University of Texas, Arlington
Arlington, Texas

Typologies:

Architectural Associations, Dynamic Processes, Digital Tectonics

by Thomas Rusher

The notion of existing historical typologies in architecture from component and assemblies to program and space, and how designers approach this knowledge base relative to nascent associations with emerging technologies calls into question techniques, relationships, and pre-conceptions of historical design canons. In addition, how digital techniques might enhance or redefine existing analog design methods is a contemporary topic and interst of mine. Algorithmic Operatives, Scripted Surfaces, Digital Fabrication, and Animated Conveyance Techniques are just a few emerging Digital Design Typologies that I research. We are in the midst of a developmental technological era of rapidly changing digital devices, fabrication/proto-typing equipment, and experiential virtual spaces.

How can digital media be used in both an inventive and generative fashion without complete loss of authorship and humanity to the computer? What is the architect's role both in and out of digital space? What are the approaches to digital media and analog links to architectural principles of design? In all three of my Digital Design classes, these topics are studied and explored through varying investigations depending on the level of the student. Investigations of historical known types, running empirical studies to understand digital constructs, developing of dynamic digital operatives as a generative device, and, (in my advanced digital design classes), examining of animated temporal organizational structures are researched as a means of establishing "generative digital techniques." The development of rhythmic tectonic structures, through dynamic means while creating analogous conceptual relationships to known architectural types and cross pollinating with allied design fields is leveraged as an initial point of departure. This runs in tandem with my own independent theoretical studies related to algorithmic structures, component development through dynamic means, and frozen animate conditions as the establishment of digital typologies (Figure 1). While a student at Columbia University in the mid-1990s in Greg Lynn's Design Studio, I began a line

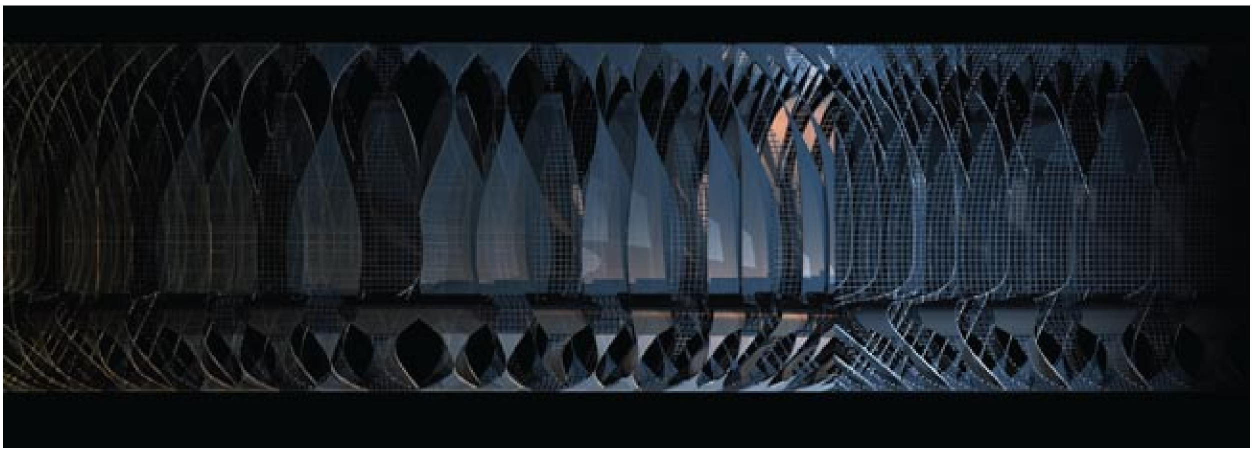

Figure 1: Tom Rusher: Dynamic Algorithmic Assembly Process.

