TEX-FAB: A new model for collaborative engagement

Brad Bell[1], Kevin Patrick McClellan[2], Andrew Vrana[3]

[1]University of Texas Arlington, [2] University of Texas San Antonio, [3]University of Houston

Abstract

TEX-FAB is a non-profit organization founded between three universities in Texas with the primary function of connecting design professionals, academics, and manufactures interested in digital fabrication. The three co-directors established TEX-FAB as a collective action, one that attempts to combine divergent interests and capabilities, for the purpose of strengthening the regional discourse around digital fabrication and parametric design. The three primary avenues for accomplishing this goal are set out as Theoria (Lectures / Exhibitions), Poiesis (Workshops) and Praxis (Competition). We see this type of effort as a new paradigm focused on providing a network of affiliated digital fabrication resources, and a platform for education/ exchange on issues of parametric modeling. It is our position that TEX-FAB engages the new and growing awareness of a regional and global hybridization. We seek to leverage the burgeoning global knowledge base to produce a more specific and contextual dialogue within the region we operate, teach, and practice.

Introduction

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Organizational History

TEX-FAB was formed in 2009 by Brad Bell, Kevin Patrick McClellan, and Andrew Vrana. With professors Bell, McClellan and Vrana each teaching digital fabrication curriculum at University of Texas Arlington, University of Texas San Antonio, and University of Houston respectively, there was a pre-existing mutual interest and dialogue in place. What was evident out of these conversations was a strong awareness of similarity in situation. We all shared and were cultivating relationships with fabricators, academics, and professionals in the urban centers where we lived. We were all leveraging our universities as a bridge back into the community to strengthen ties for the purpose of applied learning opportunities for our students. We were all very interested in developing digital fabrication techniques and methods that investigated substantive and material realities. Our journey to this point was not impetuous. Our educational trajectories all started back with connections at Texas A&M twenty years prior. Over the following two decades, dialogue, and at times collaborative exploration, laid a framework that facilitated the formation of TEX-FAB.

At the core of the TEX-FAB initiative is a fundamental belief that collaborative interaction within the architectural process is no longer a choice but a necessity. Even as we look back into the nascent stages of our own education, it is clear when engaging the deep computational capacity of the digital software to explore complex geometries that relinquishing some degree of authorship is already at play. What arose from the co-authorship of the digital and fabrication toolsets we employed as students, pioneering and exploring these issues while at Columbia University and the Architectural Association in London, has now been brought even more into focus as we apply this in practice. Beyond our academic affiliations, each co-founder maintains an active practice, which serves as a venue for application of issues being researched within the academic realm. For each of the co-founders of TEX-FAB position in both the academic and professional worlds is as essential to the origins of TEX-FAB and our capacity to work together as our pre-existing working relationships.

Since the very earliest stages of putting together TEX-FAB we have pursued this as an opportunity to create a vehicle for interaction and conversation between a wide-range of designers. Within Texas there is an emerging network of companies, institutions, and individuals focusing on the exploration of parametric design and the digital production of building components. Specifically, there is a growing opportunity for collaborative exchange between the academic, technical, and professional communities by leveraging the immense resources found in some of the largest metropolitan centers across the United States.

TEX-FAB 1.0 launched initially as a website in September of 2009 and served to initiate a call to interested designers in the region. On February 4th-6th TEX-FAB hosted the first round of workshops and lectures at the University of Texas Arlington. The event was completely sold-out and drew participants from throughout Texas and the 5 contiguous states. TEX-FAB 2.0 launched in the summer of 2010 as the second round of workshops, lectures, exhibition and competition. The event was hosted at the University of Houston February 10th – 13th again with a completely sold-out round of workshops and even more ambitious lecture series and exhibition component.

Three Modalities of Interaction

TEX-FAB is organized around three primary tenants that provide specific ways in which the collection, distribution, and sharing of information about digital fabrication and parametric modeling take place: Theoria (Lectures / Exhibitions), Poiesis (Workshops) and Praxis (Competitions / Commissions). These three avenues are not unique by themselves, and are certainly found collectively in other regions. However, it is when we survey our own context and examined the unique opportunities within the Texas and Southwest Region we see TEX-FAB filling a vital role in shaping the discourse.

