Animate Assemblies: Reactive Structures

(Empirical Modeling, Component Logic, Sustainability)

by **Thomas Rusher**
University of Texas at Arlington
Arlington, Texas

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The development, generation and synthesis of animate spaces, digital logics, universal design, and sustainability as reactive constructs has been a major focus of mine and was incorporated in the architectural classes I taught over the last year. The latter two are clearly important contemporary topics, especially with a large segment of the United States' population approaching retirement age and with the advent of a new understanding of the importance of harvesting renewable resources and of utilizing complementary techniques to preserve valuable and finite resources. The incorporation of animated tectonics and empirical modeling as a method of discovery, and of making analytical and conceptual connections to analogous constructible structures is both a novel concept and a venerable method of exploration. Engineers and scientists have developed formulas through empirical studies of trial and error, cause and effect modeling, and more recently through computer simulations, digital versions of the same technique. The designer, being a bridge between the creative and the rational, is in the unique position to leverage this type of investigation to discover new spatial, tectonic, and sustainable structures. The sharp divisions between perceived architectural realities vis-à-vis known "built" typologies and the ability of the digital to transform and to reshape the definitions of normative strands becomes an interesting line of investigation for me and begs to be studied. Comfort Architecture dominates the rural agrarian landscape of the country, controlled by economics, social standing, and general familiarity. The role and the responsibility of the designer is to question, evaluate, re-evaluate, experiment, and speculate as to new possibilities while understanding and fusing together the positive gains that have been acquired traditionally within the discipline. In many ways, turning to Cinema, Art, and Philosophy as a means of understanding drama, visual arts, temporality, and space (as it relates to the human condition), while making correlations to the "real" from the "digital" has been a catalyst for me to seek out new creative applications of 3D Modeling and of time-based software like form•Z and Maya. How does digital technology affect our daily lives and how does it inform the architect as to the possibilities of the future built world? Can technology enhance the human condition, without simultaneously crippling it to some degree? Can simulations and speculative scenarios aid in the development of the right questions? Is the role of the digital destined to be caught up in the genre of representation and in the rapid documentation of known types, or can the base be expanded to develop new digital logics that inform the designer and feed the profession with novel connections to the known? The role of the designer is to field the questions, answer a few, and then to generate more.

The exploration of the digital realm has moved in many directions: some more technical, others more mathematical, still others more concerned with time, efficiency and production. Finally, another direction strives to leave the human component intact to make critical creative and intellectual design decisions, while interpreting and reinterpreting the information revealed. I fall into the latter category, using the device as a generator of spaces, ideas, form, environments, and the like in order to make informed, intellectual, lateral-thinking design decisions from the digital speculative to the constructible possibilities. Programs like form•Z and Maya allow students, scholars, and practitioners to develop new "animated notations" that can capture the intangible and manifest it as digital material. Dynamic proportions, frozen animate states, and remnants of the process etch their way through spaces and surfaces. Just as Corbusier utilized the modular and regulating lines to capture proportions with a T-Square and pencil, these programs allow for real time dynamic control over animated constructs that deal with the proportions of ethereal (Figure 1).

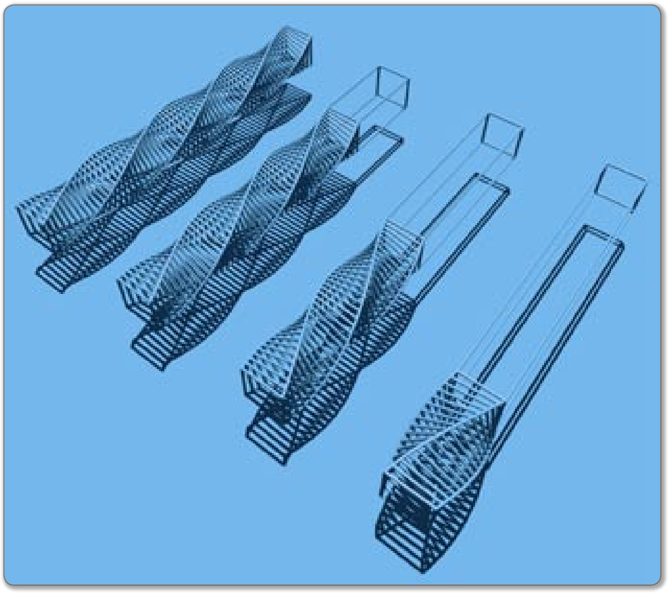


Figure 1: Digital operatives: orientation study.

