University of New Mexico
Albuquerque, New Mexico

Digital Mutations: Exploring Methodologies in Fabrication

by Tim B. Castillo

The emergence of digital fabrication processes in architectural practice has reconfigured our methodology in creating constructed space. As the profession begins to incorporate these processes, architectural education becomes the forum for exploration into these new technologies. As many design schools across the country have begun to incorporate digital fabrication such as CNC mills, 3D digital printers and laser cutters into their pedagogical mission, the University of New Mexico has limited resources and is not currently able to incorporate this technology within their curriculum.

The challenge for our institution is to develop a methodology for educating our students in emerging digital fabrication processes, so that they can be competitive in the professional environment. The studio was set up as a design build process, the client being the Digital Filmmaking Institute. The program was to develop the interior space for the Insomnia Lounge for the Duke City Shootout Film Festival in Albuquerque, New Mexico (Figures 1, 2).

In working with a very limited budget, the students were asked to be innovative in their approach to developing the space and to incorporate processes of digital culture as a way of informing the production of the installations (Figure 3). The focus on innovation is critical in working with limited financial resources as it forces new readings for material and spatial exploration. Relying on traditional material and fabrication processes in many instances inflates monetary expenditures. The positive use of digital technology allows a series of visualization studies that can explore several material options that are integrated into spreadsheet data sets that give projected cost analysis (Figure 4).

Figures 1,2: Fabrication studies for Duke City Shootout.

Figure 3: Cardboard panel mutation study.

Figure 4: Digital rendering study of installation.

The insomnia installation program defined the pedagogical framework for the studio and investigated innovative spatial creation through fluid production based in digital and analog mutations. Exploring the potential of digital information and understanding how it affects architectural spatial configuration was a primary goal of the studio. By incorporating new methodologies that borrow from the automotive, aeronautical and cinematic professions, the students were asked to reconsider traditional design practices. Utilizing vector based principles and simulations, the studio worked with imprinting processes as a means to develop analog constructs. This systematic operation can be defined as versioning, a process that attempts to rethink the design in terms of procedure and outcome in ways that common practice and conventional design methodologies cannot conceive [1].

As the profession continues to evolve using digital technology, information practice has become the standard for contemporary building execution. The emphasis on data organization and comprehension has become fundamental in translating between modes of production. Design data information migrates through various forms of translation (i.e., vector drawing to digital scaled prototype to construction document to full-scale fabrication) in the process of any architectural project. It has placed an added burden on academics to pursue models that incorporate a more holistic understanding of data design integration. The opportunity for this research to occur in academy allows for more innovative analytical design methodologies that expand beyond comprehensive design tools, such as building integrated modeling systems. The downside is students are not as well versed in s specific parametric software that might make them more viable to step into a professional setting right away.

The mission of this studio is to develop analytical evaluation tools to understand the migration of data through various informational systems and critically assess the opportunities for both analog and digital innovation. Through a series of performance modules the studio researched computer controlled manufacturing principles and began a dialog of transference spatially and materially.

The foundation for the exploration began by understanding how data can inform and inspire new spatial possibilities (Figure 5). The students were asked to create a series of vector animations in Flash MX mapping ergonomic activities. The students documented movement by photographing a series of time lapsed images that focused on the various forms of movement. They researched structural organizations by documenting the fluid movement traces and then converting them into 3-dimensional spatial data.