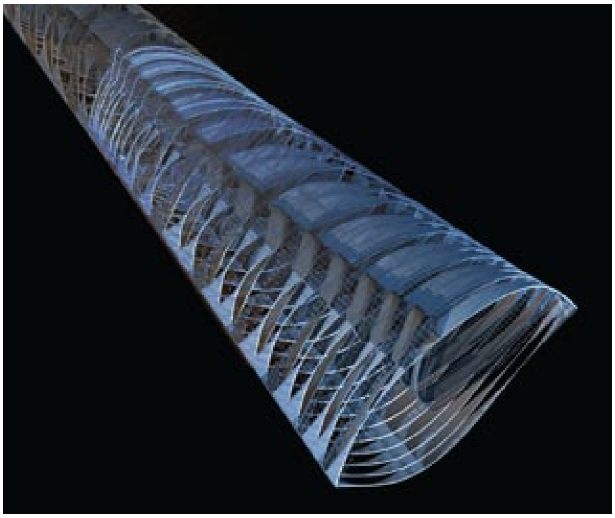

Figure 2: Tom Rusher: Variable Spatial Porosity/Digital Tectonic.

of study that incorporated animation as an analytical and generative apparatus. "Through experimentation with non-architectural regimens, architects may discover how to engage time and motion in design."[1]

My interests lay in the immersion of topics that range from synthetic structures, digital skins, material amalgamation, digital/analog tectonics, stochastic structures, digital relationships of component to assembly, links to allied design disciplines, atmospheres and environments, material studies, cause/effect spatial relationships to program and finally, the cinematic aspect of dynamic performative communication using sound and animation in the conveyance of concepts (Figure 2). In order to understand the development of these Emergent Digital Design Typologies and how they may inform, add value to, and/or redefine physical architectural types, an understanding of the psychology of known typologies and how we tend to recognize, embrace, and intuitively understand "known" categories need to be investigated. Digital Constructs both environmentally and behaviorally need to be understood in order to create conceptual bridges to the physical. Finally, looking to allied design fields that have had much more experience with technology to generate designs such as the aerospace and the car industry are of great analytical and conceptual value to the architectural profession in understanding how digital tools may inform designs.

Typologies are not constructed over night but rather tend to happen in movements over time and with a grown consensus in the particular industry for accepted practices. "Typology plays a significant role within material practice. It allows for a clear selection of architectural organization from among the almost limitless possibilities available today."[2] A good example comes from the car industry and with the concept of Uni-body Construction. The main tenant of the Uni-Body construction type is the merging of components into a unified whole where structural chassis and skin components of body panels, windshields, and the like work in conjunction with each other to create structural, fuel, surface, performance, economic, and safety efficiencies. This involves innumerable components from rear light configurations, air intake grills, and windshields, to doors, thin metal skins, merged bumpers and naturally, the main structural steel chassis. All of these components are tied to the logic of aerodynamics, ergonomics, and design aesthetics which establish a symbiosis of efficiency, systems logic, and styling. The first two categories, (aerodynamics and ergonomics) are beholden to "function" the latter, (aesthetics) to "distinction." Yet, in distinction all are linked through the overarching typology and logic of Uni-Body construction. It is also known as Monocoque Vehicle Construction which is Greek for single (mono), and French for shell (coque).

Distinctions are made through material and surface fluctuations. Although all components have a sense of being different, they are in fact all the same by virtue of being part of the same "family" of components and industry accord. Looking at front fenders, grills, and headlight configurations, the current design trend is to construct head lights in crystalline chambers, emphasize the mimetic expressions of air intake grills for aggressive styling, and seamlessly connect front to side to top establishing a morphological sequence from X to Y to Z coordinates. The car industry is a good model to analyze as an allied design field that has incorporated sophisticated design and simulation software decades prior to architects to aid in the understanding and development of their products and establish efficiencies in cost and life cycle. The main advantages of Uni-Body construction are lighter weight construction, integrated surface as support skin, safety, and fuel efficiency. Despite the advanced use of sophisticated software, this industry still runs physical empirical studies to understand the ramifications of their design before it goes to market. Prototypes of new models are taken on to closed tracks to test breaks, speed, and acceleration, or the "performance" of the vehicle, as a completed system. They are crash tested for safety studies to gather empirical data and refine designs accordingly and are taken through wind tunnel tests to understand how function and distinction can work in tandem.

Architecture also has its accepted typologies from structural and mechanical systems integration, to surface, space, form, materials and programmatic requirements. Having worked for several large architectural design firms including Polshek and Partners and SOM NYC in the late 1990s to early 2000s, I had the opportunity to work on a variety of large scale building types from museums and cultural centers to airports, retail, mixed use, hospitality, office and transportation centers. This experience has given me an insight into many different building typologies and a curiosity about their relationships to each other, design, history, and the notion of how technology feeds new conceptions. In understanding complex existing building typologies, one needs to be able to extract the "characteristics" of the type that the computer might be able to expand on, establish efficiencies to, or entirely reinvent. This establishes a historical grounding to the research with a well-established knowledge base that becomes relevant in designing a bridge from the virtual to the physical. Given a perusal of the Time Saver Standards Book, one might develop a sense that each building type has been distilled into its function and programmatic relationships but the third dimension of "distinction" is not brought to bear.