The notion of the empirical model has been an essential method of testing ideas without necessarily knowing all variables, potentials and outcomes. A set of "rules" are established to describe the observed phenomena, and loose objectives are constructed in order to "test" a hypothesis. The base concept is to rationalize potentials while simultaneously setting parameters and constraints for a speculative outcome. Then, we observe the results, extract phenomenological data from the experiment, and apply the knowledge to the stated problem and/or develop new strands of thought that were not conceivable without running through the process. Proposals such as devising "recipes" for various functions such as blending, camouflaging, and tiling as pure phenomenological actions[1]. Then the knowledge base was applied to spatial and surface conditions of an architectonic nature.

Data gathering, phenomenological excavation, and design application were leveraged using 3D and 4D dynamic empirical event structures as a catalyst for novel design concepts and technique development for several studies that I designed. The inquiry into dynamic digital logics as a generative tool has been an interesting line of investigation for me since my graduate studies at Columbia University, where I was first introduced to a wide array of advanced digital tools. The first project was one I developed during the course of advancing my research into solar and wind technologies. The Self Sufficient Solar Shifter (S4) was a design for a public shared energy collector (Figure 2). The next project was an independent one that I ran as a senior level design class with a student who entered a competition for an educational facility. Each project incorporates ideas of digital logic development, novel ways of conceiving of a structure via programmatic expansion and re-definition, and the use of 3D and animated techniques to arrive at a design solution.
In the course of researching renewable sources of energy, I've become familiar with solar thermal and photovoltaic system design and installation. The orientation of the array becomes critical, and the angle of the system relative to the degree latitude dictates the optimum angle for efficiency. During the course of the more technical and conventional aspects of designing a solar photovoltaic system, the notion of a "responsive array" struck me as being an innovative and potentially efficient type of system. How can an array respond to the temporal cyclical aspects of the sun at various times of the day and different times of the year? The concept of self-sufficiency and dynamic controls as both generative and literal structures became a design imperative. What does it mean to be a self-sufficient, or even net energy producing structure? This led me to the notion of a public structure that not only was self-sufficient but could supplement the supply of energy needs for a metropolitan area. With the rising costs of energy, the concept of decentralized collectors on individual homes and businesses will be the wave of the future. Current central plants will become hubs for the redistribution of collective energy. The concept of public structures serving the good of the group, by both being self-sufficient and providing a credit to the citizens becomes a relevant topic of investigation for the design of the public structure.

The Self Sufficient Solar Shifter, or (S4), project was a speculative design for a flexible public transit stop that incorporated various aspects of information interfaces, partially enclosed zones, and energy collection and redistribution technologies. A series of empirical studies

Figure 2: Self sufficient solar shifter.

were conducted in form•Z to understand digital tools that could dynamically adjust forms both vertically and horizontally to accommodate variable positions and maintain habitability. Pivot points that could adjust to various positions both independently and co-dependently were set as a design parameter. Space-capturing forms were developed, and the optimum location for the pivots were established based on the function of the transit stop. The empirical models that were set up initially were utilized to study component form, orientation, position, and connections between each other and as an animated assembly. The use of the standard 30 frames per second at 10 seconds was a constant, and variability was incorporated via time-based adjustments. The understanding of animated assemblies and the development of phantom rhythms were discovered through adjustments in the spline-based parameters of the animation editor. Subtle controls created controlled variability of components (Figure 3). Looking at both active and inactive states for a responsive structure that adjusted for both solar orientation and water collection set some constraints on the studies (Figure 4). Velocity vs. acceleration, compressed moments versus expansive ones, and phantom impressions versus physical entities were revealed through the studies and helped to inform the development of the S4.