The lecture offerings provided or co-hosted by TEX-FAB to date have attempted to provide a broad range of exploration into digital fabrication. Lecturers are from both the academic, professional, and fabrication communities, all with significant accomplishments within the field. A select list of lecturers provided by TEX-FAB includes: Scott Marble of Marble Fairbanks / Columbia GSAPP NY; Axel Paredes of Universidad Francisco Marroquín, Guatemala; L. William Zahner, Ceo & President of ZAHNER®, Patrick Hood-Daniel; and Branko Kolarevic of University of Calgary. As well exhibitions have become a central element to our TEX-FAB event 2.0 in Houston. The current exhibition features the work of the recently completed international competition hosted by TEX-FAB entitled REPEAT. This exhibition will become a travel to a variety of locations within the region in 2011 & 2012. This will provide greater opportunity for stimulating dialogue around the issues of digital fabrication and parametric modeling.

Workshops are currently the primary avenue for education and direct interaction between academics, professionals, industry partners, students and professionals. TEX-FAB maintains a policy of reserving half of all available seats for students and at the same time aggressively pursues participants from a wide range of architecture and affiliated design offices through out the region. Workshops are two-day events led by internationally recognized instructors within the field of parametric modeling and provide a robust opportunity for participants to be exposed to the highest level of concentrated learning possible. A select list of workshop instructors and courses offered include: Rajaa Issa of McNeel & Associates: *Architectural Geometry and Algorithmic Design*; Andy Payne of Lift Architects: *Grasshopper*; Marc Fornes of theverymany: *Scripted Design*; Chris Lasch of Aranda / Lasch: *Algorithmic Design*; Gil Akos and Ronnie Parsons of Studio Mode: *Parametric Design.*

Competitions are the third and most far reaching of the three TEX-FAB tenants. The competition is a platform for a very diverse set of designers to explore the potential of parametric modeling. Unique to our mission however is a desire to see competitions result in a built commission – regardless of scale. So to that end, TEX-FAB sees the process of fabrication coming out of the competition to be one that can leverage the TEX-FAB network and utilize it's inherent values to provide a robust support system for fabrication, installation, and construction. In the summer of 2010 TEX-FAB took on the ambitious task of hosting an international design competition.

REPEAT Competition

In June of 2010 the REPEAT competition launched with the explicit intent of promoting the role of digital fabrication and parametric design within the Texas region. With the organization and development of the competition brief, context and goals beginning March

2010 and the final installation planned for February of 2011, the competition cycle – start to finish – was to be one year. The deadline of October 31st, 2010 was established and promotional materials where distributed to over 200 Universities internationally and online within digital fabrication and parametric design communities. A total 95 teams of 1-4 designers from 19 states in the US, 18 countries and 5 continents registered, ultimately receiving 73 submissions.

Figure 1. Geography of REPEAT Competition participants.

The REPEAT brief asked entrants to look first at the connection and then, through repetition define of the whole. By reevaluating the design process and looking at it from the connection, what might emerge? We encouraged the generation of cutting edge design proposals for a structure with the only caveats being it be generated and conceived digitally, incorporate repetitive elements, be optimized for relocation and transportation and be produced through fabrication technologies available within Houston, Texas. These three 'programmatic' parameters served to be very open ended and broad, while another constraint was included that served to delimit the work, a budget. No more than $10,000 could be used in the competition proposal's production costs. The role of Houston as context was also significant and provided the perfect backdrop for the objective put forth by the competition, as it is within cities with atomized light manufacturing capabilities like Houston, there exists a potential for designers to engage fabrication via direct communication with machines. Harnessing the network of fabricators already affiliated with TEX-FAB we established the means and methods of production for the winning entry and ensured the production and costs were fixed.

To further define the potential and enlist greater interest in REPEAT we invited five leading figures in the world of digital fabrication and parametric design to jury the competition: Patrik Schumacher (Jury Head), an internationally recognized educator, acclaimed theorist and Design Director at Zaha Hadid Architects; Marc Fornes, founder of the influential design practice *theverymany*; Lisa Iwamoto of Iwamoto + Scott, architect and author of the seminal work Digital Fabrications: Architectural and Material Techniques; Chris Lasch partner of the renowned experimental research studio Aranda \ Lasch; and Blair Satterfield, an educator, award-winning inventor and founder of the design collaborative Houminn.

