

“Out of Failure”: Disaster Relief and Digital Fabrication

“In the days after hurricane Katrina devastated southern Louisiana and Mississippi, the Federal Emergency Management Agency (FEMA) bought 145,000 trailers to house the thousands of victims displaced by the storm. Over the next five years, the trailers -- which emitted unhealthy levels of formaldehyde, but which were nevertheless used by thousands who couldn’t find any other place to live -- became a symbol of the federal government’s bumbling in the face of a national tragedy. Sold at auction, and then repurposed as housing for BP cleanup workers, the trailers remain a problem that just won’t go away.”¹

STEPHEN MICHAEL SLAUGHTER
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“A sprawling global team of meteorologists who examined the marquee extreme weather events of 2012—including Hurricane Sandy, drought in the U.S. Midwest, and melting arctic ice—found that human-induced climate change was a factor in half of the dozen events they studied... The authors were especially interested in how climate change affected Sandy’s storm surge, which caused massive destruction on the coast of New Jersey and flooded parts of New York City. They concluded that the surge—a mound of water formed by a hurricane’s winds and forward motion and pushed in front of the storm as it approaches landfall—was worse than it would have been in 1950 because sea level has risen in the past 60 years. That rise in sea level has been attributed to warming temperatures and melting arctic ice. And that rise means that future storms less powerful than Sandy are likely to cause more damage than they would have decades ago.”²

POLEMIC

The techniques of digital description and information technology in architecture have begun to shift the basis by which architecture is analyzed and evaluated. Concerns of form following function have been displaced by the idea that form is a product of technique at the service of affect, primarily pictorial, sculptural and phenomenal. Marjan Colletti, self proclaimed digital aesthetist and guest editor for the “*Exuberance*” issue of *Architectural Design* magazine, frames the prevailing work in digital formalism as a reaction to the rational and conservative practices of computing in engineering and commercial or corporate architecture. He argues that unlike engineering, which uses computing technology to optimize and modulate, the



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exuberance inherent in this new trajectory of architectural investigation gives occasion for the architect, not engineer or programmer, to finally “show off”.

“The celebration of exuberance defines an architecture that begins where common sense ends,” Colletti states. An architecture, arguably, not responsible for anything greater than the successful execution of technique for aesthetic effect. As the academy struggles to shift its mode of investigation and production to churn out yet more representation of procedural, script based schemes, the fundamental typologies architecture has historically been in the service to describe and attempt to accommodate, and the overall built environment has yet to reap great benefit from these explorations and their representations of exuberance.

SEMINAR

It is these three topics, the increase in extreme weather events due to climate change, the ineffectiveness of FEMA to offer sustainable solutions for disaster relief, and the critique that prevailing digital practice in architecture fail to make use of the infinite potential of computing power and technology to address real human need that motivated a seminar co-taught last fall by Brian Davies and Stephen Slaughter, in the University of Cincinnati’s College of Design, Architecture, Art and Planning (DAAP) within the School of Architecture and Interior Design, called “*Out of Failure*”.

The mission of the seminar was to employ a parametric modeling technique in the design of a digitally fabricated temporary structure that could be useful in times of hazard response due to natural and/or manmade calamity, which, given the escalating severity of weather related catastrophe, could be argued is one and the same. The process started by diagramming small, confined living and work quarters for the purpose of understanding ergonomics and spatial efficiencies, to establish a new metric beyond that of prevailing standards for comfort and performance. Next, the students were asked to imagine a disaster scenario, context and delivery method a shelter could address, then design its interior surface to respond to the body, tasks and culture and its exterior surface to respond to the environment, climate, and

Figure 1: Destruction from Hurricane Sandy, Breezy Point, Queens, New York, October 2012.

terrain. The purpose of this exercise was to create a virtual poché from the interstitial space between the shelter's interior and exterior surfaces that a "waffling script" (algorithm building plugin for the computer modeling program Rhinoceros) could section into structural ribs that would later be milled from inch thick plywood.

Working in groups, the class of 16 went through the design process and presented seven proposals at midterm that were voted on to decide which three would be pursued further and eventually, in part, built at full scale for the final. The teams whose projects were selected absorbed the teams whose projects were not, and work progressed on revising and elaborating the shelters for full-scale mockup. For the seminar's final, the students presented three full-scale partial bay prototypes that were reviewed and evaluated in terms of fabrication, detail, joinery and construction.

