FROM ART TO PART | DL-1_RESONANCE HOUSE®

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Abstract

Moving from digital models and physical stereo lithographic models to hand-fabrication and digital assembly allowed the students to move from creation to completion. As part of our holistic design process, the studio fabricated almost all components for the project. These elements include the wood flooring and cantilevered staircase, the copper and wood skins, the building's structural panels, and the two-story light vortex. This project—a single-family, in-fill house located within an historic downtown neighborhood—is subject to historic district zoning regulations, design guidelines, and Board of Architecture Review approvals. The students designed these areas through a series of two-dimensional plans and axonometric drawings, three-dimensional physical and digital models, and four-dimensional time-based animations. The building massing separates into two core elements: a gabled copper volume and a wood screen volume. The hinge point of the house is the light vortex. Photosensitive floor-mounted lights designed to augment the volume of natural light will provide a continuous light rendition on the sculpture. The project is scheduled for completion in October 2005.

1. Introduction

The sites for digital architecture are becoming more synthetic, ultimately providing the architect a place to improvise within spatial and temporal limits. To respond to this context, I created a digital, design-build studio and forged interdisciplinary relationships throughout the university including the College of Engineering, the Center for Robotics and Manufacturing, the Center for Visualization, and the Center for Historic Architecture and Preservation. The projects varied in scale, site, context, and material and represented a broad spectrum of design execution. In 2003 Dr. Dennis Domer, the Director of the Center for Historic Architecture and Preservation (CHAP) at the University of Kentucky formally introduced me to University of Kansas Professors Dan Rockhill and Kent Spreckelmeyer. During the ensuing semester, my studio and I traveled to Lawrence, Kansas to speak with Kent, Dan, and their current students about the design-build projects that they had previously enabled for their students. What we learned from that trip shifted my subsequent design studios from experimental installations (1999-2002) to permanent inhabitations (2003-present). The digital design-build studio illustrated in this paper examines our current project. Reflecting the realities of the profession today, this real-world project actively integrates advances in software into the design process, allowing students to move beyond basic representation and documentation of the design concept to an advanced analysis and understanding of fabrication concerns. The studio sought expertise for this project from the professional design community and forged ties with local and national industries. Practitioners were involved not only in the formal jury reviews but dynamically integrated into the monthly design charrettes. Students developed their designs in the context of a professional design team, which included structural engineers, fabricators, contractors, architects, theorists, code enforcement officers, and civic officials as well as members of local governing organizations, including our local architectural review board. See Figure 1.

1.1. Schematic design

In the fall 2004 semester, a comprehensive College of Design studio encompassing students from the Schools of Architecture and Interior Design and the Department of Historic Preservation collaborated on various market-responsive proposals for an in-fill site within the downtown Lexington area. After resolving a sequence of complex issues ranging from understanding local building codes to implementing historic overlay guidelines, student teams formulated designs for
presentation that offered a proof-of-concept, real world construction experience for the students. The competitive aspects of the twelve students and the divergent nature of the design teams found a common ground in November 2004 after they attended the 2004 ACADIA National Conference in Toronto, ON. The project that emerged by the fall semester’s end touted a design mission statement of “a market-driven, architectural response to public and private lived space bridged by light.” The students presented this common proposal to the Lexington-Fayette County Urban Government (LFUCG) Board of Architectural Review (BOAR) for schematic design review and then to the College of Design’s all-school review. The lessons learned from these external reviews shaped the current design proposal.

1.2. Design process

The process of moving from digital-to-physical models to stereo lithographic models to hand-fabrication and digital assembly was important to our studio investigation because it enabled the students’ opportunities to integrate quickly different design solutions. The necessity for this digital-to-digital (D2D) approach, stemmed from the narrowness of the existing site, the site’s immediate adjacency to surrounding historic structures, and the temporal weather patterns that often plague construction schedules in the early Kentucky springtime when the house was due to begin construction. This process resulted in a series of shop-made, pre-constructed assemblies that could be temporarily stored off site and when needed, easily transported to the site and then tilted into place. To understand better, how the pieces of the construction puzzle would fall into place, I also had the students produce a sequential animation of the construction assembly and a \( \frac{1}{2}''=1'-0'' \) scaled, laser cut wood structural model. For many of the students it was the first time that their incremental digital drawings and hand-sketches were actualized. See Figure 2 and 3.