The relationship to the digital era that we are in the midst of is certainly not discussed at any length and how it might allow for a rethinking of and perhaps produce a dividend of further time savings by establishing virtual connections analogous to the known "architectural associations." Here is where architects are called upon to not simply problem solve, program, and be cost-effective but to inspire, create, reinterpret, and orchestrate a built environment with connections to dynamic virtual processes. In other words, to create its "distinction" through the understanding of its key typological characteristics while exploiting the new technologies as a way of informing, enhancing or perhaps, establishing a new series of design typologies linked to dynamic digital techniques. Analyzing building typologies closely reveals accepted norms and working models for the types developed through pre-digital means. Each building type is beholden to its function, programmatic scope, the laws of physics, and economics, but once again, distinction is beholden to techniques, analog organizational matrices and accepted forms of the historical types. Here is where the role of the computer becomes interesting. Is it simply a way of expediting and visualizing pre-computing methods or should the computer allow for new methods and models to expand on analog techniques and establish a language for the zeitgeist of the 21st century?

There are several Digital Typologies in developmental stages having a direct link to architecture that range from scripting, algorithmic architectures, animated techniques, dynamic digital operatives, and computer aided manufacturing (CAM), to virtual social networking sites such as Linked In, My Space, and Face Book. One approach I have explored is to leverage the emerging toolset of software and development of "dynamic digital operatives" as a means of designing novel organizational structures and "digital tectonics." Through this process the creation of "traces" of the dynamic process as "frozen moments" emerge as new digital constructs with physical potentials. I've been refining and evolving these techniques over several years using the new functions in **form•Z RenderZone** and other 3D modeling and time based software packages. Examining the 2002 Serpentine Pavilion by Toyo Ito and Arup as an example of digital operations being utilized as a design generative, they set up a simple problem for the pavilion by asking a question. How do you float a slab and transform the box?[3] Their technique was to establish a control for the boundary, (the box) and dynamically arraying a frame in plan to establish a stochastic reading that was then mapped onto the control element. Members became continuous and bent

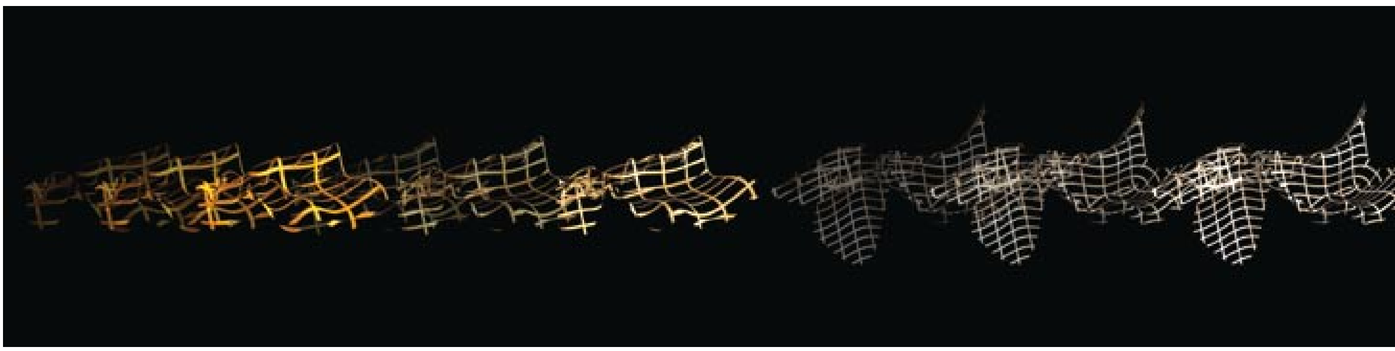

Figure 4: Tom Rusher: NURBS Surface Morphology: Trait Inheritance.

along edges to create ground connections. A coded matrix was used to define the placement of opaque, transparent, and open zones in the pavilion working with in the logic of the dynamic organizational system. The final product was an integrated stochastic armature with variable of glass and painted metal panels that leveraged the ability of the new fabrication techniques to produce "mass customized" elements.

