ability, and site-specific requirements.

Assignment Three

This design phase seeks to unify all designs from the first and second iterations into a cohesive and integrated proposal, bringing four teams to two or one. Students refine the design strategies developed in earlier assignments, advancing, organizing, and optimizing the work toward a complete and practical outcome. Upon completing the design phase, students form teams based on specified design development tasks, with leadership and task assignments reflecting individual interests, skills, and demonstrated abilities. These decisions are coordinated by faculty with the selection of the most suitable site on campus to best support the goals of the design-build project. At this stage, pre-construction activities begin in preparation for Build Week. Tasks may involve preparing general conditions, staging the site, templating and cutting for fabrication, and tracking project expenses such as materials, tools, and delivery services. All essential components have to be in place and delivered on-site, ready for the start of Build Week.

Assignment Four

The final project marks the culmination of the studio, where the primary directive given to students is simple: *build it!* Following the completion of construction, students prepare a final presentation that documents the process phases, highlighting critical steps and successes. External critics join the final review, engaging with the built work firsthand and initiating discussions about lessons learned. The conversation during the final review prompts reflection on the negotiations between ambition, constraints, predetermined construction instructions, and improvisation - recognizing the project as both a learning experience and a tangible creative achievement.

Results

Since 2019, the studio has constructed six pavilions across various campus and off-campus locations, each reflecting distinct design goals, ambitions, achievements, and challenges while operating within a budget ranging from fifteen to twenty thousand dollars. Over six consecutive summer studios, student cohorts explored a range of materials and construction methodologies, such as 2x4 timber framing, wood bending, metal sheet folding, metal scaffolding, fabric, robotic 3D concrete printing, welded rebar reinforcement, and shrink wrap applications. The design-to-construction processes evolved with the unique demands of each project, balancing on-site operations with prefabrication. Through this process-driven approach, students gain firsthand experience integrating material considerations and fabrication strategies into their designs, shifting how they think about architecture and its relationship to construction.

Pavilion One: Linear Repetitions, 2019

The inaugural project within the Design Build Studio (Fig.2) was a multi-phase exercise exploring the intersection of architecture, technology, and human interaction in public space. The final design, which was positioned in the southeast portion of a central courtyard within the College, is rooted upon a sightline-based axis that runs through the adjacent building, from the southwest edge of the quad down through its eastern corner. This axis creates a central “view corridor” that is both carved from and drives the overall form, with everything from floor orientation to roof patterning responding to it. A simple grid is subsequently extrapolated from this datum, with vertical dimensional lumber used for space delineation.

Fig. 2. The Linear Repetition Pavilion, 2019.

As a build, the project incorporates mostly nominal materials with limited customization, which is ideal in terms of budgeting and supplies. The interlocking 2x4 gridded canopy acts as both sculpture and structure, supporting the project’s vertical units. The vertical units slot into the large floor plinth, which is held up using a simple block foundation system so as to sit lightly on the site. A stair that rises up from the floor acts as a diaphragm for the structure as well as a light box. Articulated as an “object in the landscape”, the project uses dimensional lumber of varying height, position, density, and color, defining spaces by highlighting occupants performing various modes of occupation. A space intended for exploration, the scheme develops human scale-based paths and spaces that branch of the main corridor and a vertical ascension opportunity that allow spectators to climb to a plane above the realm below and view the surrounding context from an entirely new vantage point.

As a construct, this project ultimately creates a space of discovery, interaction, and transformation, where the built form is as much about how it is experienced as it is about its physical presence.

Pavilion Two: Fabric and Frame, 2020

The second construction was built during the Covid-19 pandemic, requiring students to design and build a temporary pavilion (Fig.3) that could be disassembled, transported, and displayed at multiple locations. The studio leveraged divergent thinking through progressive precedent research, ultimately converging on a deployable shelter situated in the architecture building main courtyard. The design combined metal scaffolding, wood boards, and fabric wrapping, integrating considerations for social distancing and pandemic safety - including the sanitization of tools after each use - across all phases of construction, fabrication, assembly, and demounting.

The construction process unfolded as a hybrid workspace with screens and cameras installed on the construction site, as a communication platform between on-site participants and online students - affected by travel bans or health accommodations - who contributed remotely. Those working online supported the build by

producing digital construction drawings and fabrication instructions, while on-site students evaluated design choices through hands-on fabrication and assembly testing. Continuous documentation of the building process enabled real-time feedback, facilitating iterative refinements informed by on-site validation.

