

Digital Design through Production Pedagogy: Cases Involving Student/Industry Collaboration.

Kevin R. Klinger

Director, Institute for Digital Fabrication – Associate Professor of Architecture – Ball State University
krklinger@bsu.edu – <http://www.i-m-a-d-e.org>

Abstract. Innovation through digital design in contemporary practice has led to completely new ways of designing and making architecture. To prepare for these innovative opportunities, students are turning to alternative skill sets than those traditionally gained in an architectural curriculum. This paper argues that we must reconstruct our architectural curricula in order to better prepare students for a shifting professional landscape. While current material-based production realities of translating digital design into built form have much in common with modernist traditions, exercises, sequences, and collaborative opportunities in schools should pass through a relevant lens examining the true potential of working with the information age.

Keywords. Digital fabrication, informed architecture, total design through production, collaboration, industry partnership

Innovation through digital architecture: design and production

Innovation through digital design in contemporary practice has led students to turn to alternative skill sets than those traditionally gained in an architectural curriculum. Course sequences, most still in place since the modernist transformation, are outmoded and need to be reconsidered with content for a generation adept with navigating the digital data flow. “Cross-disciplinarity,” “collaboration,” “connectivity,” and “creative construction” are the rallying themes to guide us to reconstruct our architectural curricula. Students should be encouraged in innovation and life-long critical learning to best prepare for a workforce reliant upon new orders of exchange across space and time. These four themes are further articulated:

- 1) Design principles have shifted, and now include much more downstream information into the schematic development of an idea. Many players coalesce to add value to a total design through production process. We must also invent new languages to continue this conversation about digital architecture on any meaningful level. “Terms such as beauty, scale, and proportion that were once used to describe the massing, articulation, and texture of pre-digital architecture have given way to adjectives like smooth, supple, and morphed, derived from digital-age vernacular” (Rosa, 2001).
- 2) Information is at the center of the exchange. Those skilled at navigating multiple layers of information will be in control of the design project. With the complexity of data generated (digital code, modeling, visualization, analysis, and production), we must effectively manage and exchange information and consider all aspects of the total design through production (Klinger, 2008).
- 3) Collaboration is critical to the success of each project and should involve industry partners early in design formulation. As feedback loops (ShoP, 2002) are now integral to the formulation of both, process and product, it is increasingly necessary to involve and understand the value added by all players.
- 4) Production realities must be woven into design thinking. At Ball State University, we have developed a series of courses/workshops where the classroom experience encourages collaborative design and fabrication in partnership with industry to provide strategies for a total design through production process. These courses encourage innovation by students deploying cutting-edge technologies, which rely heavily on advanced digital

design and production skills (parametric modeling, scripting, digital fabrication, and design through production feedback loops).

Students are immersed into team-oriented responsibilities that facilitate a seamless information exchange with industry partners. This highly collaborative design and production process suggests some critical strategies for innovating curricula.

The Institute for Digital Fabrication (IDF) (i-m-a-d-e)

The Institute for Digital Fabrication at Ball State University acts as a catalyst for digital design and fabrication and serves as a conduit between students, design professionals, and manufacturing. By engaging regional industry partners, students apply skills through immersive, team-based projects, and solve real problems through managing complex sets of design constraints—materiality, economy, ecology, culture, efficiency, fabrication, assembly, and performance. These collaborations draw upon industry partners using advanced manufacturing techniques, and work with regional cultural institutions as a platform for their realization. Visits are made to many different industries, including custom glass, brass casting, metal fabricators, Indiana limestone, wood veneer, Indiana hardwood, plastics, and recycled rubber. Frequently, these visits lead to collaboration and offer students broader knowledge of production methodologies, which are immediately fed into design and fabrication strategies. In many cases, the project leads to innovation for both the student design teams and the industry partner.

Informed architecture

Form is informed! Informed architecture is contingent upon a conversation between digital code, modeling, visualization, analysis, and production. It is increasingly necessary to understand and coordinate all of the players who may add valuable feedback. Thus, it is critical for students to remain well-informed about the total potential of each project.