In my advanced computer and design class at the University of Texas at Arlington's School of Architecture, students explored with the development of digital operatives and the establishing of dynamic organizational structures, through a series of abstract animated empirical and analytical models. One of the major tenants of the study was to have the students discover and categorize "digital typologies, dynamic operatives, and animated conveyance methods" while establishing conceptual analog links to architectural typologies from component, to assembly, to systems (Figure 3). Behavioral characteristics of digital objects were analyzed in order to understand its intrinsic value, logic and limitations. For instance, there are NURBS, (Non-Uniform Rational B-Splines), typologies based on initial spline construction and line typologies, orientation of lines, open or closed sections, and so on. Each variable of construction adds to the performance of the structure. This coded information affects the flexibility of the NURBS and once created inherits these traits (Figure 4). Additional control points may be added or subtracted but the inherent behavior of the structure vis-à-vis its initial line type does not change.

Conceptual links to architectural structure, skin, space, digital tectonics, and ultimately program were generated and leveraged for a final conceptual proposal for a transportation building type. Beginning with base elements of parametric primitives, known steel typologies, non-Euclidean forms, lines, preprogrammed formula surfaces and splines, students learned how to parametrically control digital materials. Derivative elements such as NURBS, Lofts and Sweeps were also utilized as generative control structures. Dynamic operatives with the ability to embed new parametric controls through the application of the deformative operations in **form•Z** allowed for the development of the empirical studies. The idea was to create a "family" of components that exhibited variable characteristics while inheriting traits of previous iterations over to the next through an animated morphology of interrelated operations as a technique for component development. Another method was to analyze the "tween" or interpolated sections generated by the computer by moving from one state to another as a way of generating variable components with incremental

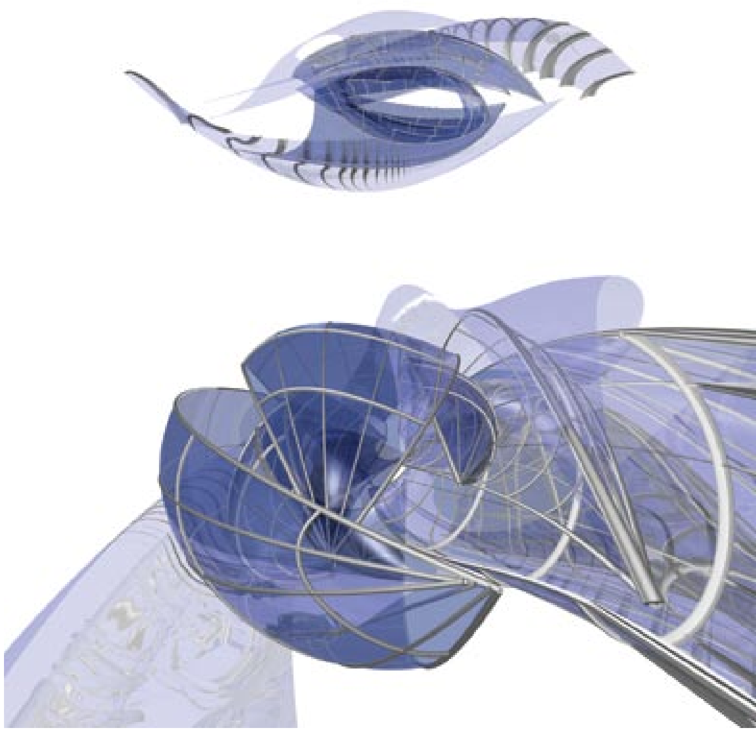

Figure 3: Student: Sergejs Aleksjevs: Tectonic Assembly.

