Digital Craft: Incorporating Material, Technology and Performance in Design

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Digital craft are contemporary techniques by which matter, force and geometry are organized. Digital craft orchestrates a robust exchange between digital processes and physical behaviors. New design and manufacturing tools are redirecting the relationship between form, material, technology, and performance within architecture by altering design processes. These processes open up a new role for craft at two distinct scales during design. The first is at the scale of the architectural model, where form is conceived as the expression and potential of geometric systems. Digital craft at this scale relies on a range of tools, from generative modeling to environmental and structural simulation to surface modeling in anticipation of digital fabrication. The second scale at which digital craft is used is that of building assemblies, where the impact of material, building technologies and performance become inseparable from form.

The term "digital craft" has been used to refer to the achievement of expert control over a variety of tools native to digital description, from modeling operations to scripting with user generated algorithmic code. In these references, craft refers to digital technology as a medium that, like the media of traditional craft practices, requires skilled hands to control. Digital craft can also refer to design processes that incorporate other material practices in the design process to direct or redirect the tendencies of digital tools. Both of these definitions of digital craft are of interest to our panelists because of their concern with workmanship. Malcolm McCullough, in *Abstracting Craft*, cites David Pye's description of workmanship as dependent on "the judgment, dexterity and care that the maker exercises as he works." [1] Expert workmanship has long been a quality sought by architects in the products of the numerous craftsmen that produce their built work, but it is also an expectation cultivated by architectural education. Educators emphasize the expert workmanship expected in design representations—drawings, renderings, and scale models as well as buildings. This shared concern within the discipline has found renewed pedagogical weight in coursework and faculty research developed around the practice of digital craft.

The work presented on this panel is promising for its multimedia exploration. When it is used in reference to physical artifacts, digital craft incorporates both the digital medium and a second medium or material. The digital medium refers to the organization of bits of information—and, for our panelists, the digital is ultimately synonymous with geometric description. Regardless of the software interface, digital tools produce geometric entities located in relation to one another within a system of measure. The language of modeling software builds tools that produce a range of geometric types. The affordances of each tool ,therefore, rely on a particular geometric logic. These geometric potentials are quite material in that they exhibit particular behaviors in response to manipulation. It is this digital medium that is both informed by and informs other media.

The second medium in digital craft projects varies with material implications that range from more abstract to more corporeal. Of special significance is the uncanny capacity of digital craft to produce extrasensory effects or to state this differently, to exhibit heightened, synthetic qualities in the face of digital manipulation.[2] Due to these effects, it may not matter as much as it once did what the second medium is. Hybrid mediums exhibit slippery, illusive material behaviors requiring that the digital craftsperson be especially good with his or her hands. This skilled hand is needed when directing the behavior of both digital and material matter.

In Frank Barkow's "Revolutions of Choice" he describes his office's "expanding interest in emerging technologies, know-how and materials transformed by analog and digital tools."[3] He continues by describing the role of the one-to-one scale architectural prototype. He states that the "prototype has become the single most important instrument in our work for gauging or determining an architecture's success aesthetically and performatively. . . This is a way for us to close the historical gap between representation (models and drawings) and a building. The prototype does not represent an architectural condition so much as it precisely duplicates and forecasts its material and tectonic characteristics and performance."[4] This method of research is blooming within the academy as well and serves a similar purpose: as a bridge between academic research and professional practice. This is not to say that academic studies of digital craft are professional building proposals, or should be. However, the integration of material, tectonic, technological, and intellectual concerns embodied in speculative assemblies is a form of high achievement in our field, and as such, comprehensive work on this integration by students is an important form of practice.

At UCLA A.UD, I participated in the development of a new studio called TechCore in 2011. This required studio introduces graduate students to digital craft through the problem of a building envelope. An existing building is the site of an extension and new building façade that was presented schematically and developed through one half-scale prototypes over the quarter. Students were introduced to digital modeling tools and four materials (wood, metal, composites and concrete), using historically significant case studies. These initial case studies unpacked the intellectual territory associated with these material systems while leaving the design process open to the influence of technology and digital processes.