The project simultaneously developed from the inside toward the outside and from the exterior through the interior, resulting in a design proposal with two courtyards that mediate the urban “front door” and the private “terrace.” A thorough analysis of the historic patterns of development in the area proved that the current in-fill zoning guidelines were incompatible with the immediate context. The studio presented these findings to the BOAR, which in turn, supported our contextual assessment. The building’s orientation now responds in part to two forces—the shift of the surrounding buildings to the railcars that served the Western Suburb in the mid-1800s and the prevalent solar angles in the region. While equally important, the vitality proposed by these opportunities affected the building design in uniquely different ways. Like the storefronts that line the street, the rotation of the building opens the front façade to oncoming traffic. In fact, our building, anchors one of the “Kodak” moments along the historic streetscape at the intersection of Old Georgetown Street and Ballard Street. Likewise, the building’s placement exposed the building to a wider degree angle of southern exposure, which in turn allowed the students to examine the uses of applied shading devices and passive green systems for blocking the sun’s rays during the cooling months while allowing the sun to pass through during the typical heating months. Over the ensuing weeks, a more formal design development package that responded to the reviewer’s comments began to take shape, including the building massing, the design of the facades, and the selection of building materials. The BOAR unanimously approved the scheme and issued the required Certificate of Appropriateness (COA) on January 18, 2005. See Figure 4 and 5.
1.3. Design development: Permitting-fabrication-assembly

Upon COA issuance, the structure, DL-1 Resonance House®, began to develop. The studio focus shifted from conceptual design and design development to permitting, constructability, and fabrication. To facilitate the project, the studio also enrolled in a construction methods course entitled Building Systems Integration taught by Professor Bruce Swetnam in the School of Architecture. In this class, the methods of making and realizing the project were pre-determined from our initial research. As a collective team, the studio completed a design and fabrication schedule, and (using the BIM software program REVIT) produced a comprehensive set of working drawings and digital visualization models within the first five weeks of the spring semester.

In consultation with Peyman Jahed, Ethan Buell, and Gyles Winkler of Buell, Fryer, and McReynolds Structural Engineers, our original BIM models became wood and steel fabrication shop drawings. Using these documents as a set of shop tickets, the students digitally dimensioned, cut, and assembled standard components into open-wall wood structural panels under the supervision of Carroll Fackler, the Director of the University of Kentucky, College of Agriculture, at the Department of Forestry’s Wood Utilization Center.

In our initial planning schedule, I had allotted two weeks to complete the 50+ panels, but once the floor templates were established and cut sheets produced, the assembly took only three days to complete. The students transported the results of these efforts to a staging warehouse located less than one mile from our site. As part of our holistic design process, the studio fabricated almost all components for the project. These elements include the wood flooring and cantilevered staircase (four days) and the wood skins (four days).
1.4. Project erection and site construction

Even with the extremely tight tolerances of the digital-to-digital process, the choice to use poured-in-place concrete rather than pre-cast concrete foundation caused a slight delay in the erection of our project. Fortunately, the modulation of the building was able to absorb the discrepancies without negatively affecting the design. To understand better the deviations from the original dimensions, the students digitally measured the building and began developing an alternative as-built digital model to track the changes.

On June 9, 2005, the summer session began in full, with the tilting of the first floor wall panels and framing of the interior walls. By June 15, the second floor sub floor was in place in the rear volume and framing the stair tower was underway. By June 17, the “bridge between the two volumes” was set and work on the front volume’s second floor was beginning. Two weeks later, the finish framing
and the enclosed black box were complete.

2. Light Vortex

“Metal is the material of our time. It enables architecture to become sculptural; it also expresses technological possibility as well as the time-honored characteristics of quality and permanence.” Frank O. Gehry

To elevate the digital-to-digital processes that I have been developing over the last six years and to expand our links to industry beyond the region into the national level, we visited the fabrication plant for the A. Zahner Company, who has fabricated a majority of Frank Gehry’s work as well as Steven Holl’s Turbulence House among others.

I wrote a proposal for them to assist us in fabricating, engineering, and installing of a portion of our project, a 24-foot tall sculptural light element, and the light vortex. A small section of this sculptural element was on exhibit during the 2005 ACSA National Conference in Chicago and then installed at the all-College of Design exhibition in Lexington. See Figure 10.

Designed in FormZ and Rhino, then translated into Catia before fabrication, this two-story element, structured with aluminum fins and substructure and then clad in stainless steel, literally wraps light around its surfaces. Like a sunflower, the light vortex, with its angel hair stainless steel finish, responds to the incremental differentiation of light throughout the day. Designed in collaboration with the Cuban lighting designer, Joe Reybarreau, photosensitive floor mounted light fixtures augment the volume of natural light so that its skin will appear to change colors over the course of the day. In addition to lighting, the form creates a figural focal point enclosure that contains the fireplace box, and acts as a mechanical plenum that conceals all of the mechanical ducts and electrical conduits that rise to the second floor. Due to its placement, this object anchors the entry sequence and is visible in a variety of angles both inside and outside of the house.

3. Conclusion

Founded to facilitate design build projects for schools of design and historic preservation Design Lab, Inc.’s mission to enhance the built environment through research and education allows for a unique approach for students to work on real world design, fabrication, and construction solutions while receiving academic credit. Design Lab’s professional volunteers manage all of the business end of the transactions with the client and help source financing for the project through corporate sponsors and other donations. Design Lab also provides grants to their partner schools and scholarships to students of design and preservation. The creation of Design Lab, Inc® and its affiliation agreement with the University of Kentucky, has given the students invaluable real world learning experience that narrows the gap between the design drawing process and actualization methods.

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Areas of Interest include Design, Fabrication, Historic Preservation, Photogrammetry, Flexible System Design, Visualization, Architecture, and Urban Design.