MAN AND MACHINE: IDEATION AND MAKING

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Abstract

The realization of architecture, that is the building of the physical artifact, requires numerous collaborative participates that requires a communication network in order to realize the vision (Barrow 2000). All efforts to communicate a design idea prior to physical realization, that is manufacturing or construction, are forms of visualization (i.e. representation). Herein lies the fundamental problem, the designer(s) must en-vision, and communicate that which is to BE ... physical, yet is NOT... physical (Barrow and Mathew 2005). In this paper, we will review the emerging Human-Computer-Interface and technology influences on process and product; here we find the "humanistic" component is a critical factor in the success of "digital" strategies.

1. Introduction

Technology experts in related fields outside architecture define technology as consisting of three (3) interdependent, co-determinant, and equally important components (Tushman 1988):

- Hardware (HW)
- Software (SW)
- Humanware

Therefore, man (i.e. people) and machine (i.e. technology/computers) are intricately interwoven in a symbiotic relationship. Since the Industrial Revolution cycles have occurred of innovation with integration of machines in manufacturing processes, yet the knowledge and ability of the "human" has remained paramount and critical to "Making" (i.e. manufacturing/construction) (Schodek et al 2004, Barrow 2000). In the field of architecture, "designers" who conceive of space and form are "Pathfinders", those who dream, who "vision (Norri 1997). Recent progress in Hardware (HW) and Software (SW) allows the designer to use the computer in the early design phases for conceptual visioning and ideation of form, space and place. In addition to evolving digital "ideation," emerging collaborative "design-build" teams are increasingly using "digital" strategies in the process of "making."

2. The Problem

Heretofore, most agree the computer has been a hindrance to creativity, sensitivity, tactility and experiential phenomenology. (McCann 2004) The design process remains a humanistic intuitive process of complex explorations and respective decisions facilitated by representation and visualization strategies. Until recently, the complexity of engaging the computer hardware interface via keyboard and mouse, as well as the innate numerical binary structure of software applications, have not been compatible to the fluidic flow of human hand-to-eye interaction (Barrow and Mathew 2005). Often, in architecture, traditional and digital media users consider technology a seperate entity from the human user resulting in confusion and conflicts in pedagogy and practice.

3. The Claim

Only recently have we seen the emergence of digital design tools migrating into the design studio; this is attributed to the evolving human-computer-interface (HCI) that now allows an increasingly fluidic means of creative design ideation and digital representation. 3D modeling (i.e. BIM) strategies are allowing multiple levels of information to be generated from the same geometric model which facilitates early design development as well as downstream communication for making (i.e. manufacturing and construction). The digital and traditional media strategies can be interwoven to gain the benefits of both strategies for the visioning and making of architecture.

A crucial component of the emerging HCI are software (SW) and Output options, these are the subject of the next section.

4. Software + Hardware Output

There are numerous emerging representation/ visualization SW and CADCAM Output systems; they are recapped as follows (see Table 1 - 2)

5. Dimensional "Thinking" – 0D to 7D

In our recent pedagogy, research and practice we have developed a language for the communication of representational "thinking" relative to technology and "dimensions" (Mathew and Barrow 2005). The following diagram depicts "0D – 7D" (see Figure 1).

6. Ideation and Making

In this section we will review two projects and a third project will be referenced, the Bilbao Guggenheim Museum. These projects offer an array of scale and typology issues that are representative of our teaching, research and practice. In each project, the computer is used in various phases of design, as well as manufacturing and construction.

The following images are excerpted representative examples of the emerging and evolving digital "design-make" process.