This data then migrated into 3-dimensions, utilizing NURBS (Nonuniform Rational B-Splines) modeling in **form•Z** they captured the dynamic spatial activity. The students then

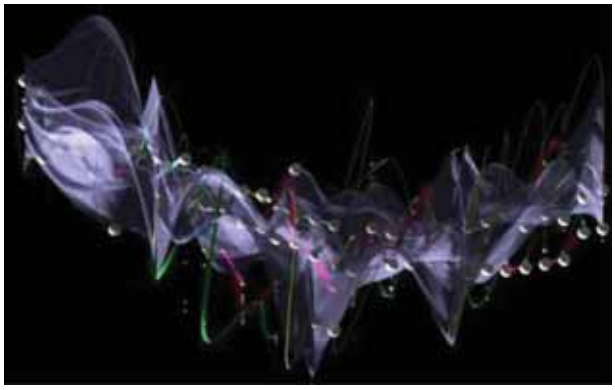

Figure 5: Network model images.

began to probe the models and delineated the result in orthographic and axonometric drawings (Figure 6).

These drawings were the basis of form translation into analog prototyping. Understanding how parametric process can inform design we began to explore the digital models to understand how they could be translated into analog prototypes. By analyzing the data produced in the visual simulations, a methodology of extraction was critically probed for each model. Applying mathematical and scientific operations, the students uncovered spatial, tectonic and network formulations for further development (Figure 7).

The analog translation inherently produces visual information that each student must read as a framework for further exploration, unlike digital analog prototyping technologies (3D printing, laser cutting, CNC milling) that produce direct translations of digital data into analog models. These mod-

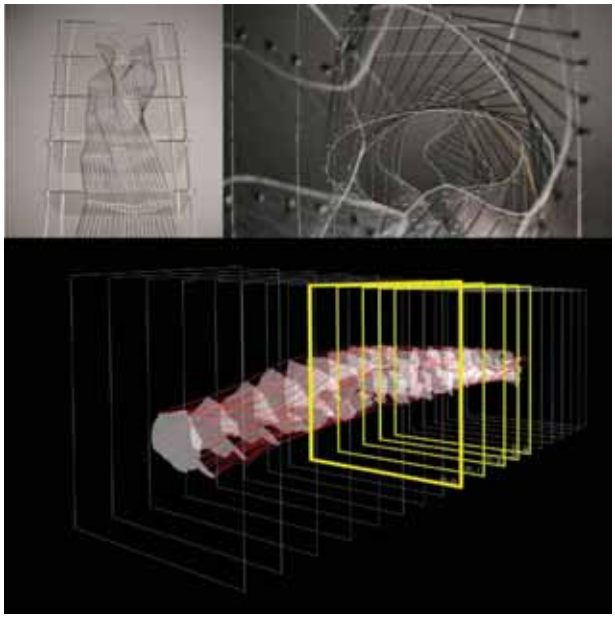

Figure 6: digital + analog translation studies models.

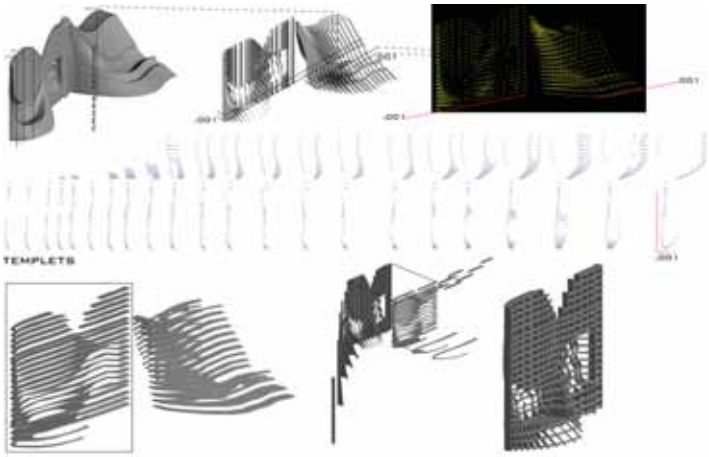

Figure 7: Digital translation study.

els are intended as mutant systems that explore a multiplicity of conditions and allow for various modes of design development. This included material innovation, exploration of dynamic structures, spatial networking, and tectonics.

This research allowed the students to begin to be anchored in real world forces, permitting an opportunity to understand how the migration into physical systems forces reconfiguration of the data. The ability to work haptically is essential to understanding the architectonic application of these studies.

