Traditionally dominated by heavy, rigid formwork, the reliance of cast-in-place concrete on inflexible and excessive material methodology has unnecessarily constrained its formal, technical and structural design parameters and possibilities. However, recent advancements in material technology and research, as well as digital material simulation have created possibilities for lighter weight, tensile and malleable formwork assemblies. These assemblies allow more flexible configurations and variable density. Proposed as a potential replacement for the ubiquitous sheer walls found in most tall concrete buildings, this new configuration offers novel material effects, variable porosity and contingent configurations.

DYNAMIC TENSILE NETWORK

Cast Thicket proposes a new tensile paradigm for site-cast concrete. Leveraging the compressive nature of the scaffold, this exterior frame allowed for the internal mold to be almost entirely in tension. Within the gallery scale and transportability constraints of the scaffold, a tensile network is developed to become the centerline for both concrete mass and steel reinforcing. Starting from an initial grid converted to virtual springs in Kangaroo, an optimization scheme is set up similar to a game of cat’s cradle.
Played out over a series of iterations the virtual spring simulation was trained into an optimized interlaced network. Using two types of nodes, fixed and dynamic, allowed the framework to be moved either directly by positioning fixed nodes or more subtly by changing the tension on the springs thus repositioning the dynamic nodes. Further adjustments were made by adding and subtracting springs or changing connection paths. This nuanced, haptic design process sets up an interface that adjusts to the structural concerns from Buro Happold while creating a formation that demonstrated maximum flexibility of the system.

STEEL FRAME
Replacing the formwork frame and rebar used in typical concrete construction, this prefabricated and highly calibrated steel frame acts much like typical rebar, serving as a tensioning device and holding the concrete in compression. It further composes the armature from which the thin membrane formwork is hung. The steel frame is composed of a series of struts and nodal joints, and is assembled node-by-node (Figure 1). The nodal joints are radially notched steel pipe accepting corresponding struts at specified angles (Figure 2). Further calibration of the joint is achieved using an angle-finding jig to ensure the precise configuration of each node and corresponding strut component (Figure 2). The struts are fabricated with male and female components which, when assembled, produce a T-shaped cross section providing additional structural support.

PLASTIC FORMWORK
A series of concrete hexagonal struts cast into a formwork of ruled surface panels wraps the steel frame. Refined from optimized, relaxed surfaces the plastic panels simultaneously direct the flow of concrete and create a free-flowing system of load paths (Figure 3). This thin membrane of polypropylene replaces typical plywood and steel forms. The individual pieces of plastic formwork are stitched together through a system of interlocking tabs designed to be easily assembled by hand, and to respond to the unique curvature of each piece (Figure 4).

CONCLUSION
This research projects beyond its prototypical installation to address current issues in creating tall concrete structures. Cast Thicket presents one spatial outcome from a flexible system that can be multiplied and scaled (Figure 5). The flexibility inherent in the system allows for a new type of porosity while the casting process creates a novel tectonic outcome.

KEN TRACY directs Yogiaman Tracy Design whose projects in the United States and Indonesia include “Cast Thicket,” the winning proposal for the international 2012 TEX-FAB APPLIED: Research through Fabrication competition. Formerly, Tracy was founding partner at Associated Fabrication, a design and fabrication company based in Brooklyn, New York, whose clients include Zaha Hadid, the Vancouver 2010 Winter Olympics, Chanel, KAWS, Vito Acconci and the Museum of Modern Art. As a Visiting Assistant Professor at Washington University’s Graduate School of Architecture, Urban Design and Landscape Tracy established the Digital Initiative Lab (DIL), a facility for large-scale digital fabrication while teaching studios and developing integrated, digital core-curriculum. He has previously taught at the Pratt Institute, Columbia University and the New Jersey Institute of Technology. Most recently Tracy has been appointed to the faculty of the American University of Sharjah as an Assistant Professor.

CHRISTINE YOGIAMAN is a founding partner of Yogiaman Tracy Design, which currently designs projects in Indonesia, focusing on the use of digital techniques along with contextual influences to create culturally embedded, affective work. By combining labor-intensive acts in craft culture with rule-based, digital frameworks, these projects multiply the everyday to intensify space. Christine started her tenure at Washington University’s Graduate School of Architecture, Urban Design and Landscape in 2009 where she coordinated the graduate core studios and representation curriculum. Yogiaman is currently an Assistant Professor at the American University of Sharjah. Christine won 3rd place in the 2012 Steedman International Design Competition, and 1st place in the 2012 TEX-FAB APPLIED: Research through Fabrication competition.