Table 1: Digital Design Software Typologies (Barrow and Mathew 2005)

Digital Design Software Typologies				
Type	Typology	Intuitive	Rational	2D / 3D Software Applications
1	Conceptual Design	X		Alias Sketchbook, Architectural Studio, Photoshop, SketchUp, etc.
2	Free-Form	X		Rhino, Form-Z, AutoCAD 3D, etc.
3	3D Object Oriented		X	ArchiCAD, Revit, MicroStation, Architectural Desktop, etc
4	Viz - Presentation		X	3D Studio Max / Viz, Maya, SoftImage, etc.
5	Simulation		X	3D Studio Max, Catia, Unigraphics, etc.
6	CADCAM		X	Rhino, Catia, Unigraphics, SolidWorks, Pro-E, Inventor, etc.

Table 2: Digital Design-Make Output Typologies

Digital Design-Make Output Typologies							
					Dimensions		
Type	Typology	Intuitive	Rational	Output Device	1D	2D	3D
1	Microsoft Word	X	X	2D Printer (1D text)	X		
2	CAD (Conceptual Design)		X	Laser Cutter (2D)		X	
3	CAD (Conceptual Design)	X		3D Printer (3D)			X
4	CAD (Conceptual Design)		X	CNC Router (2 or 3D)		X	X
5	CAM (Production/Manufacture)		X	CNC Router (2 or 3D)		X	X
6	CAM (Production/Manufacture)		X	Plasma Cutter (2D)		X	
7	CAM (Production/Manufacture)		X	Water Jet (2D)	X		

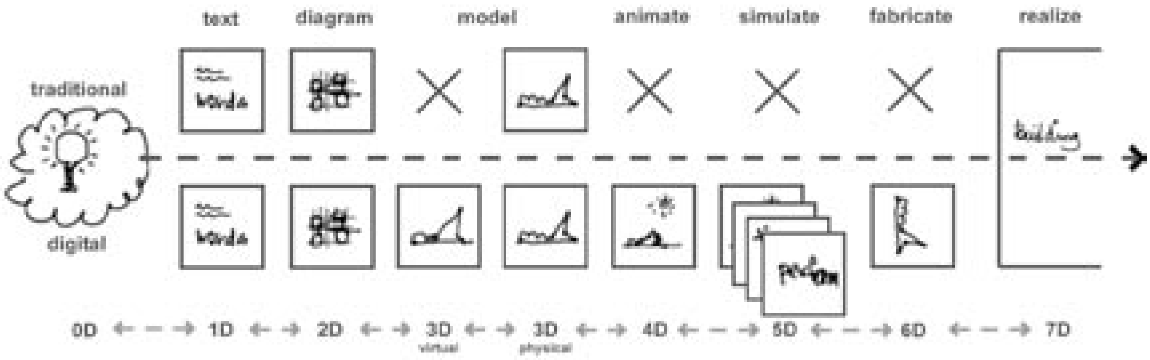


Figure 1: Digital Design Dimension (D) Typologies: 0 - 7D (Barrow and Mathew 2005).

6.1.Project 1 – Student Studio Project – Wind Mobile

Table 3: Digital Design-Make Representation/Visualization/Making – Wind Mobile

Student: Alison Wade – Graduate Student - Interior Designer / Artist Course: Digital Design I – Fall 2004 / Instructors: Barrow and Mathew / Project: Free-Form Expression	

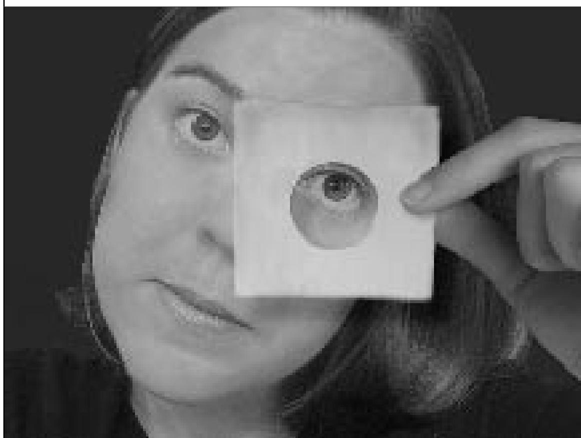
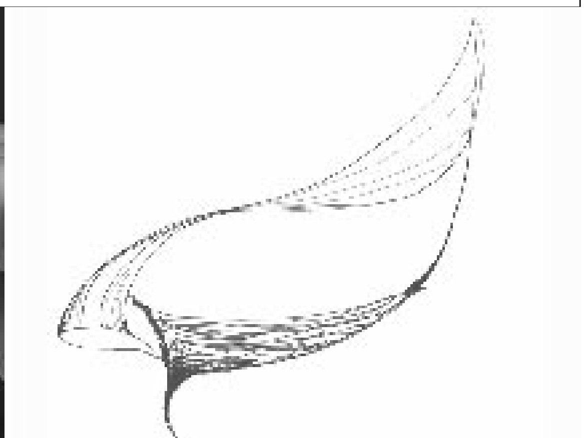