The following is a description of each prototype the students presented at the final, in their own words:



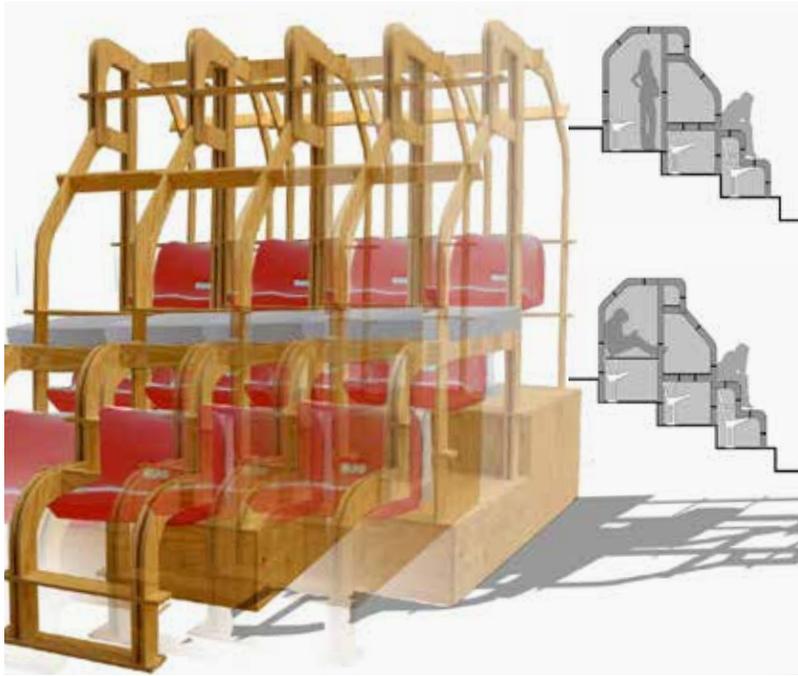
PROJECT 1: SPACE:ROLL

Space:Roll began as a reaction to disaster, not just natural, but also political and social. We started by focusing on the events following hurricane Katrina. The category five hurricane was one of the deadliest and most destructive in US history, affecting more than 15 million people. In its path were destroyed homes, government buildings, and entire communities. With nothing remaining, many were forced to relocate or move to FEMA trailers. As with most situations, there was a gap of time in which families were left in limbo, living in an overcrowded Superdome while they waited for trailers or were able to move in with relatives. From this failure in organization and response time, we found an opportunity to create something that could be flat packed, driven to any site, and easily assembled by a few people. In creating an enclosure that rolls to create multiple interiors, we are able to maximize the habitats programmatic uses and capitalize on efficiency of space...

The shelter's rib system is made up of four types. These are tied together with simple horizontal elements that are all identical to make for easy construction in the field. The reduction of unique members and the utilization of narrow spans in compression allow for less material to be used in the fabrication. Less material lowers the cost of each shelter and facilitates shipping.

Figure 2: Project 1: *Space:Roll*
Team_ Kate Bogenschutz, Tyler Gentry Mary Jo Minerich, Nick Schoepner, Alex Ziemba.

... With the recent coming of Superstorm Sandy and the destruction it's left, we've come upon another situation in which Space:Roll becomes necessary. In New York City, Staten Island, and New Jersey where homes were flooded and destroyed, Space:Roll could easily be distributed and assembled to sit in Battery Park, on the Jersey Shore, or in abandoned lots, creating temporary housing for thousands of displaced families in need.



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PROJECT 2: STADIUM

When Hurricane Katrina hit New Orleans in 2005, the Superdome became a shelter for those who were unable to evacuate the city. There were roughly 9,000 people who sought shelter in the Superdome on the night of Katrina's landfall. The number was later nearly doubled. Living conditions inside deteriorated rapidly, with reports of violence, sexual assault, drug use, and even a suicide. A better system is needed that protects human dignity while creating a safer and cleaner environment for its inhabitants. After seeing the devastation caused along the East Coast by Hurricane Sandy in late October of 2012, we realized that a versatile design could function in disaster-hit cities around the world. While not every city has a permanent fixed dome structure like the Superdome, many have convention centers or other arenas. The Atlantic City Convention Center is located in one of the hardest-hit areas by Sandy, and could contribute additional relief housing for the hundreds of refugees displaced from the hurricane.

One of the reasons for the poor conditions inside the Superdome was due to such cramped living conditions. We want to dramatically increase the occupiable space by extending from the field into the seats. Our design is intended for one adult and children. While the race, age, income level, etc. will vary in the temporary population, the demographic for which we are designing is especially in need of safer, cleaner, and more private spaces. Natural disasters like Hurricane Sandy are often forecasted at least a week before they strike. A large shipment of plywood can be delivered to businesses with CNC milling machines within a 30-mile radius of the designated disaster-relief center. When a large-scale storm

Figure 3: Project 2: *Stadium*
Team_Diana Chan, Dina Elawad, Adam Fischer,
Madeline Goryl, Ryan Schmidt, Molly Smith.