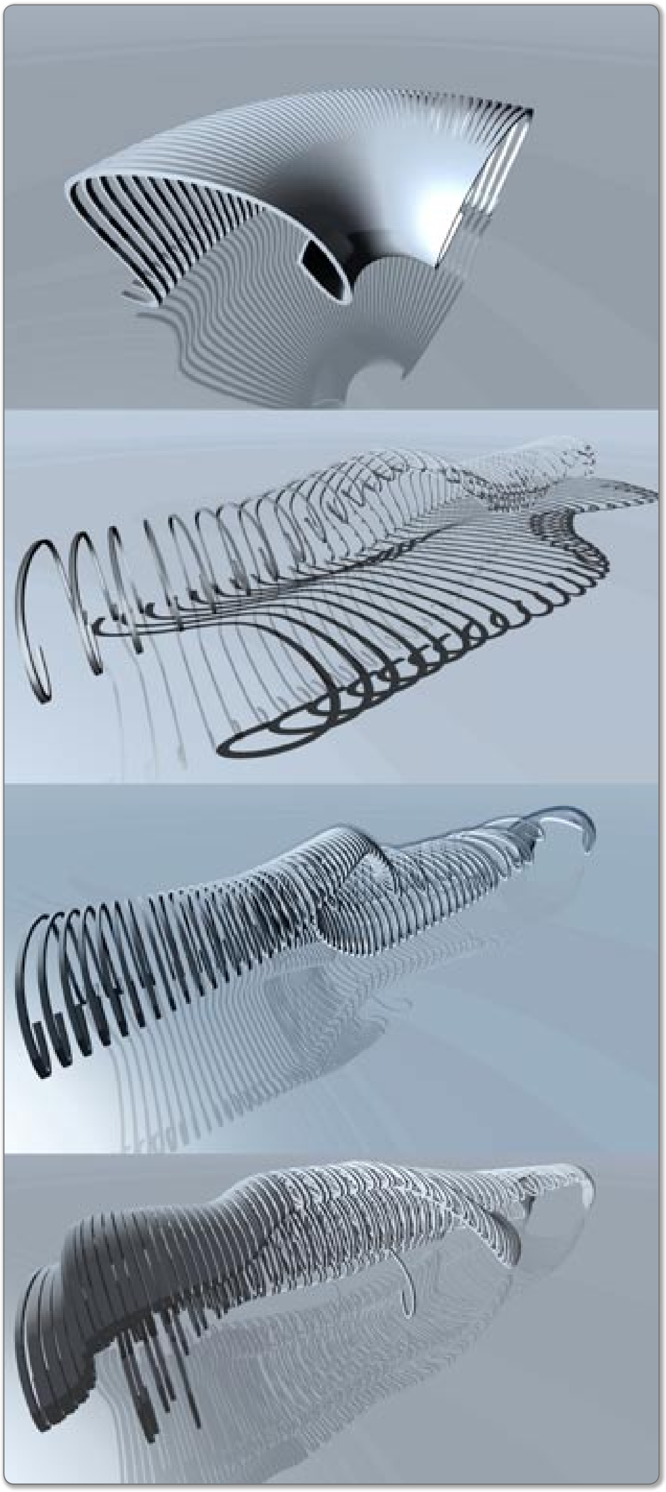


Figure 3: Empirical models: animated assembly development .