Haven't we exhausted the “neo” arguments over 20+ years as digital techniques came fully onto the scene? We have heard about new digital techniques fostering a “neo-baroque.” This forecast falls away when we have to translate tectonic information out of data! Optimization and efficiency are now once again completely desirable. Construction realities conjured up tales of a “neo gothic.” Making implies craft, if even advanced-machine craft, and a “neo arts and crafts,” is now underway, led by the potential

art and craft of the [informed] machine (Wright, 1901). These “neo” speculations are rich with potential. While we should say a resounding “yes” to all, there remains something unique in the spirit of this new age that transcends the past as we aim for informed architecture—“architecture as a true symbol of our time” (Van der Rohe, 1950).

Informed architecture is a loaded term, which carries also the power of opposition, as in “misinformed,” “uninformed,” and “underinformed.” Structuring knowledge is vital, as we outline principles to guide architecture through a vaporous vista. Herein lies the true potential of an innovative curriculum that is open to multiple forms of knowledge acquisition. Well-formed information revealed by rigorous processes and openly shared strategies float around us, globally. Yet, charted waters are difficult to find, as clearly marked lines—“Mercatorial Projections” for architecture (Klinger, 2004)—have submerged, and all at once our same field has become unfamiliar. We need MORE information!

...Connect globally

Astonishing innovation is occurring at all levels of the total design through production process, most notably in design genesis, material testing, performance analysis, systems integration, digital fabrication, and assembly. Those who diligently exchange, encompass, and openly reveal information in their methods are the true explorers in architecture today.

Certain global centers of activity have emerged with particular expertise, nonetheless the real energy informing architecture is one of distributed agents (flocking together, apart) continuously connected to a network of knowledge capital, radiating open-source techniques, and deploying (dare I say) universal strategies. We continue to search for order through mathematically derivate, scripted formulation, just like the Greeks, who found “harmony” with the golden mean through analysis of natural systems and subsequent mathematical/geometric application. Only now, we are armed with a deeper knowledge of complexity using devices that rapidly interpret elegant equations. In this new panorama of diverse experimentation, connecting globally is critically important for the dynamic evolution of knowledge.

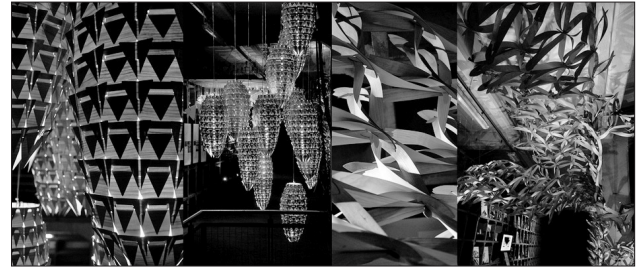
...Make regionally

A production ethic underlies informed architecture, with exchange of information at the core. However, the building industry has been notoriously slow in the implementation of technological advances. The potential energy of each process/project engages in retooling production, advancing manufacturing, and leading innovation. Critical linkages with industry have enabled the translation of information into material/construction logics that fabricate the necessary infrastructure for a productive future. This is a future of a materially diverse, simultaneously regional and universal, mass-customized, constructed and synchronized world.

Cases involving student/industry collaboration

The following cases recount design pedagogy that deals with negotiating “exchange” with multiple industry partners. Design proposals rely heavily on advanced digital design and production skills (parametric modeling, scripting, and fabrication). Multiple industry visits throughout the semester, immerse the students in team-oriented responsibilities to facilitate a seamless information exchange with partners—schedules, different data files, fundraising, budgets, press releases, and a public web exchange of ideas—all in parallel with the overall task of design, research, and experimentation. Two key ingredients are needed in the pedagogical concoction: 1) Practical project production realities, and 2) Innovation by design.

Cases 01a,b | Hardwood Veneer Morphologies:



Indiana has a long tradition of producing hardwood veneer from regionally harvested trees. Both made of Indiana Hardwood veneer made available through industry partner David R. Webb Company, the “Bodhi Tree” and “Luminaire” highlight the more subtle properties of hardwood. The thinness of veneer allows wood to bend, twist, and glow—revealing latent and innate qualities. These qualities are exploited in projects that reveal the “light/lighter” qualities of this typically “heavy” material.