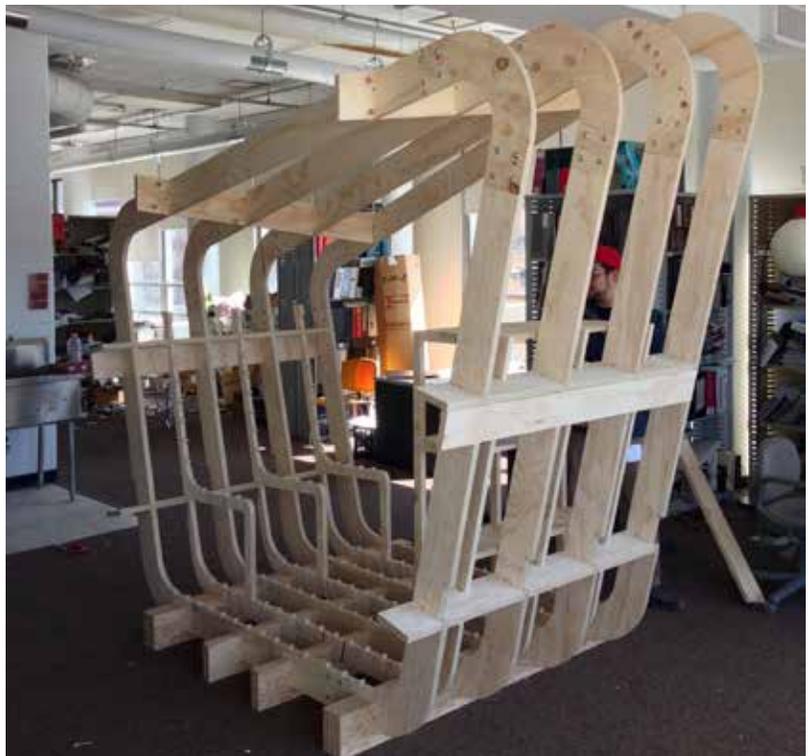


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develops on the radars, the files can be sent to be milled and then to be stored at the arena.

PROJECT 3: [RE]CONESTOGA

Designed to occupy the same footprint as a single car, the relief unit easily plugs into various city infrastructure, such as parking lots or beneath highway



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Figure 4: Project 3: *[re]conestoga*
Team_Reuben Alt, Alec Gardner, Tony Mangione,
August Miller, Joe Southard.

Figure 5: Construction of second part size, full-scale
prototype, April 2013.

underpasses. Parking spaces within car parks and surface lots offer flat foundations for quick construction of the unit.

The ribs are pre-tethered for rapid assembly and are locked into position by the base rails and longitudinal elements. The vinyl shrink-wrap skin provides up to six months of weatherproof protection. In the event of an urban disaster, the units can provide temporary shelter or a base for relief efforts. The units are intended as an operational component of relief camps that would have separate hygiene facilities. The units can function autonomously as distribution centers for potable water, cellular phone charging stations, or as coordination centers.

INDEPENDENT STUDY

At the Final's conclusion a second vote was held to decide which of the three schemes would be elaborated in the construction of a second partial bay prototype and later produced full size, full-scale for the prestigious International Contemporary Furniture Fair (ICFF) held yearly in New York City.

This auspicious opportunity to present the work of the seminar came with challenges but also, and most importantly, allowed the team to further the investigation as to whether this technique and delivery method would be viable to address the need of disaster relief. The students collectively chose Project 3: [re]conestoga, to pursue for ICFF, and through an independent study the following semester work began on consolidating the best ideas of the three bay models into one amalgamated scheme with the goal of streamlining its method of construction and vetting potential flaws or failures in the system with regard to detail and fabrication technique. These accomplishments could not have been achieved if not for the remarkable staff of the Rapid Prototyping Center housed in DAAP; Scott Lincoln, Nick Germann and Aaron Rucker. Through their collective efforts, working with the students, a third partial, full-scale prototype was fabricated and evaluated. As with the previous prototypes, the lessons of the second full-scale mockup were analyzed and synthesized into a final virtual model that would later be milled and assembled for the furniture fair.

THE INTERNATIONAL CONTEMPORARY FURNITURE FAIR, NEW YORK, NY

With the prototype's milling, erection, appraisal, disassembly and preparation for transport complete, the team's goals of producing the best work possible to represent the school, college and university had only installation and public engagement yet to assail. The mission was to take advantage of the opportunity to engage the international community of designers the forum attracts, to make strategic partnerships with colleagues, crafters and companies who could



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Figures 6 and 7: Prototype Installation, Booth 3036, International Contemporary Furniture Fair, Javits Center, New York City, May 2013.

aid in advancing our research. To expand on this effort the team worked with the Dean's Office to come up with strategies to take greater advantage of the experience in New York to not only make connections at the fair itself, but to try to engage a larger community of alumni and University supporters, to facilitate relationships that could benefit both the project and the program as a whole. Through these efforts, discussion with leading academics in the field were sponsored, conversation with small startups as well as multinational corporations were initiated and alliances were made to establish both partnerships with the University and conduits for the donations of materials. But aside from the mission itself, in trying to solve how a digital technique and technology can be used to produce low cost, hyper efficient disaster relief shelters for the greater good, the greatest benefit of "Out of Failure" is providing students with an experience not typical to academia or co-op. The team conceived, designed, built, marketed, traveled and served as both sales staff and ambassadors to the University. It was an experience, sometimes messy, sometimes daunting but always "real world" and most importantly, more than simply a lesson in computer modeling and scripting, it was a lesson in life.

ENDNOTES

1. Bruce Watson, *The Awful Odyssey of FEMA's Hurricane Katrina Trailers*, Daily Finance, August 28, 2010.
2. Willie Drye, *Scientists Weigh Climate Change Role in 2012 Weather*, National Geographic, September 5, 2013