	

Figure 2: 0D – Thinking - ("Vision")	Figure 3: 2D – Digital Sketch

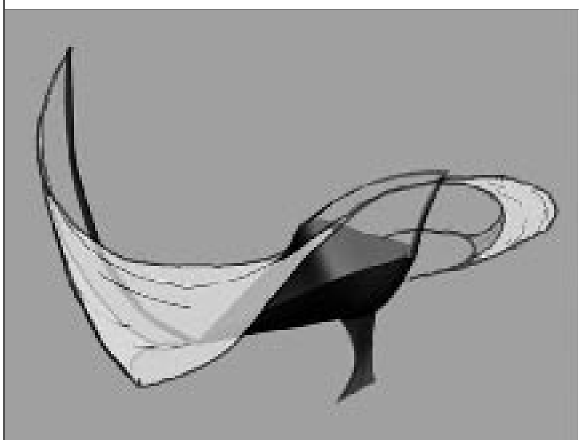
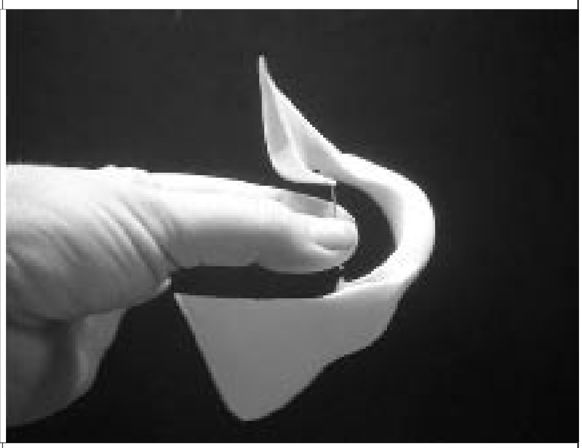
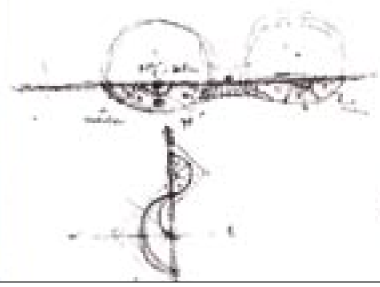
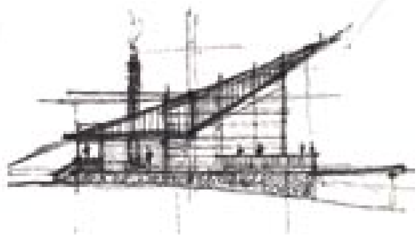
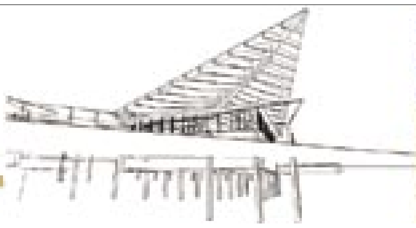

	

Figure 4: 3D + 2D – Model (CADCAM – Digital)	Figure 5: 3D – Model (CADCAM – Physical - Static)