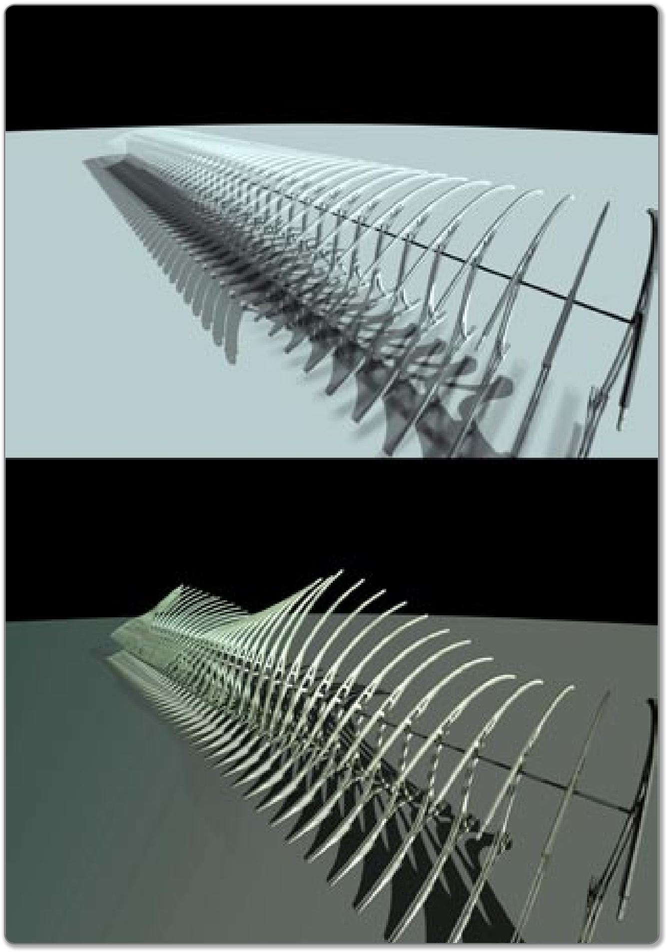
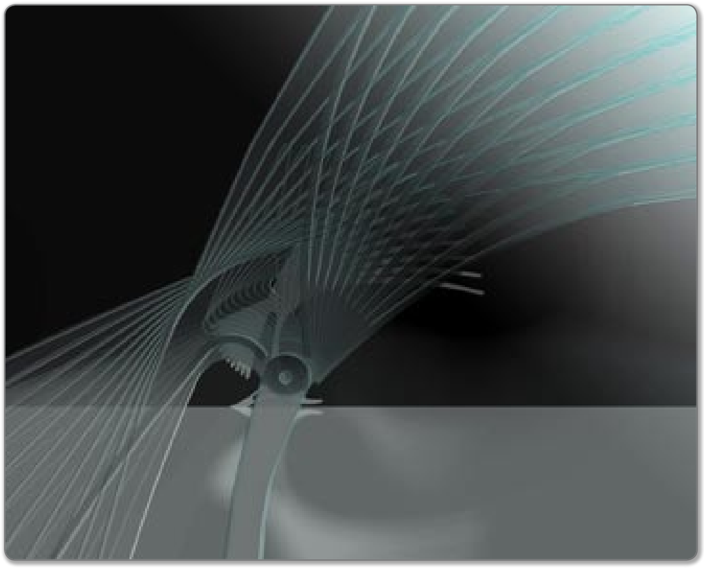


Figure 4: Empirical models: active/inactive states.

The establishment of dynamic digital techniques that aided in the understanding of strategic orientations relative to site conditions and to the development of real time control over positioning of components was achieved through the studies and was applied in the final design proposal. First, computerized explorations were conducted, and controlled dynamics were then transferred and updated to a "real" site where the influences dealt more with contextual issues of orientation, wind currents, sun angles, views and habitability. Utilizing macro operations in form•Z, the development of control over multiple, interconnected, faceted components leads to the basic design configuration of the S4. Through a series of empirical models, we studied and began to develop a degree of control over the dynamic operations, such that changing directions, angles, temporal allusions, and spacing led to the refinement of pivoting components and flexible panels (Figure 5). The introduction of site and an understanding of the orientation of the sun relative to the shifting as a technique allowed for modular variability, while maintaining

Figure 5: Component development: range study.