The studio choreographed formal experiments in step with computer-aided manufacturing processes and material behavior such that the three were linked from the start. The faculty speculated that when formal experimentation is conducted in step with these parameters, material research would find its way directly into the prototype. The parameters were cultivated as active agents of design innovation.

Through an extended and in-depth investigation of composite material systems that embody a range of performance types, material expressions, and technical interfaces, the techcore studio allows students to work collaboratively to integrate and develop a sophisticated large-scale building envelope. In doing so, students develop an intimate understanding of the creative opportunities of the media used and a deep appreciation of architectural design as a material practice.

I offer the following reflections to our panelists and others who inspire students with digital craft pedagogy following our department's most recent attempt to engage this content.

Regarding *material,* design studio curricula can incorporate intellectual and physical work with a wider range of materials, especially those found in contemporary architectural assemblies. Most students and many young professionals learn about a material when a project demands that that they know one intimately. This often happens within the confines of professional practice, when schedules, tolerance for risk, and capital are tight. This context discourages the intellectual speculation and historical research that the academy so readily affords. To expand the pedagogical contribution of digital craft, students can be taught to embrace both digital and physical media with curiosity. As more of these experiments develop within the academy, it's important to be clear about the fidelity that a prototype has to a design proposition. So often, one-to-one physical examples of digital craft are full-scale architectural models misunderstood as architectural prototypes or mockups. One is not better than the other unless students don't know which one they have made.

Regarding *tectonics*, be clear about the fidelity that a tectonic solution has to a design proposition. Again, full-scale models made of paper, cardboard, and plastic—all of negligible weight and performance capacity—contribute little to speculations on architectural assemblies. While installations and pavilions are useful introductions to digital workflow, workmanship, teamwork, and economics, their lack of self-weight, thickness, and robust material behavior are inadequate simulations of the sometimes dirty, always fascinating behavior of matter and its translation into architectural assemblies.

Regarding *technology enthusiasm*, acknowledge that the implications of design are more serious and pertinent to culture than a particular technological process. Teach students to assess the political, social, and disciplinary implications of their work. The intertwined side effects of technology on form, space, and tectonics are a strong, associative thread that has been convincingly used to track the evolution of architecture. Digital craft contributes to this history when it draws the abstract and the material together rather than insisting on their separation.

Regarding *digital fabrication*, the now-ubiquitous fabrication technologies available to students are useful tools for learning firsthand the organizational and aesthetic impact of machine logic on design. However, so often students embrace the limitations of their tools as design parameters. This confuses the constraints of representation with the constraints of building. By introducing students to a broad array of production tools, the disposition of architectural surfaces can be explored without the constraints of digital or manufacturing technology.

This approach can be extended to the architectural model. In order to avoid architectural proposals that respond first to digital tools and their geometric constraints, students can be taught the value of the architectural model as a design tool. Rather than produce a physical model with fidelity to a digital model, this common practice can be reverse-engineered. Physical models can be used to rethink the use of digital modeling operations. Using 3-D scanners and photographic analysis, intricate digital models can be produced from these physical artifacts and exhibit qualities that common modeling operations resist. The goal of this alternative design process is to develop ambitions that are brought to digital tools rather than aligning ambitions with the anticipated by-products of the tool.

In closing, our panelists offer a range of digital craft projects that develop from multimedia explorations in a range of contexts from the academic to the professional. The projects reveal expert knowledge of both digital and material processes and serve as pedagogical models for future explorations of digital craft. Each demonstrates the relevance of this fertile territory for speculation regarding organization and assembly at scales ranging from furniture to towers. ◆

ENDNOTES

1. Malcolm McCullough, *Abstracting Craft*, (Cambridge, MA: MIT Press, 1996),
2. I've written about this capacity in a paper titled, "Plastic Realities" for the 2007 ACSA Fall Conference, Material Matters, USC.
3. Frank Barkow, "Revolutions of Choice. *Oz* Vol. 33: Augment, 2011, p. 10.
4. Ibid, p.12.