6.2. Project 2 – Architectural Project – A Mississippi Lake House

Table 4: Digital Design-Make Representation/Visualization/Making – Lake House

Vision and Visualization = Ideation and Communication
Architect: Larry R. Barrow Client: Withheld at owner's request Location: Mississippi, US - (Specifics withheld at owner's request) Project: A Lake House
  
Figure 6: 0D – Thinking - (Vision). Figure 7: Concept Sketch Figure 8: Concept Sketch
  
Figure 9: Concept Sketch Figure 10: Digital 3D Modeling – Ideation - Ideation – Larry R Barrow - Architect Figure 11: Making - Making – Carson Creations – F. Lee Carson

6.3. Man + Machine

The following images provide additional visual documentation of the human engagement with machinery in the process of using CADCAM and the making of artifacts and architecture (see Figures 12-13).

7. Findings and Analysis

Our comparative study of a small scale design project and an architectural project, both of which utilized "digital" ideation and making strategies, reveal both similarities and major differences. In project 1, the student studio project, the designer generated the form from "visioning" and "visualization" strategies using "0D – 4D" digital tactics and was thus able to generate all phases of the "ideation" and "making" using digital media and CADCAM output. So one can say the "digital" environment enabled the generation of the curvaceous form with a near seamless translation into "physicality." However, even at the small scale of the mobile sculpture, collaboration was necessary; the designer was not familiar with the skills necessary to generate the 3D printed model, and was thus dependent on the studio Teaching Assistant to output (i.e. print and prep) the "physical" model. In Project 2, the house project, the architect (i.e. the writer) used traditional media in the early phases of conceptual design (0D-2D) graphics and then engaged the "digital" environment using 3D "digital" modeling for schematic design form and space studies. A 3D Building Information Model was utilized which leverage parametric and object oriented modeling which facilitated multiple design studies and early "low viz" output that proved invaluable to the

Table 5: Human and Computer / Machine Interface Examples

Human and Computer / Machine Interface Examples	
	
Figure 12: Project: Panel Mold Fabrication Mississippi State University – US Lab: Raspet Aerospace Center CNC CADCAM Expert: Clay Shires	Figure 13: Project 3: Bilbao Guggenheim Museum Location: Bilbao, Spain Design Architect: FOGA – LA, CA - US Executive Architects: IDOM – Bilbao, Spain Image Source: IDOM – Louis Rodriguez, Ph.D. (PM)

designer, owner and the building team for discussion and collaboration. Additional leverage was possible as the "digital" model allowed multiple perspective exterior and internal view (camera) points which afford extensive studies as the design evolved. A collaborative "design-build" project delivery model allowed the interweaving of "ideation" and "making" as the model was used as a central "geometry" to establish aesthetic intent and control manufacturing and construction dimensions. Traditional methods of "free-hand" details, which were linked to the 2D and 3D graphic output of the BIM, were used to develop construction details for fabrication and erection.

Our pedagogy, research and practice examples have included 3 projects which provide a wide range and scale of projects for our analysis. Extrapolated general principles are as follows:

- Design remains a creative intuitive endeavor of which the human mind is the genesis of "ideas."
- Hand-To-Eye coordination for free-hand fluidic drawings is being facilitated by emerging technology via more user friendly SW and CADCAM Output systems.
- The human remains the most important factor in the realization of technology strategies.
- Technology drives collaboration and teamwork.
- At no scale of "design and making" did we find a project that was realized solely by the "artist" or "machine," rather, all projects require an amalgamation of human team members and congruent machines.
- At the highest level of design and manufacturing humans remain fundamentally critical from artistic "ideation to making" (see Figure 13 above - Bilbao).

8. Conclusion

Process and product potentialities continue to expand as "digital" technology progresses in architecture; research should continue in this area relative to the Human-Computer-Interface and the evolving relationships between people and machines and related organizational strategies. While digital technology is increasingly transforming the design-make paradigm where building components are increasingly fabricated on or off-site, human intervention and collaboration, interwoven with technology (i.e. machines) is increasinlgy essential for the making of architecture.

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