Submitted to the competition was a rich and varied collection of proposals that explored and intently challenged preconceived notions of form, use and assembly. It can be argued that production and design have become two distinct processes in architecture since the advent of the formalized design document. It is evident within the numerous competition entries that this method is being questioned. Previously wherein the conception and production of drawings have occurred months and sometimes years before anything was realized physically, the digitally conceived work proposed in many cases was produced simultaneously along side small-scale tests and models that not merely represented the work, but instantiated it as a version - an iteration. These projects were on-the-one-hand speculations and reflections on the potential of digital fabrication and parametric design, while on-the-other hand realizations of that potential.

The success of the competition was evident in the winning entry designed by Vlad Tenu, a young Romanian architect practicing in London. His ongoing research focuses on the integration of computation, science and technology in the architectural design process, involving generative computational methods,

digital fabrication techniques and interactive design. He studied architecture in Lasi, Lisbon and in London at the Bartlett, UCL, where he was awarded a MSC. in Adaptive Architecture & Computation and a Certificate in Advanced Architectural Research.

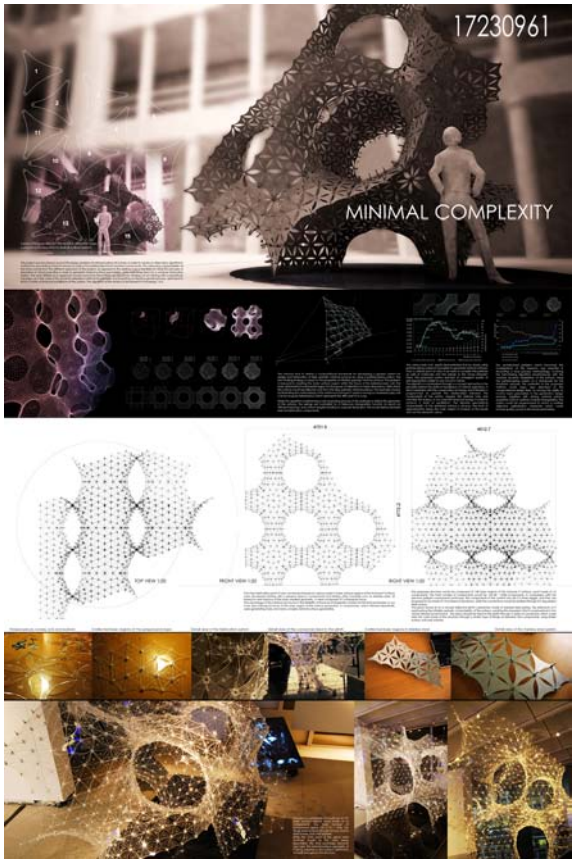

Figure 2. REPEAT competition winning entry "Minimal Complexity" by Vlad Tenu.

The jury selected Minimal Complexity for the aesthetic beauty, technical superiority and elegance of detailing. It employed structural robustness, material efficiency and an inherent logic of assembly embodying the principals of the competition brief to the highest degree. While a great many of the submissions showed real promise the jury focused on a selection that was feasible by adhering to the context and budget. In keeping with the spirit of the competition intent the jury enumerated four Runners-Up and another seven Honorable Mentions that embraced the brief as is reflected in the comments by Chris Lasch for one of the Runners Up, "it uses a low tech solution to leverage high tech design thinking and does it through a clear assembly logic that seeks to combine the abstract logics of geometrical assembly with the fine grain affordances of their chosen material."

Minimal Complexity – Optimization and Construction

With Minimal Complexity selected the optimization process was initiated between TEX-FAB and Vlad Tenu. One of the primary interests for the Directors of TEX-FAB in generating REPEAT was to find a collaborative partnership with a designer or design team and work through the spectrum of issues needing resolution in order to bring the design to realization. In this manner, TEX-FAB would not just a serve fabrication consultant, but work closely with the winner to resolve a wide range of issues resulting ultimately in our constructing the piece.

Stage one in the optimization came though weekly teleconferences between Vlad and TEX-FAB and email communication. We also made use of an online communication and work coordination system to provide a central location for the exchange of ideas, files, technical information, scheduling, etc. This stage took approximately three weeks to complete and was an essential part of establishing a collaborative dialogue with Vlad Tenu as well as resolving issues needing clarification prior to starting fabrication. Stage two of the optimization process was to construct a ½ scale version of Minimal Complexity at the University of Texas Arlington. The goal for this phase was to understand the intricacies of the piece as well as discovering fabrication issues. Because Vlad had already constructed the scheme at a smaller scale and with range of materials, we were able to start with a very developed understanding of what was required in working with the design as proposed.