The studio then applied the extraction of this data to a small-scale program that demonstrates the economy of production and material. These studies focused on fabrication innovation, template organization and digital data mutations. The result of these studies informed the foundation for development of the insomnia space for the Duke City Shootout (Figures 8-10).

In order to work efficiently, the studio was broken up into five teams. Each team engaged the insomnia program and created an innovative scheme for the insomnia lounge. The challenge for the teams was to create space that was economical both in material and process. The students started by exploring materials that would be cost effective and structurally sound for the space.

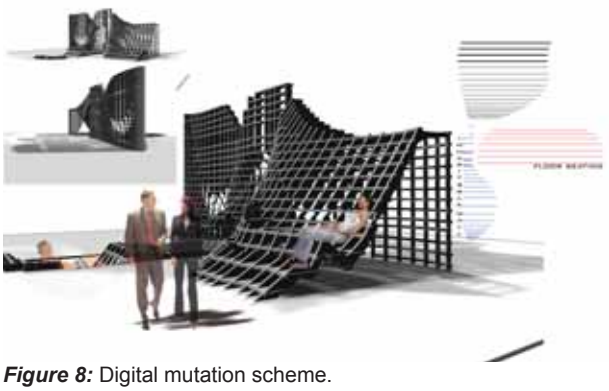

Figure 8: Digital mutation scheme.

Figure 9: Fabrication templates.

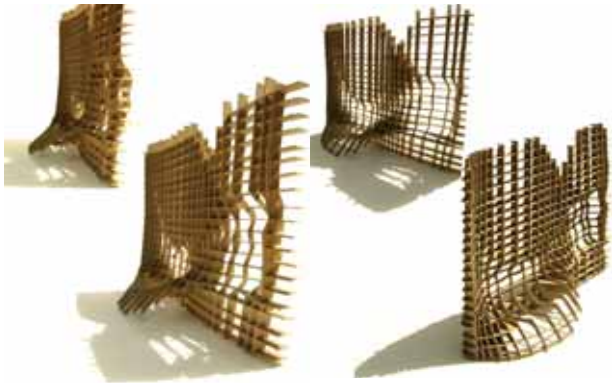

Figure 10: Analog model.

The development of the Insomnia Lounge for evolved as a competition format. Each team was to develop a scheme that the board of the Digital Filmmaking Institute could critique. The final iteration engaged in a process of full architectural production. The students were to expand on the research developed in the previous modules and produce a full-scale installation investigating material, tectonic and tactile permutations derived through digital experimentation. The main objective was to work on a performance driven methodology that incorporated digital and analog prototyping strategies to select the most efficient design (Figure 11).

Figure 11: Full-scale tectonic + material study.

Figure 12: Digital rendering of spatial configuration.

The final project began with *performance base modeling* [pbm] techniques that respond to critical data dictated by spatial forces and contextual specificity. The students were to produce an installation that addressed a series of spatial events including event seating, an editing station and bar (Figure 12). By generating a series of performance models, design intentions could be evaluated spatially and programmatically.

As the process evolved we spent considerable time focusing on material analysis, probing for structural capacity, modularity and economic efficiency. These investigations yielded a variety of latent systems that challenged traditional fabrication strategies. These materials required research into new patterning and geometric processes to uncover methods of assemblage. Ultimately, what emerged were several composite systems that were dependent on interactions between surface and structure. Singular systems were no longer applicable; rather everything was interconnected to function as a collective whole, producing intelligent performance derived systems.

The selection of the final scheme was a challenge for the board and ultimately yielded the selection of two schemes. The collaboration and integration of the two schemes was a relatively easy process as the students were able to apply the fluid methodologies explored previously and derive another mutation for the final installation.