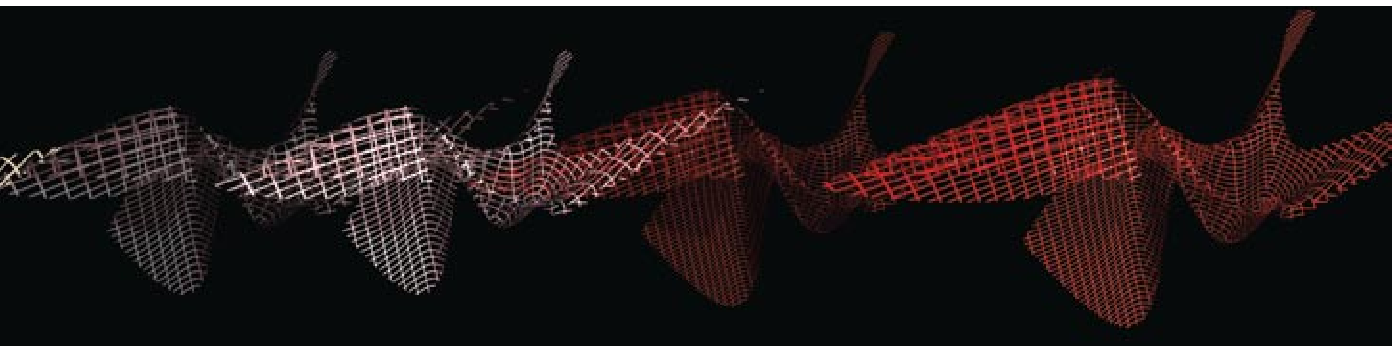

Figure 4: (continued):

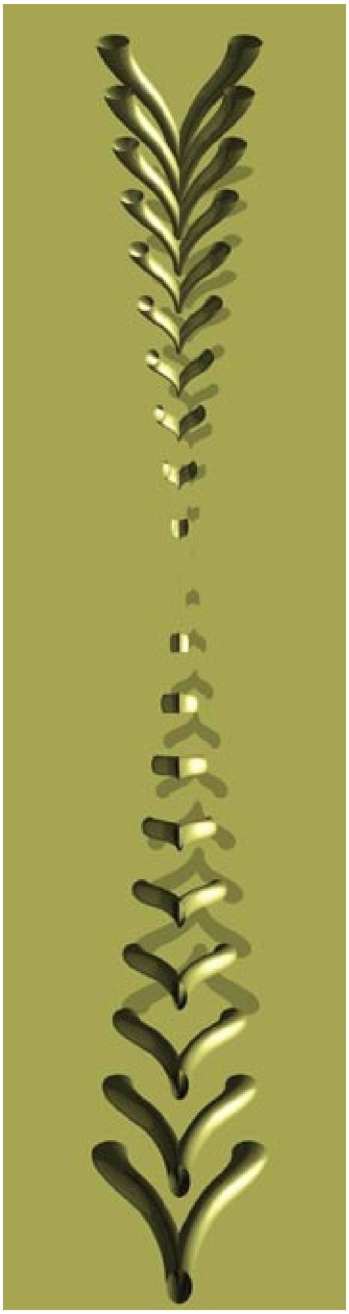

Figure 5: Alexander Kwong:
Tween Morphology: Animated Component Development.

temporal links (Figure 5). Dynamic Methods and were expanded on for the development of a "stochastic steel chassis" (Figure 6). The bend, twist, bulge, and other tools in software packages such as **form•Z**, 3DS, Cinema 4D, and Maya, allow for real time control over the creation of digital components and animated phenomena while affording the ability to "nest" operations. Nesting

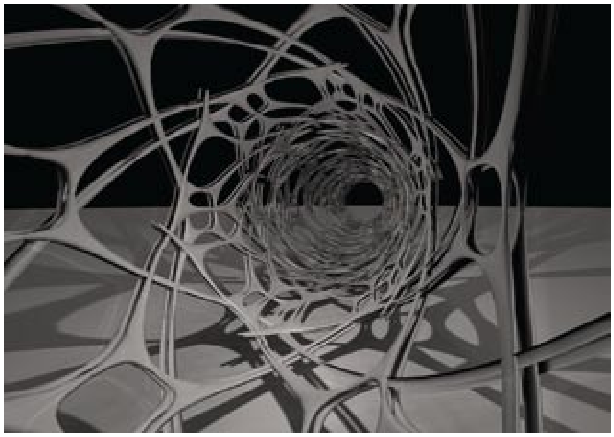

Figure 6: Michael Peguero: Stochastic Steel Structure.

operations allows the user to apply multiple characteristics to an object giving rise to new possibilities of component development. Control mechanisms were established and the development of a dynamic stochastic steel chassis, reactive surface studies, animated material explorations and temporal extractions with distinctive spatial and surface characteristics were designed and analog links to specific transportations typologies were engaged as new digital tectonic typologies (Figure7).