Over the course of eight days the University of Texas Arlington team was able to successfully fabricate and assemble the seven foot scaled version of Minimal Complexity (Figure 3.) With this in place the TEX-FAB

directors along with Vlad could more effectively understand both technical details and assembly sequence concerns discovered through the construction process.

Figure 3. Prototype of Minimal Complexity constructed at the University of Texas Arlington prior to full-scale fabrication at the University of Houston.

This was an invaluable step in the collaborative process because it raised a series of issues that required collective resolution. Issues like part numbering, templates for sub assemblies, bolt length and type, workflow studies, and special installation equipment needs were all resolved during this optimization process.

Minimal Complexity – Final Construction

After the optimization phase operations moved to Houston where final fabrication and installation would take place. The competition was predicated on the ability to utilize resource for materials and fabrication partners in the greater Houston area. To that end, very early on in the process of developing the project for construction, Crow Corporations who is a digital fabrication partner with TEX-FAB and metal fabrication company located in Houston, was brought in to help resolve technical issues for laser cutting aluminum. Once TEX-FAB, Vlad Tenu, and Crow Corporations established that 14-gauge aluminum was the desired thickness for the several thousand pieces needing to be cut the next step was to check for structural soundness of the design, material properties and connection detail. For this the Buro Happold New York office was enlisted to coordinate a detailed structural analysis (Figure 4.)

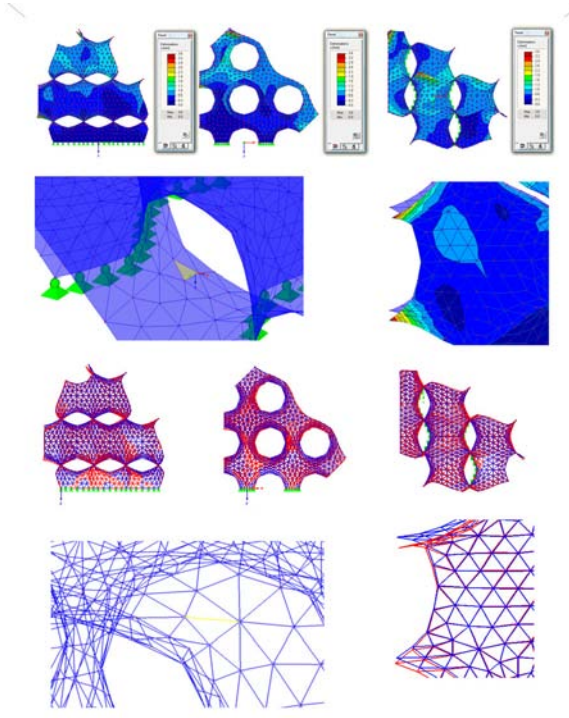

Figure 4. Finite Element Analysis Model produced by Erik Verboon of Buro Happold, New York.

A Finite Element Analysis models was run on the geometry as both a shell and beam structure. The Global Shell Model, using iso-parametric finite shell elements, revealed to be very sound under the dead load of the piece overall.

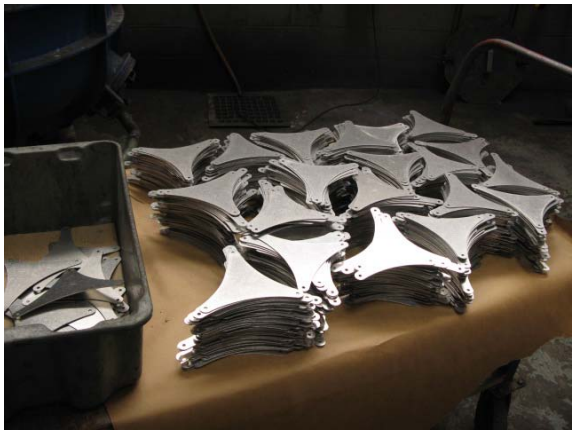

Figure 5. 2368 total parts laser cut of 14 gauge aluminum.