Fig. 3. The Linear Repetition Pavilion, 2020.

This experience prompted broader questions about the future of collaborative hybrid workspaces and their potential to enhance cooperation between professionals across different locations. The project demonstrated how digital and physical workflows can be integrated, offering insights into new ways of managing remote and on-site collaboration in architectural practice.

Pavilion Three: Folded Aluminum Arch, 2021

The 2021 design-build project was externally sponsored and commissioned by a new hotel development. The installation was constructed on campus and then moved to its final location. Students designed and built a 25-foot-long, 12-foot-tall arch composed of folded aluminum elements (Fig.4).

The arch's form, with its conical shape and patterned openings, was generated parametrically using Rhino and Grasshopper. The emphasis on digital design explored the integration of technology and craftsmanship with the transition from digital model to full-scale construction. Responding to site constraints, the arch marks the pedestrian entrance to the hotel, creating a threshold for visitors. Its lightweight structure, weighing only a few hundred pounds, was assembled on its side and then rotated upright by a team of students who were also able to transport the arch by hand and carry it from one site to another.

Fig. 4. The Folded Aluminum Arch, 2021.

The colorful detailing makes the arch visible from a distance, while its role as both a public art piece and a gateway to the hotel entrance encourages closer exploration and interaction. By filtering light and air through its crafted voids, the arch creates a dynamic and engaging experience for pedestrians. The exploratory nature of this design-build project merges design vision with technical execution, combining offsite prefabrication with on-site assembly.

Pavilion Four: Robotically 3D Printed Landscape, 2022

In 2022, the studio investigated robotic 3D printing to develop custom elements for construction (Fig.5). Students designed and fabricated a 30-foot-long concrete bench that serves as both a retaining wall and seating area, integrating with the existing topography of the site. The double-curved, continuous form of the bench provides a variety of seating options, accommodating different postures and body sizes while also incorporating planting areas for native vegetation. Students learned about the constraints and possibilities of 3D concrete printing, experimenting with formwork-free overhanging geometry, and the structural limitations of the material. To facilitate off-site fabrication, the bench was printed in 30-inch-long sections, which involved consideration of weight and transportation logistics.

Fig. 5. Robotically 3D Printed Landscape, 2022.

This prefabrication process required students to prepare shop drawings and validate digital simulations of robotic 3D printing beforehand, prompting them to think strategically about the timing and choreography of design, assembly, and on-site installation. The bench's fluid form and integrated planting areas blend the manufactured structure with the natural landscape while encouraging human interaction with the built environment.

Pavilion Five: Assembly Beyond Standard, 2023

The 2023 Design Build Studio explored the creative potential of 2x4 dimensional lumber to construct two distinct structures, demonstrating design principles centered on modularity, customization, and contextual responsiveness. Each built outcome embodies unique ambitions while employing shared design-build strategies, particularly the use of long elements formed by stitching together shorter pieces.

The first construction, LatBend, is a sinuous, modular bench made of cedar wood, designed to transform linear building components into a fluid form. Although initially constructed on campus, the structure was designed for relocation to its final site. To enable easy transportation, it can be disassembled into three segments, ensuring flexibility in both installation and mobility.

The second pavilion, AxiRota, occupies a courtyard-like space that serves as a bridge between the architecture building and the broader university campus (Fig.6). The design is guided by a controlled sequence of compression and release geometries.

Fig. 6. The AxiRota pavilion, 2023.

As visitors move through the pavilion, they transition from an intimate, compressed entrance to an open release,

creating a dynamic spatial experience. The cove-like entry creates seclusion before expanding into public gathering areas. The pavilion's non-standard modular construction allows for gradual differentiation, with each section being unique and tailored to achieve a spatial transition effect. The large studio team enabled the labor-intensive customization and detail that defines AxiRota.

Together, these pavilions demonstrate applications of dimensional lumber in modular design, showcasing how material and form can harmonize to create functional, adaptable, and contextually responsive structures.

Pavilion Six: A Trio of Structures, 2024

The 2024 Design Build Studio increased the ambition to move to the construction of three partial pavilions as mock-ups and design options for a larger structure envisioned for alumni engagement events, developed at the request of the university President. The studio again explored complex formal spaces built with exploratory construction techniques. Situated adjacent to the President's house, the project challenged students to design an open-air pavilion for gatherings, providing shelter from rain and direct summer sunlight while harmonizing with the surrounding forested landscape. Instead of a single structure, the studio produced three built pavilion chunks, each showcasing a different approach to fulfilling the project brief.

