

digital RE thinking: digital literacy in beginning design

Recently much attention has focused on digital technology's affect on architectural education.¹ The debate regarding design process and digital tools is nothing new to academic circles discussing what students, instructors, practitioners of architecture face due to rapidly changing technology, software and how design pedagogy should change². Currently, the variables in this conversation circulate around implementing new tools such as BIM, IP and digital fabrication into the curriculum. This paper will discuss a digital design process through two curricular exercises for beginning design and how at the College of Architecture at the University of Nebraska-Lincoln has explored the application of digital tools and digital environment in education.

At the beginning design level the challenge has been how to subvert the digital tools available to develop a strong design foundation supporting the generalist core. The first example demonstrates a digital design process by beginning architectural design students exploring the morphology of industrial designed products (figure 1). The book by Kieran Timberlake, *Refabricating Architecture*³ is a model that has inspired a re-thinking of architectural practice. The authors' design methodology has been co-opted for the morphology project. The second course example investigates a digital collaborative project titled "shared city" completed by third year students who engaged the digital design process to create and fabricate a collective block wall. Students explored the concept of mass-customization enabled by incorporating laser cutting technology and Autodesk Revit software. The morphology and "shared city" projects go beyond technical Computer-aided Architectural Design (CAAD) competency to introduce *Digital Literacy*, taken from Paul Gilster's book of the same name, where he recognizes that this new digital world "calls for a new set of assumptions and a fundamental reorientation in thinking."⁴ Expanding his definition beyond the Internet, I see digital literacy as seeking a digital discipline, which "master's ideas *and* keystrokes" embracing a variety of digital tools for a strong basic design foundation.

We already have a beginning design foundation built around compositional or visual literacy methodologies, "to read with meaning" and to understand design, like it or not, the digital is merging with society becoming ubiquitous. Relevant to our discussion, digital drafting has replaced hand drafting, building information modeling (BIM) is evolving 3D solid modeling, and other architectural issues affected by the digital shrink and expand the space of education and practice. As architectural education converges with the digital network, Web2.0⁵, and the information age the foundation of beginning design will be reformulated, a digital RE thinking. Incorporating digital literacy in beginning design focuses a critical eye on not only the multiplicity of issues typically too broad for beginning design, but contributes to a healthy digital discipline concerned with the mastery of the design tools used in architecture.

The value of *Digital Literacy* in beginning design education allows students to explore the networked digital age, the complexity of combinations, mash-ups, and hybrids to understand the diverse and complex networked digital world's relationship to architecture.

¹ Topics discussed at length in; Proceedings from Cranbrook 2007: Intergrated Practice and the Twenty-first Centry Curriculum; Report on IP, ACSA Topic Groups for the Accreditation Review Conference; TAP-AIA Workshop "Future of Architectural Education"; ACSA Panel Discussion: Failing Often Failing Early: Field Notes from Explorations in BIM, IP and Collaborative Practices in Architectural Education.

² A couple to look at: Omer Akin, *Computational Design Instruction: Toward a Pedagogy*, CAAD Futures Digital Proceedings 1989., or Sarah Benton, *Mediating between Architectural Design Ideation and Development through Digital Technology: Dynamic Animation Toys and Mediation Methods in Designing*, eCAADe 25, 2007.

³ Kieren, Stephen and Timberlake, James. *Refabricating Architecture: How Manufacturing Methodologies are Poised to Transform Building Construction* (New York, NY: McGraw-Hill Company, Inc. 2004)

⁴ Gilster, Paul. *Digital Literacy* (New York, NY: John Wiley & Sons, Inc. 1997)

⁵ User created web content found on wikis, blogs, social-networking, open-source, open-content, file-sharing, peer-production, etc., Wikipedia, <http://en.wikipedia.org/wiki/Web2.0> (accessed February 9, 2008)

During design there is an oscillation between the methods and use of digital tools or media⁶ used to design and the issues being designed for. In other words the design process foregrounded by the design tools we use and the architectural issues that we are exploring. In the networked society we find ourselves swimming in we need a critical tool, a digital literacy to unlock the digital issues affecting architecture while educating students to utilize the digital tools at their disposal for learning⁷. For the purposes of this paper, I will focus on the former, the design process, digital tools and the resulting product.