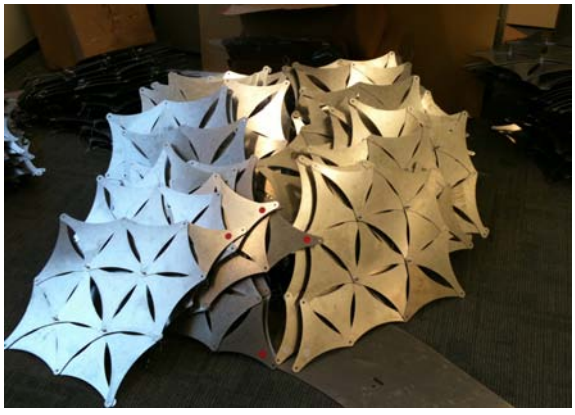

Figure 6. Individual pieces assembled into sets of 16 to make 148 quad sections of the Schwarz P Minimal Surface.

The final structure is composed of 148 basic quad sections of the Schwarz's P Surface with each section being made out of 16 parts resulting in 2368 total pieces. The true strength of the design is found in the simplicity of repeating the same 16 parts through out the entire surface. When each of the basic quad regions is set up for assembly, the curvature of the surface is introduced through the alignment of the 16 parts.

Based on the optimization model, the FEA analysis and the consultation with Crow and the direct communication with Vlad, TEX-FAB initiated a 2-week assembly process. Because of the limited number of unique parts, the process of assembling the basic quad regions was highly repetitive. It was determined by that creating sub assemblies out of the 16 part quads would allow for easier installation (Figure 7.) This size and division of the sub assemblies was based on how two people might be able to handle the part for installation in terms of both weight and size. Once all the sub assemblies were constructed final installation began.

Figure 7. Sub-assemblies constructed out of 14 quads.

TEX-FAB took control of the means and methods of final assembly by employing a series of templates, base plates, ballasts, shoring, scaffolds and hoists to manage the vertical development of this self-organizing structure. The process of building up the system up into 16 part quads led the planning and construction of larger subassemblies or sections of the structure that could be built on the ground and then positioned correctly and bolted in. The choice of 14 gauge laser cut aluminum with ¼" holes proved to be ideal for workability and joining with a variety of fasteners that served to align the parts progressively.

A pattern of tightening and loosing the fasteners at adjacent components was learned by the assembly team in order to allow for hole alignment before final bolting was accomplished. The structure's progressive rigidity as the fasteners became fully engaged was further proof of the designer's concept, the engineer's FEA analysis and TEX-FAB's expertise as fabrication and logistical

consultants. The main assembly took approximately 20 hours with a team of 3-4 members who were new to the system.

Figure 8. Assembly in the atrium of the University of Houston College of Architecture Building.

Regional and Global Coalescence

In the course of the 20 months since the establishment of the TEX-FAB and the incorporation of *Digital Fabrication Alliance, the three outlined avenues: Theoria (Lectures / Exhibitions), Poiesis (Workshops) and Praxis (Competitions / Commissions), have all been tested and proved successful. Our growing network of collaborators within the region is reinforced to a greater degree as needs arise – creating a dynamical relationship adaptive to specific challenges. Additionally the local intelligence of our structure is extended and enhanced by a link to a broader, global, affiliation that we can call upon to a greater degree for material and technique specialization.

In the case of the REPEAT Competition, our local network partners in manufacturing, such as the Crow Corporation, enabled the completion of Minimal Complexity economically.

Figure 9. Finished assembly for the TEX-FAB 2.0 Workshops, Lectures, and opening of the REPEAT exhibition.

Figure 10. View of Minimal Complexity in the atrium.

We foresee the inclusion and expansion of our network as an array of fabricators located in each of the urban centers that we currently operate. These fabrication partners enable our endeavor in the illustration and implementation of parametric design and digital fabrication in other cities in the state and serve as a model for how the local and regional might work together for production and fabrication purposes.

The extension beyond the Texas region into New York for the structural engineering, and ultimately the inclusion of Vlad Tenu, in London, as a catalyst for a project, in effect reinforces the porous nature of TEX-FAB. Additionally, our own tri-city base of operations for TEX-FAB joined with affiliation to three different academic institutions, provide a layer of collaborative and interconnected opportunities for the advancement of digital fabrication issues. As a platform for education and exchange, and a collaborative partner in the production of projects, TEX-FAB serves as a unique and new model for advancing issues that will only continue to transform the way we design and produce architecture.