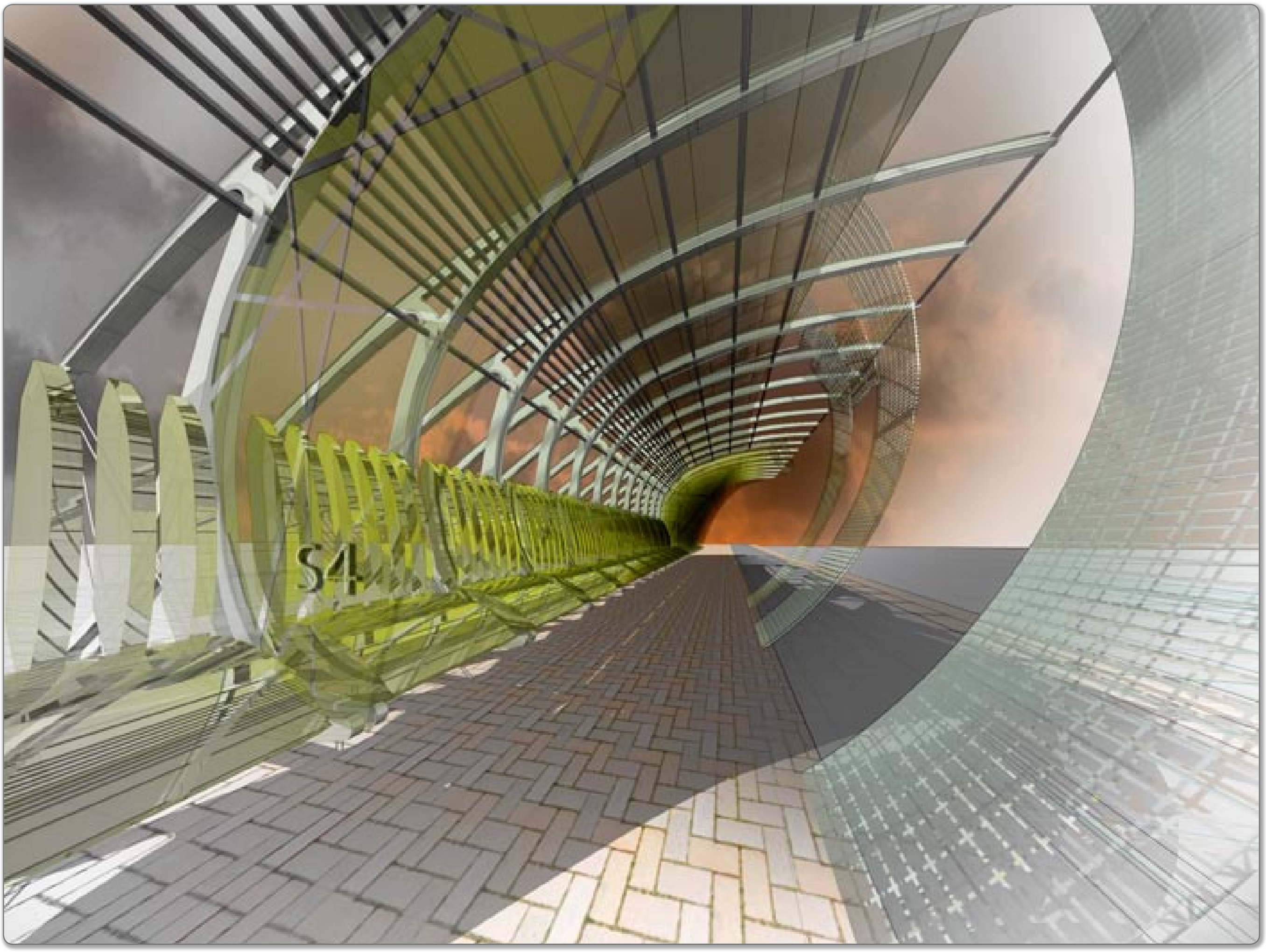


Figure 6: Hibernated state.