In my introductory level digital design class, digital operatives were leveraged to develop a digital design methodology that established a "digital logic" of manipulation and construction. In the curriculum, this is the first formal class where students are exposed to 2D vector, 2D raster and 3D modeling. As such, the students have had limited exposure to graphic computer software at this level and robust yet easy to use 3D modeling software like **form•Z** affords the students the ability to tool up quickly

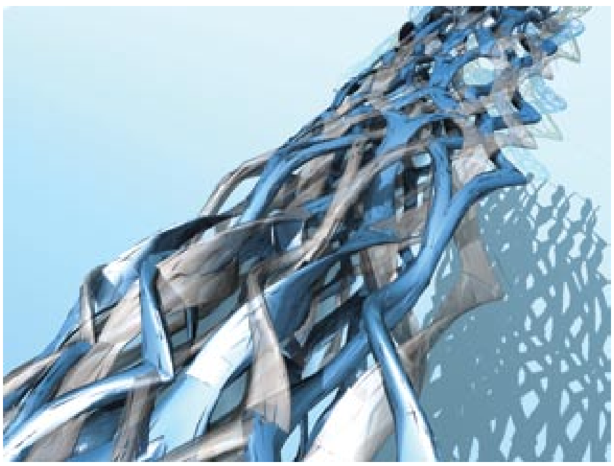

Figure 7: Alexander Kwong: Reactive Surface: Woven Assembly.

and still produce sophisticated digital works. Students were grouped into pairs to enter a design competition for a small transit stop in Milwaukee during the last two weeks of the semester. This was an opportunity for the students to collaborate, and synthesis digital design concepts and skills introduced earlier in the semester. Two groups of students in this intro to digital design class placed in the competition. The first group received one of three merit awards for their Village Green submission. The concept was to develop a synthetic bunker with light sensors that established a signaling system for approaching busses while incorporating sustainable technologies to power the station and recycle materials (Figure 8). The second group received an award for pushing the "programmatic boundaries of the design" for their Mobius Motion Scheme. This group developed both digital and analog methods for the development of their "continuous strip" concept. This "animated strip" would respond to programmatic and site situations. Differing strip typologies were established to incorporate signage, public digital communication devices, seating, and shelter (Figure 9). In each instance the software aided in the development of dynamic techniques, visualizing tectonic possibilities and in the rapid deployment of the concepts of the projects.

The use of empirical studies as a teaching aid for students to "discover" digital potentials, analyzing of existing architectural typologies, the extraction of base characteristics, and the development of an approach to synthesis the virtual and the physical has been an invaluable teaching instrument for me. Making conceptual links between known typologies and emergent digital ones becomes a higher order thinking skill which allows students to synthesize complex processes and speculate as to new possibilities based on an understanding of existing architectural typologies as a control. Animation as a means of understanding "real time" processes and designing dynamic organizational structures that leverage the processing capabilities of the computer is still in its nascent stages and deserves attention by the