The shape of the “Luminaire” is customized, as updates within the parametric design model directly drives the laser cutting of components precisely. Veneer components are coated in polyacrylic and assembled by hand using notching and slip joints. No hardware is necessary, and anyone can assemble the final form. The product of the “design” is unique, and the role of the “designer” is shared with the consumer.

The “Bodhi Tree” is formed from self-similar laser cut veneer components. The curvature and tension of twisting strengthens each unit to form a stable and resilient lattice. The overall assembly and geometry emerges as a self-organized form-finding experiment, which allows for the creation of a gradient of variegated densities, strengths, and geometries with light-catching surfaces. The resulting mesh is used to define space and filter light in otherwise stark interior environments. The project was the result of a three-day charrette with IDF Visiting Fellow, Steven Deters.

Case 01c | reBarn



Partnering with the local Muncie Parks Department, students identified an underutilized portion of a park adjacent to the White River in Muncie, Indiana. The “reBarn” program evolved to enhance the site by connecting users more solidly to the landscape in a tactile and visual manner, and provide a new platform for activity (crawling, climbing, sliding) and reflection (sitting, chatting, viewing, and reclining). Two main materials were explored and deployed for the project: 1) recycled barn wood from a local “Pennsylvania” barn built 100 years prior. A taxonomy of the unique members was created and the catalogue was translated into vector information for CNC production of individual components. 2) Metal for joints and additional skin-form. Students visited A. Zahner Metals in Kansas City, where they collaborated on engineering/fabrication information for individual connection braces and custom textured aluminum panels—each brace and panel unique. The industry collaboration informed the formal design intent. This kind of innovation through information in partnership with industry drives the energy for the total design through production methodology.

Case 01m | Manufacturing Material Effects Design Exhibition



Coincident with the International Symposium and subsequent book release: *Manufacturing Material Effects: Rethinking Design and Making in Architecture* [Klinger, Kolarevic 2008], students designed, fabricated, and installed an exhibition at the Indianapolis Museum of Art. The exhibition framed the materials from leading global designers, fabricators, and software thinkers who closely examine collaborative design and production practices based on innovative and experimental processes of material exploration. In this spirit, the students designed in immediate consultation with industry partners from local wood, aluminum, limestone, and plastics industries. Not a single component of the display system was purchased at a hardware store.

The design consisted of a digitally fabricated plywood armature, vacuum formed backlit acrylic panels, aluminum clips, and limestone support footers. The students exchanged digital files with the limestone and aluminum fabricators for direct fabrication using laser cutting and CNC milling. They also optimized the plywood components and connection details based on efficient nesting by design in order to minimize production waste. The vetting of design schemes by industry partners led to a design process that was truly informed by production, cost, and material considerations. Industry and Institutional Partners: Indianapolis Museum of Art, Institute for Digital Intermedia Arts and Animation, Arrowhead Plastic Engineering, Indiana Limestone Fabricators, Mid-West Metal Products, Indiana Hardwood Lumbermen's Association, David R. Webb Company, Amos-Hill Associates, Laird Plastics.

Case 01streams | The Calibration Channel



The Calibration Channel provides a seating-platform that channels the river sounds in a manner that small groups hear the rippling water more intensely than in the open air. Primary ribs, digitally defined from the simulation models, contour an interior skin, which acts as a secondary structural element and a smoother surface that better accommodates acoustics. The structure rests on digitally defined and milled Indiana limestone feet, shedding water away from the wood surfaces. The installation was erected in roughly one week, with very few modifications to the pre-fabricated components. As an instrument, the Calibration Channel becomes a threshold for individuals to realign their sensory energy to the sensitivities of the river. Industry and Institutional Partners: Mounds State Park, Indiana Hardwood Lumbermen's Association, Frank Miller Lumber, Indiana Limestone Manufacturers, Big Creek Quarry

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