pivotal control over objects and spaces. The main pivot was located to the rear for safety, to have a general Southern orientation that allowed for maximum sun exposure during the summer months and for a “hibernation state,” to minimize movement, when solar collection is not occurring, such as in the evenings (Figure 6). Dynamic armatures adjust solar arrays and track the sun’s path for maximum efficiency and also, retract if the arrays begin to overheat and lose effectiveness (Figure 7). The energy used to physically pivot the cantilevered canopy was generated from the components themselves that self adjust via a pre-programmed set of movements based on specific latitude and environmental data for the site. The station is tied into the city’s grid. The proposed materials consist of recycled aluminum, cast metal, and interactive digital media. The rear of the station allows for bicycle parking to encourage healthy alternative modes of transportation. The station illuminates different colors depending on the bus that is arriving, which allows patrons to know when a particular bus line is about to arrive.

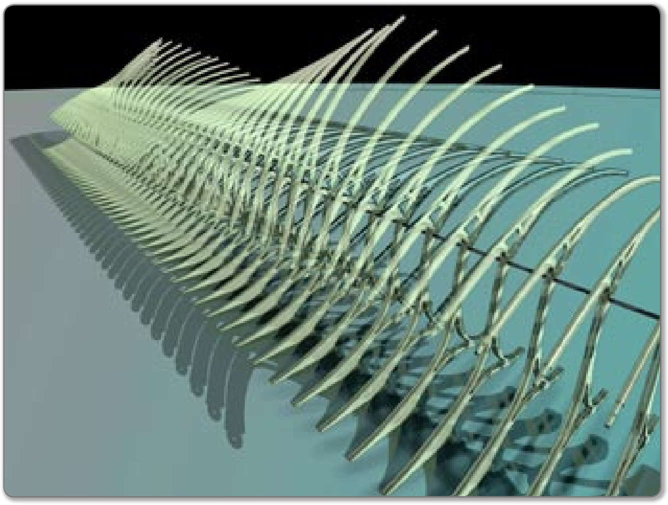


Figure 7: Dynamic assembly/component refinement.

The Evolutionary Educational Environment (E3) was the synthesis of landscape, architecture, and education as an urban reclamation strategy that established a generative “Didactic Steel Greenscape.” The steel greenscape encouraged an active and interactive learning educational model, reconnection to the land, and the re-ignited the consciousness of the public through the development of a Collaborative Community Culture (C3). The concept of E3 + C3 was to generate a sustainable culture through education and reassess the educational model as not simply a compartmentalized phase in a child’s advancement but also as an ongoing developmental journey (Figure 8).

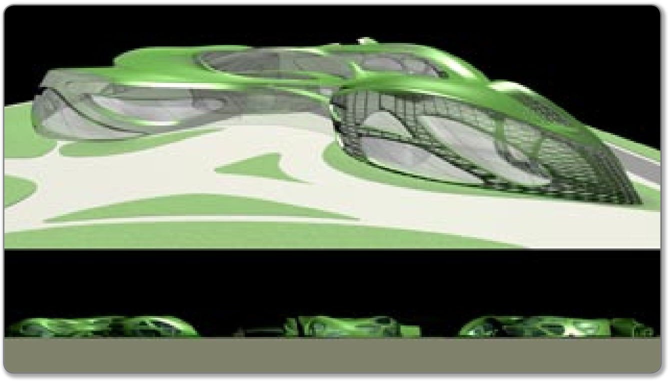


Figure 8: Main educational complex by student Sergejs Aleksjevs.