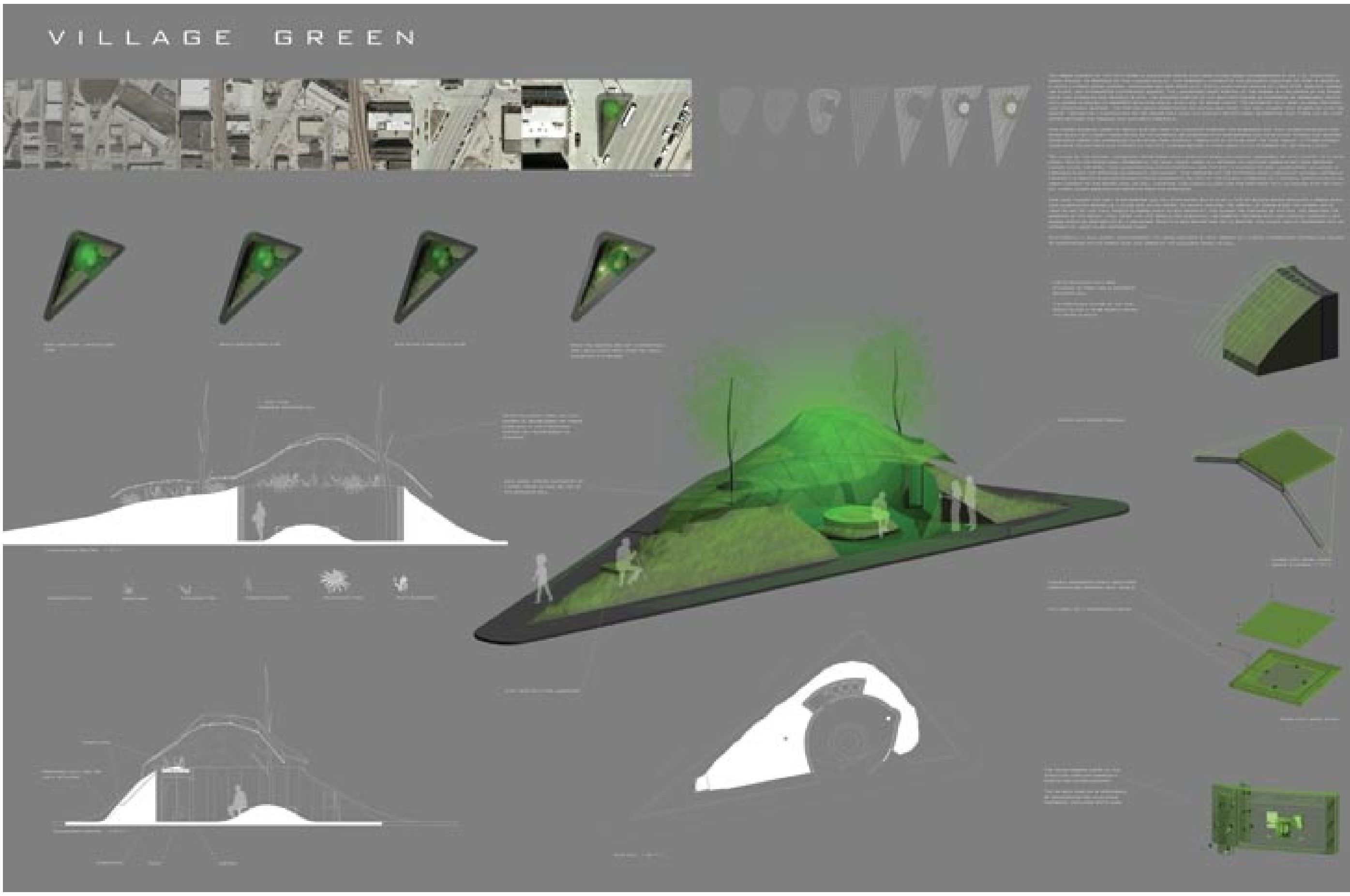

Figure 8: Frederick Thomas and Toan Nguyen: Milwaukee Transit Stop Competition: "Village Green." Award for Pushing the Programmatic Boundaries of the Design. Faculty Sponsor: Tom Rusher.