In light of BIM and other emerging technologies what should a CAAD curriculum be? 'Introduction to Computers' is a common and sometimes antiquated course offered in many engineering and architecture departments perpetuating what is potential misplaced focus on repetitive drafting or modeling procedures. Mark Von Wodtke's in his book, *Design with Digital Tools: Using New Media Creatively*, discussed the wide range of ways digital tools can change and shape the way Architecture is produced and managed. Although now seven years old, and at the pace of technological change the book is obviously outdated, the conceptual framework still has relevance. While the technology may change, how humans appropriate this information does not. Wodtke's articulation of how one "uses" digital tools is effective for professional practice where these tools are used for the production of architecture. What is critically omitted is how the digital tools contribute to the design process.

Digital tools in architectural practice supplanted the art of drafting with software that simulates the representational orthographic standards of production.⁸ The majority if not all professional software are used to represent the building design, "in the 1980's and 90's computing technology slowly migrated, *undisruptive*, into *non-design* areas of architecture. This has now resulted in ubiquitous immersion of CAD in the *production* of 2D plans and 3D *visual representational* models for architecture."⁹ It is this production standard in practice that is beginning to be challenged by new digital tools which overcome computings' initial shortcomings, "limited data processing capability, and the inability to quantify complex *intuitive attributes* of the designer and design process participants, has limited the migration of the computer into the early phases of conceptual design",¹⁰ and requires us to keep up. "Designers use media, design environments, not as a passive mechanism,"¹¹ but as an active tool to inform their design.

Case Study 1.0

The first curricular example is a beginning design exploration conducted by students in the pre-architecture program. The college requires computer competency and digital literacy early in a students' education. Our objective is to introduce digital tools at this stage so they develop in sophistication along with their ability to generate ideas in different types of media throughout their education. The project is called, MORPH . ology . [the study of the shape and form of buildings], and is used to introduce students to three dimensional modeling, representation concepts and fabrication in our foundation computers course. More importantly, this project is intended to introduce a digital design process using digital tools related to the industrial design problems and process discussed in *Refabricating Architecture*. To elaborate, the industrial process of manufacturing cars or airplanes relies on defined inputs based upon the end performance and function of the industrial object (aerodynamics, flight, etc...). The premise being that in order for students to learn the digital tools in a design process, the structure must be related to the structure of the design problem.¹²

⁶ Abdelhameed, Wael A., The Relations Between Design-Idea Emergence and Design-Solution Direction: Digital-Media Use in Mass Exploration of Architectural Design (Ascaad2006).

⁷ Rohan Bailey similarly discusses the use of digital technology as, "becoming a "Socratic machine" that provides an appropriate environment for design learning." Digital Tools for Design Learning (eCAADe 23, 2005)

⁸ Lim, Chor-Kheng, A Revolution of the Design Process (caddria2004)

⁹ Barrow, Larry. "CYBERNETIC ARCHITECTURE, PROCESS and FORM: The Impact of Information Technology" Harvard Graduate School of Design, 2000.

¹⁰ Ibid. p4.

¹¹ Abdelhameed, Wael "How Does the Digital Environment Change What Architects Do in the Initial Phases of the Design Process?" from 24th eCAADe Conference Proceedings, Volos, Greece. September 2006.

¹² Rohan Bailey, Digital Tools for Design Learning: The case of a Caribbean Design Primer for Beginning Architectural Students. (eCAADe 23, 2005)

The prescriptive problem structure looks at the digital industrial object broken down into engineered and constituent component parts, each manufactured (CAD/CAM) separately and then re-assembled from these prefabricated pieces. The morphology projects are designed and born digitally, like the automobile or airplane, the form evolves from a digital process of simulations to permutations to fabrication. This project imitates and simplifies the industrial manufacturing process; first inputs of the original object, second deforming it, and then finally rationalizing it for a fabrication output. Understanding design production in this way through digital tools and process contributes to a student's digital literacy.