One pavilion, constructed from timber, features a zigzagging form that integrates planting areas with seating (Fig. 7). The roof follows the same dynamic logic, with high and low corner points that modulate the scale of the structure. A waterproof covering of acrylic tiles filters light, providing both enclosure and a visual play of transparency and shadow.

The second pavilion, also constructed from wood, features thick plywood columns that support a cantilevered roof composed of a modular hexagonal pattern and clad in aluminum panels (Fig. 7). The same geometric logic that defines the columns, when rotated, transforms into integrated seating elements, creating a cohesive relationship between structure and function.

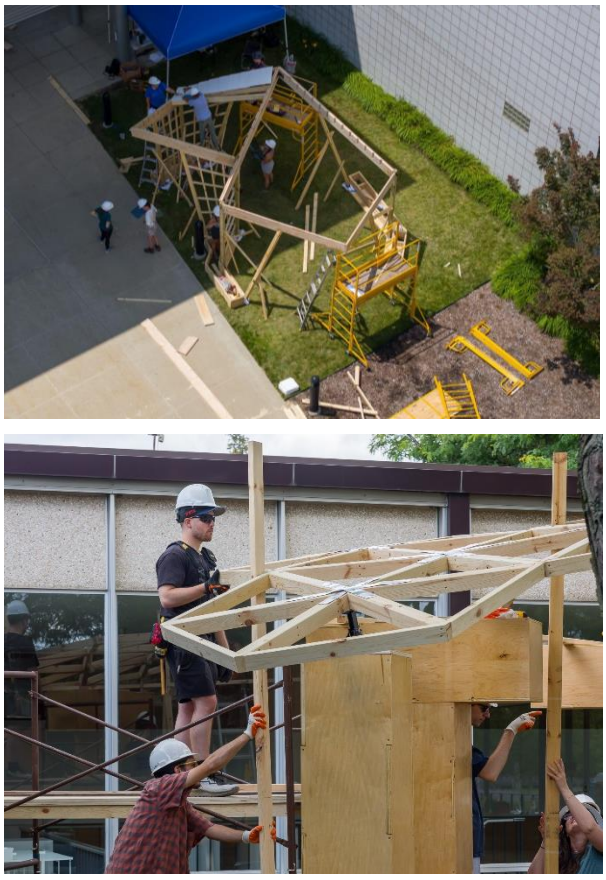

Fig. 7. Two of the three structures built in 2024.

The third pavilion is constructed with a woven steel rebar structure that evokes a sense of lightness and organic growth. The steel framework supports a cantilevered canopy wrapped in shrink wrap (Fig.8), providing shade and defining a circular gathering space below. Due to its curvilinear design and the interplay of convex and concave surfaces, students created additional mock-up sections to test the shrink-wrapping process and determine the most effective application methods.

The pavilions demonstrate the diverse possibilities within a shared design challenge, showcasing the students' ability to adapt to site constraints, experiment with materials, and create spaces that respond to human needs and the contextual environment.

Fig. 8. One of the three structures built in 2024.

The 2024 projects attempted to use the design-build experience as a way to inform larger and more ambitious projects that could not be built in a single week. The three constructions function as sectional mock-ups, allowing for a focused exploration of key design elements. During the final review, students presented scale models to illustrate the complete design concept and communicate their vision and decision-making.

Conclusions

Each pavilion serves as a case study and speculative tool, examining a pedagogical approach that integrates design theory into practice (Briscoe, 2015). Leading up to the studio, the teaching team selects a project type with a feasible scope of investigation that can be explored and implemented within the given timeframe. In retrospect, across all consecutive projects, Build Week has remained a structured yet dynamic phase where faculty guide student teams, establish standards for ambition, and manage risk throughout the process. Balancing these factors at each phase is necessary, as students often begin with highly ambitious conceptual designs that faculty refine to align with feasibility. Conversely, when students become more cautious during the design development phase, faculty encourage them to explore more ambitious solutions.

Students capitalize on the availability of their classmates to coordinate all on-site processes, from material procurement and delivery to handling, assembly, and installation. Design-build allows students to move beyond schematic design, providing a rare immediacy in decision-making (Fig.9) that typical architectural practice does not always emphasize.