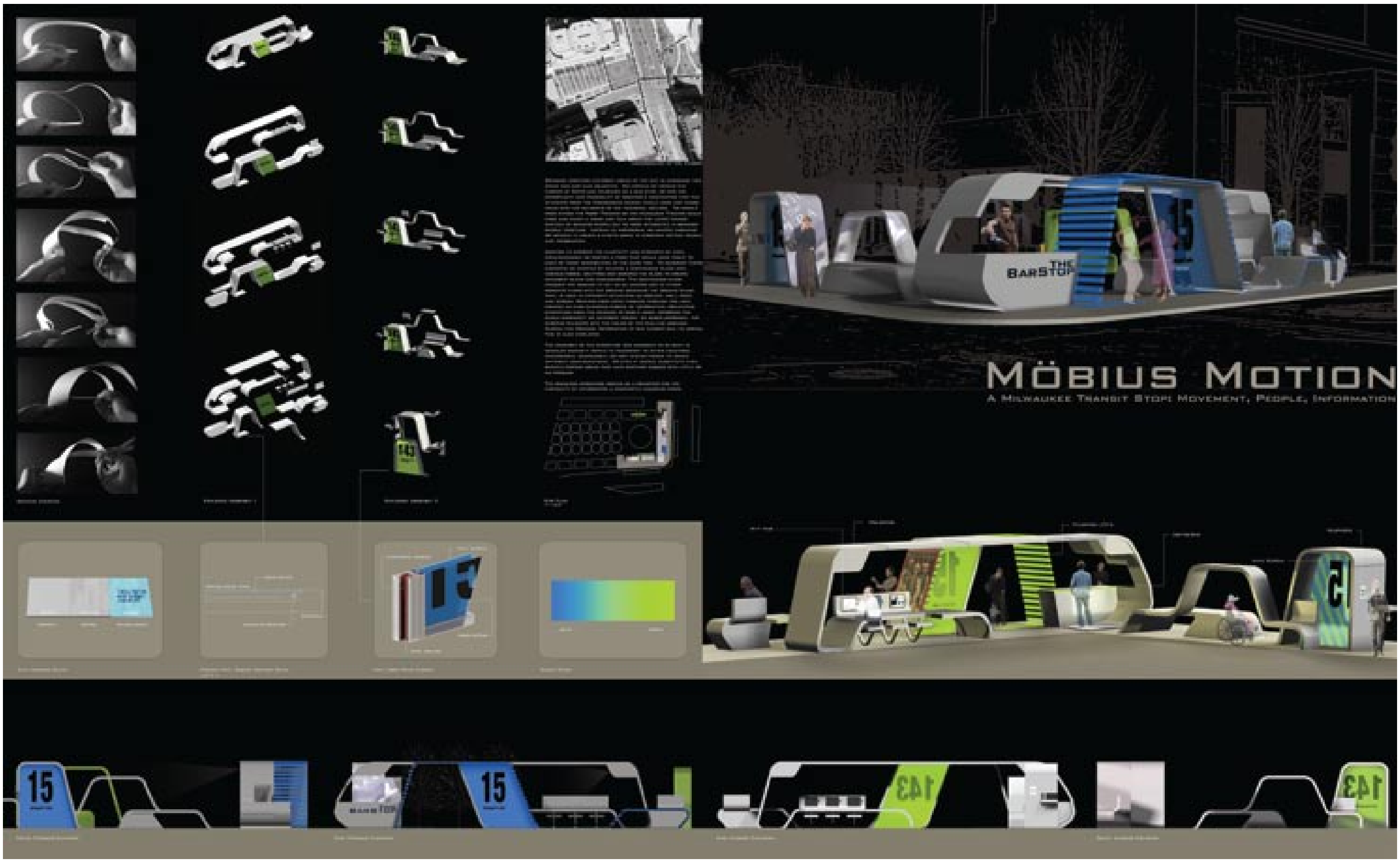

Figure 9: Michael Peguero & Bobak Firoozbakht: Milwaukee Transit Stop Competition: "Mobius Motion." Award for Pushing the Programmatic Boundaries of the Design. Faculty Sponsor: Tom Rusher.

profession as a way of incorporating the new technologies and expanding the design vocabulary. The techniques of digital fabrication that now allow greater precision in constructed components opens the design field up to new potentials that embrace the notion of "mass customization" that is proving to be cost effective, efficient, and inspiring. These digital approaches have the potential to expand on architectural typologies, develop virtual techniques, and establish novel 21st century approaches to design through digital means.

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Thomas Rusher was born in New York City and has a Master of Architecture: Columbia University GSAPP, NYC, B.SCI. Architecture: University of Texas at Arlington. He is the recipient of the Ronald E. McNair Graduate Research Fellowship in Architectural Design. He is currently an Adjunct Professor of Architecture at the University of Texas at Arlington's School of Architecture. He worked for Skidmore, Owings, and Merrill LLP, NYC, Columbia University Planning Department, NYC, Polshek & Partners LLP., NYC, B-Five Studio LLP, NYC and is currently the principal of Rusher Studio LLC, a design consulting firm in the DFW area. At Columbia he received the Lucille Smyser Lowenfish Memorial Prize for best design thesis in Greg Lynn's Studio (1996). His works are published in Abstract 1994-1995, Abstract 1995-1996 (cover), Interior Design, Skidmore, Owings, and Merrill: Architecture & Urbanism 1995-2000, Texas Architecture, Tex Files, and AutoDesSys Joint Study Annual Report 2002, 2003, 2004, 2005, 2006.