Linking various digital techniques to a digitally driven industrial design process, I feel is successful in moving students' knowledge beyond basic CAAD competency into sophisticated use of the digital tools and media critical for digital literacy. The final presentation of the project material juxtaposes the various phases from ideation to fabrication allowing everyone to visualize the process. Students are capable of critically seeing the tools used to facilitate speculation and play¹³ in the production of design solutions instead of just design representations, a revolution of the design process (Lim)¹⁴. The process of modeling, simulation, generation and fabrication with Computer-aided design and manufacturing (CAD/CAM) become important tools in the design process. The Morphology project and the similar case discussed by Chor-Kheng Lim demonstrates how the design process is greatly affected by digital tools.

Case Study 2.0

The second case study is a digital collaborative project titled "shared city" completed by Third year students who engaged the digital design process to create and fabricate a collective block wall using digital tools. Students explored the concept of mass-customization enabled by incorporating laser cutting technology and Autodesk Revit software. Collaboratively students were able to virtually visualize simultaneously the relationship of their individual block (12" square, see figure 2) to those surrounding it, responding to contextual changes in the overall wall design (4' square). Each individual started by analyzing precedents of mass-produced concrete and terra cotta works by Frank Lloyd Wright and Louis Sullivan, departing on their own modular block design inspired by an urban city typology. The final sixteen-block wall or "shared city" demonstrates the application of software to integrate collaboration and fabrication in digital architecture, enhancing analogue architectural production methods through incorporating digital processes. A critical question this project sought to answer was how can the power of BIM be co-opted to develop fundamental design skills?

The "shared city" project utilized Revit primarily as a collaborative modeling tool rather than a generative modeling tool in the design process. While each student was encouraged to develop their mass model virtually in Revit, most students tested Revit in the initial schematic development of their project. As their design evolved, Revit proved difficult in modeling more complex forms and shapes as demanded by the students; therefore, they moved to alternative platforms importing their work into the collective Revit model. Revit while having inadequate digital modeling capabilities did prove to enhance the collaboration in the design process by allowing visualization of the context and design information.

The "shared city" example attempted to capture and share the design process or information informing the overall design through Revit's collaborative environment. The project was set up with a common central file shared by all the students working on the project. Students had his or her individual separate file showing their block design that was linked to the central file. With each save the individual design is saved locally and in the shared file. This was managed through Revit's workspace feature that allows individual elements, in this case each block, to be edited only by one author at a time. This feature combined with saving to the central shared file with comments, allowed collaboration to unfold with each save of their work. The comment feature builds a living document, or history, which when opened shares with the user the living narrative describing the design with each save. Investigating the shared history from Revit the morning of the projects completion; one can see when each student saved their work and what they chose to share. These collaborative

¹³ Bentron, Sarah, Mediating between Architectural Design Ideation and Development through Digital Technology

¹⁴ Lim, Chor-Kheng. "A Revolution of the Design Process" from CAADRIA 2004 Proceedings, Seoul, Korea.

modeling features of Revit are attractive to the professional environment in the realm of integrated design, where “large teams need effective ways of achieving collaborative building design”.¹⁵

The “shared city” exploration also tested one conclusion put forward by Larry Barrow, “Our pedagogy and research has shown the visualization and representational power of emerging 2D and 3D CAD/CAM tools.”¹⁶ The fourteen students involved in this project, embraced the means of production, digital modeling and laser cutting chipboard to create a far more complex and intricate models than possible to imagine through traditional analogue production processes. There were two types of production methods explored by students using the laser cutter in the production of their models. The first was a layering technique, creating slices from the digital model to cut out of and assemble from chipboard. Some utilized this method to create solids, while others used it to create layers of space. The second production method took the solid digitally modeled forms and unfolded the sides into profiles, which were then fabricated and assembled by hand.