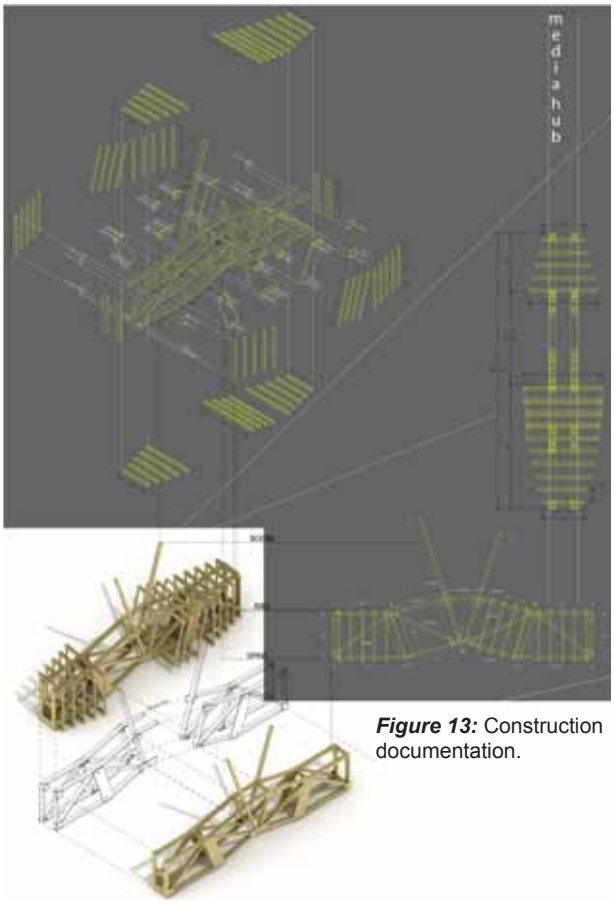

Figure 13: Construction documentation.

The execution of the final fabrication required construction documentation that was generated in **form•Z** (Figure 13). The economy of a pattern driven process allowed for a fluid and economical construction process to evolve. The final installation was constructed summer 2007 and exhibited at the main event, where more than one thousand visitors participated in the film festival (Figures 14-16).

As the digital fabrication process continues to evolve in architectural practice, academy will continue to face new challenges to provide students the ability to think within the parameters of these emerging technologies. In creating a forum that allows students to probe digital processes, we allow creative options for problem solving. Developing studios that engage diversity of manipulation of design data is critical in gaining exposure to all facets of contemporary practice.

The success of the studio begins to offer trajectories for new opportunities to emerge out of digital pedagogy. The ability to realize full-scale design and work with budgetary constraints, models professional practice in a way that the traditional theoretical studio models cannot engage. The students were rewarded with opportunities that could provide innovative solutions for impacting our spatial environments and advancing the academy of architecture.

Reference

[1] Sharples, Holden and Pasquarelli; Versioning, New York City (Architectural Design, V. 72, Sept. – Oct. 2002) p.7-9.

Figures 14-16: Final installation and process images.

Tim B. Castillo is an Assistant Professor at the School of Architecture and Planning at the University of New Mexico. He is currently the Coordinator of Undergraduate Design and the director of the Laboratory for Digital Research. While at the University of New Mexico he has rigorously been pursuing new pedagogical courses that explore applications related to digital technologies. His studios and seminars continue to investigate new progressive strategies for design that are defined by informatics, digital media, and CAD/CAM processes. In 2007, Professor Castillo was recognized by the Association of Collegiate Schools of Architecture (ACSA) and the American Institute of Architecture Students (AIAS) as the National New Faculty Teacher of the year. He is also the founder of Hybrid Environments, a critical design office that focuses on new technologies for architecture, research, and design. His work has been published and exhibited nationally and internationally in various locations including the Institute for Advanced Architecture of Catalonia (Spain), Ecole Polytechnique Fédérale de Lausanne (Switzerland), Pavillon de l'Arsenal (France), Bienal of Sao Paulo (Brazil), and University of Waterloo (Canada).