The studio simulates key aspects of widely accepted professional practice, reflecting how many firms operate in a globalized context, where work is shared among geographically dispersed teams and different tasks unfold across multiple locations. In this setting, effective communication and data sharing are essential to success.

Fig. 9. Students using a projected image to guide the assembly of bespoke construction components for AxiRota, 2023.

Students come to understand that certain decisions establish the design, while others have far-reaching consequences once construction begins. This mirrors a small-scale interpretation of the MacLeamy diagram (Davis, 2011), which illustrates how making decisions early in the design process is more cost-effective than making changes later. One of the moments of realization in this process occurs when students believe they have designed everything, only to face new and unforeseen challenges when Build Week begins. This approach reinforces the importance of decision-making both during the design phase - especially when conducted remotely - and throughout the construction process.

Each project presents a negotiation between prefabrication and improvisation. The use of wood studs

allows for adaptability and improvisation on-site, while CNC routing or robotic concrete printing demand finalization before files are sent for offsite fabrication. Unlike professional practice, where labor costs account for seventy to eighty percent of a project budget, the Design Build Studio inverts this ratio, relying on a temporary coalition of participants to drive the construction process (Groak, 1992), while the cost is focused on materials. With an abundance of available labor, students gain an understanding of the profound impact that hands-on work has on a project's execution.

Balancing constraints, project criteria, and design quality presents another challenge. When confronted with risk (Pye, 1968), students often default to oversimplification as a way to avoid customization. The intensity of constructing an entire project within a single week introduces stress and struggle, but ultimately cultivates ingenuity. As emerged during the final review discussions of this studio, moving through this experience strengthens students' resilience, pushing them beyond perceived limitations. Over successive studio iterations, students commonly exhibit the Dunning-Kruger Effect, where initial overconfidence is tempered by the reality of implementation. They move through a "valley of despair" before reaching a more sustainable level of competence, emerging with a newfound confidence in their ability to explore and execute ambitious designs. The experience cultivates finer control in design, with an awareness of constraints and possibilities that will inform the students' future work and practices. By the end of Build Week, students experience an overwhelming sense of accomplishment and pride.

The final construction creates a discursive and projective work, existing as a proof of concept suggestive of further possibilities beyond its immediate circumstances, making its principles applicable to future projects with varying constraints and criteria. Through drawing, generating construction instructions, and testing designs at full scale (Kolarevic, 2003), students reintroduce building intelligence and material understanding into digital workflows, refining outcomes with recursive, incremental adjustments. The Design Build Studio exemplifies the potential of full-scale architectural construction as a medium for unifying design and practice, while empowering students with the skills to navigate complex projects, collaborate effectively, and connect conceptual design with physical construction.

Notes:

1 Allen, Stan. *Practice: Architecture, Technique and Representation - Essays*. 1st Ed. London: Routledge, 2000.

2. Bernstein, Phillip, and Peggy Deamer, eds. *Building (in) the future: Recasting Labor in Architecture*. Princeton Architectural Press, 2010.

3. Briscoe, Danelle. *Beyond BIM: Architecture Information Modeling*. London: Routledge, 2015.

4. Davis, Daniel. "The MacLeamy Curve." *DanielDavis.com*, 15 October 2011.

5. Deplazes, Andrea. *Constructing Architecture: Materials, Processes, Structures: a Handbook*. Basel: Birkhauser, 2008.

6. Evans, Robin. Translations from Drawing to Building and Other Essays. Cambridge: MIT Press, 1997.

7. Groak, Steven. *The Idea of Building: Thought and Action in the Design and Production of Buildings*. 1st Ed. New York: Taylor & Francis, 1992.

8. Kieran, Stephen, and James Timberlake. *Refabricating Architecture*. 1st Ed. New York: McGraw-Hill, 2003.

9. Kolarevic, Branko, ed. *Architecture in the Digital Age: Design and Manufacturing*. New York: Taylor & Francis, 2005.

10. Nowacki, Horst, and Wolfgang Lefèvre. *Creating Shapes in Civil and Naval Architecture: A Cross-disciplinary Comparison.* Vol. 11. Leiden: Brill Academic Publisher, 2009.

11. Pye, David. *The Nature and Art of Workmanship*. 1st Ed. Cambridge: Cambridge University Press, 1968.

12. Richardson, Phyllis. *XS: Big Ideas, Small Buildings*. 1st US Ed. New York: Universe Publishing, 2001.

13. Wickersham, Jay. *The Making of Exeter.* Cambridge: Harvard University Graduate School of Design, 1985.