The design challenge was to reclaim an abandoned urban hardscape that had the opportunity to reconnect with other green spaces in the City of Dallas and more particularly with the downtown area that has had problems with jumpstarting a culture of pedestrian activity and reconnection to natural surroundings. E3 became the evolutionary catalyst for a collaborative community culture that embraces sustainable ideas, challenges students to become socially aware of their environment, and educates the students and citizens alike about the possibility of a smarter and more novel approach to education that incorporates the “Didactic Steel Greenscape” as the major learning device (Figure 9). The new interactive learning model would be both low tech and high tech, exposing students to a range of cutting edge technologies, while being conscious of our base connection to the land. They would be exposed to a variety of traditional, (Math, Science, & Literature) and more novel (Agriculture, Sustainability, Digital Technologies & the Arts), topics that foster interaction between the instructors, students, and public. Public cultural activities would be held in particular zones, while the main educational facility for K-6 would be located on an urban edge to anchor the E3 and engage the street.

Figure 9: “Didactic Steel Greenscape,” by student Sergejs Aleksjevs.

The Didactic Steel Greenscape became the catalyst for the spread and reconnection of green zones throughout the city, encouraging pedestrian activity and providing much needed social gathering spaces for the downtown area. The flexibility of steel was leveraged in both innovative and conventional fashions through a interconnected steel armature which was developed to support the greenscape environment, while steel tracks were utilized to open and close areas of the main educational building. During the summer months when school was out of session, the building could go into a “sleep mode”, and steel panels that move on curved tracks would be used to shut down specific zones in order to save on energy. The facility could also be adapted to summer uses by opening up only zones that were to be utilized for community gatherings, performances, and continuing instructional uses.

All architectural spaces were merged into the steel greenscape, blurring the distinction between land, building, and education. Moving through the greenscape, a series of educational vignettes were found along paths, bridges, kiosks, and buildings (Figure 10). An amphitheatre, recreation center, greenhouse, solar powered digital displays and environmental science pavilions were introduced to engage the E3 and aid in its mission to educate both students and establish a Collaborative Community Culture (C3) where citizens are actively engaged in learning and positive environmental impacts.

The possibilities that proliferate within digital media are still being discovered, refined, and expanded. The synthesis of the human component, along with interpreting the wide array of functions that permeates creative and intellectual discoveries through empirical modeling, is a wide open frontier for those with an acute eye and receptive mind. It is the role of the designer to adapt the new technologies, to transcend the development of new undiscovered constructible environments. Given the tools that can help us to understand our temporal existence, the manifestation of time-based analysis can help readdress and augment the design strategies involved in the realities of human activities and enhance the quality of human existence. Our built environments should be emblematic of an age of coexistence, the interconnected, diversified, environmentally conscious, information age. The synthesis of both traditional architectural conventions and new adaptive techniques within the digital media that are interwoven, can provide new solutions that can further enrich the human experience. Embracing empirical modeling, through careful observation, and interpretation is a pathway into the uncharted terrain that is our future (Figure 11).

References:

1. Pamphlet Architecture 27: TOOLING, by Aranda/Lasch, Princeton Architectural Press, 2006

Figure 10: Educational vignettes, by student Sergejs Aleksjevs.