These methods were generally used exclusive of each other as an approach to the construction of the final chipboard model, demonstrating the amateur handling of this new production process for model fabrication. A learning curve was expected in how students engaged Revit, but also in their first use of digital fabrication. As they progress and the digital fabrication tools become more ingrained in the working habits of the students at the college, more sophisticated and complex constructions can be expected as students gain more knowledge and experience with these digital tools of production.

In the end, how effective was the collaborative information exchange process enabled by Revit in developing qualitative design ideas? During the design process students collaboratively created a wall through a series of disconnected or tentatively connected (figure 4b) objects. The digital environment and design process through this project using the software enabled students to instantly visualize their individual design decisions in relationship to the overall context of the wall and respond to the changing context surrounding their individual site relating to the neighbor’s design and ideas; and collectively share ideas and aggravations in the living document with each save. Here as in the morphology project their digital literacy of the digital tools and process involved were crucial to the final result.

CONCLUSION

For a digital RE thinking future research into whether we need or do think differently while designing in the digital environment with digital tools affects students’ design abilities. These projects are the foundation for ongoing pedagogy shift at the college and our foundation computer course teaching current and relevance digital tools, media and process. However, the goal of this paper is to demonstrate digital literacy, mastering ideas as well as keystrokes, through the application of digital tools such as BIM and CAD/CAM digital fabrication in architectural education. As educators, we all seek to instruct students to engage critically in the design process and equip themselves with fundamental architectural and technological skills necessary for their transition to advanced design and the practice of architecture. The digital design projects discussed involve the use of digital tools in representation, deformation, collaboration, fabrication, to discuss how the digital design process enables beginning design students to understand the use of digital tools in design for architectural literacy.

¹⁵ Tuzmen, A. *Self-Sustainability of Effective Team Performance in a Collaborative Design Environment*, ed. Wassim Jabi. Proceedings of the ACADIA 2001 Conference, (Buffalo New York: Gallagher Printing, Inc. 2001)

¹⁶ Barrow, Larry. “CYBERNETIC ARCHITECTURE, PROCESS and FORM: The Impact of Information Technology” Harvard Graduate School of Design, 2000.

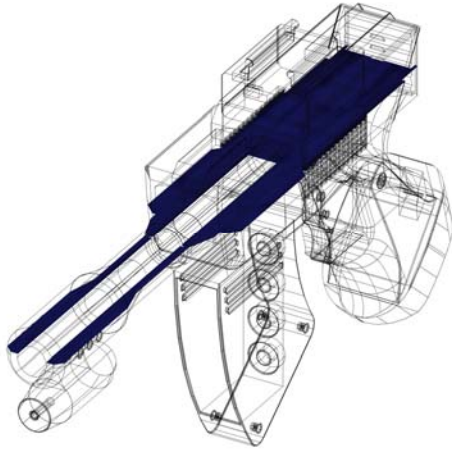


figure 1: student example by Ryan Ferguson, College of Architecture, University of Nebraska-Lincoln

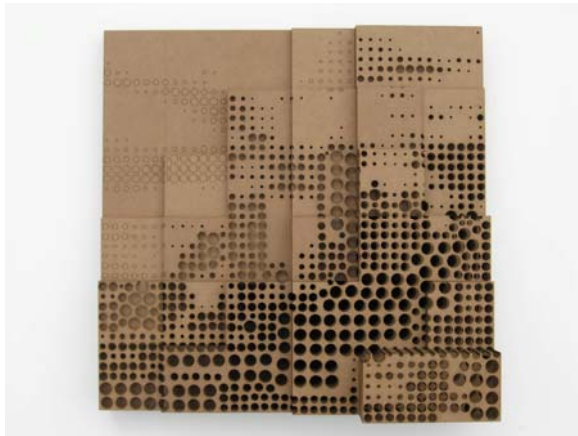


figure 2: student example by Erik Leahy, College of Architecture, University of Nebraska-Lincoln