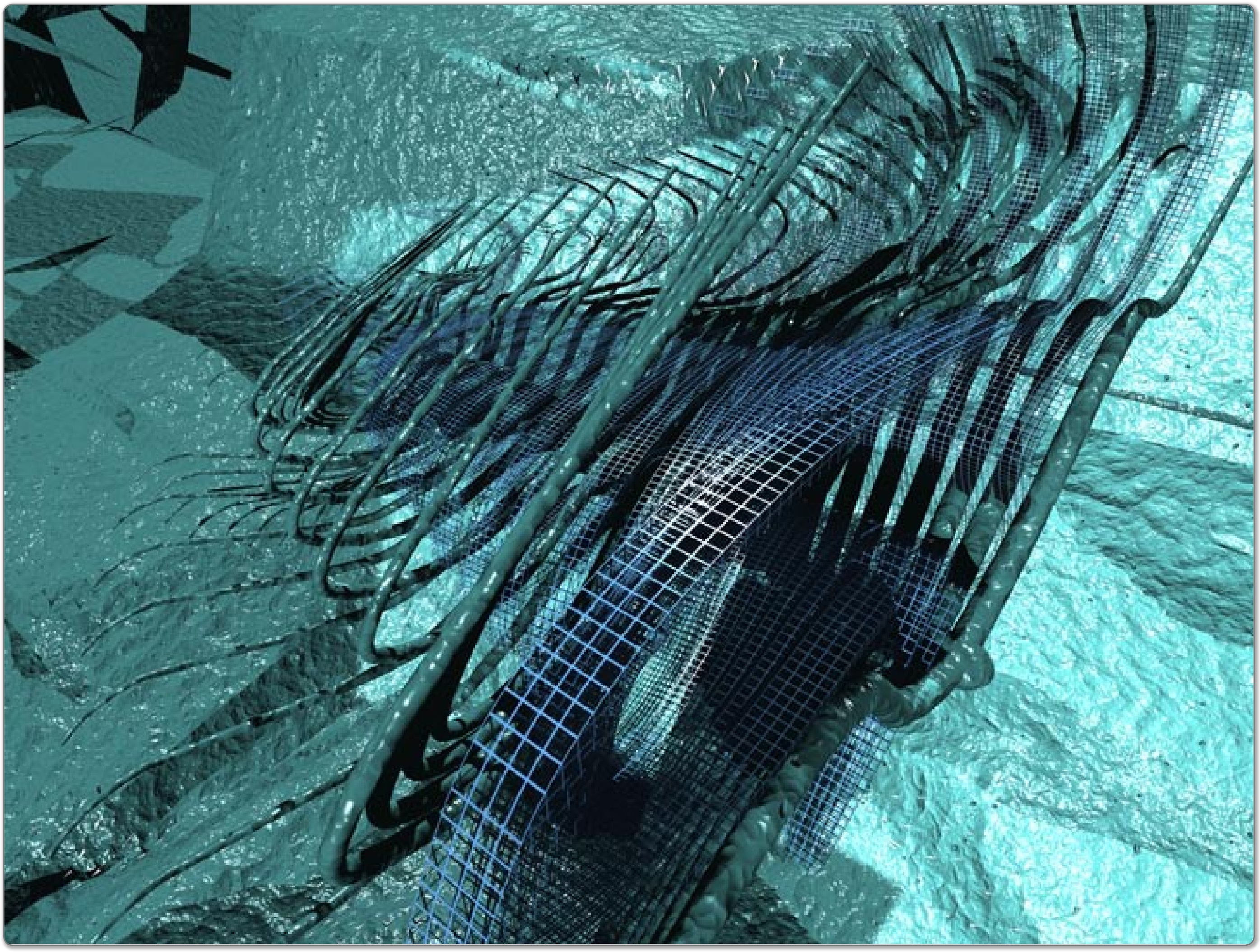


Figure 11: Digital Tectonic: animated assemblies study.

Tom Rusher received his professional Master of Architecture Degree from Columbia University's Graduate School of Architecture, Planning and Preservation (GSAPP) in 1996. He was the recipient of the Ronald E. McNair Graduate Research Fellowship for Design and was awarded the Lucille Smyser Lowenfish Memorial Award for the best design Thesis in Greg Lynn's Design Studio in 1996. He has worked for Polshek Partnership (NYC), Columbia University's Planning Department (NYC), Skidmore Owings and Merrill (NYC), and currently both teaches at the University of Texas at Arlington as an Adjunct Professor in Digital Design Media and is a Registered Architect and Principal of Rusher Studio LLC, where he works on commercial and residential design/build. His works are published in Abstract 1995, Abstract 1996 (Cover), Interior Design Magazine 1998, Skidmore, Owings and Merrill: Architecture and Urbanism 1995-2000, Texas Architecture 2001, Text Files 2006, 2008, CRIT 2008, and multiple AutoDes-Sys Joint Study Journals 2002-2010. His areas of research and specialty are Digital Design, 3D Modeling, Animation and Sound, and BIM modeling.