DYNAMIC TENSEGRITY SYSTEMS:
A CASE FOR RECONFIGURABLE STRUCTURES IN URBAN CONTEXT

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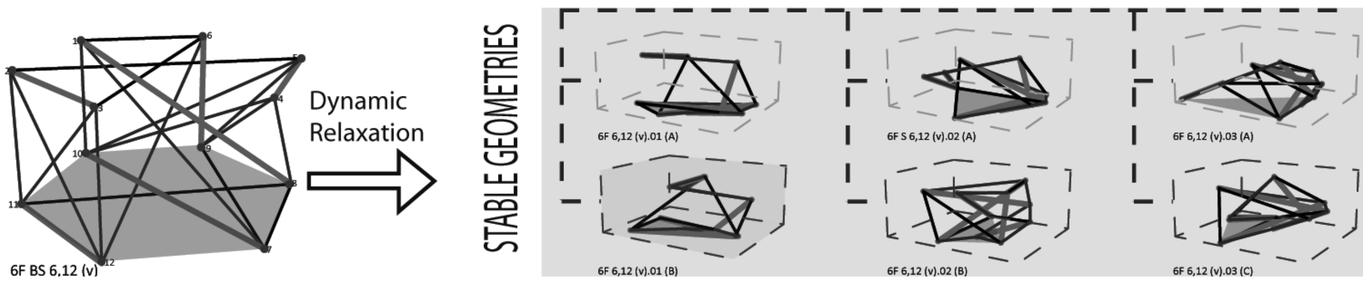
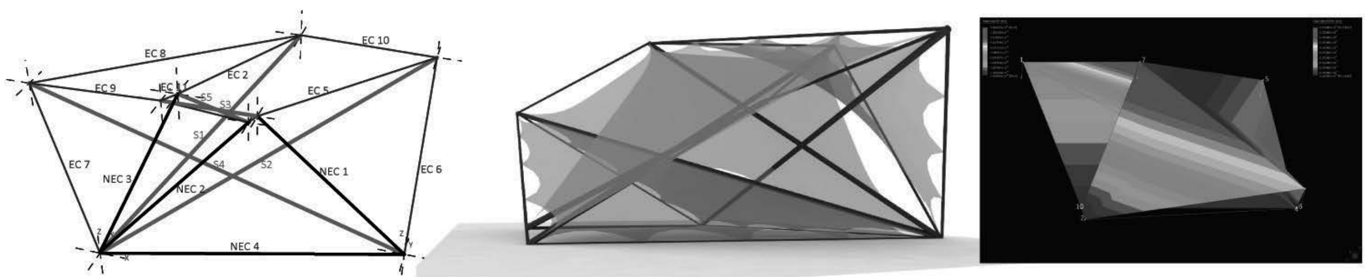




1 Top
A six strut unstable basic seed resulting in multiple stable geometries

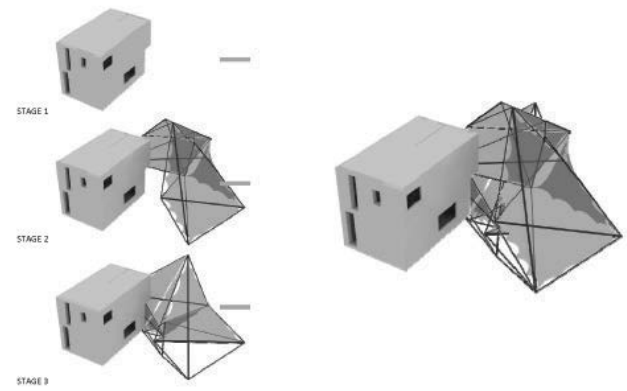
2 Bottom
Linear Buckling Analysis Test on module after membrane addition

Amidst rapidly changing social contexts, architectural structures require distributed intelligence embedded in active material systems and programmable virtual representations (digital models) that are capable of changing their internal parameter and performances in response to the context. The intriguing fascination of dynamic structures is also described by Neil Leach in his essay Swarm Techtonics wherein he states "in most advanced form, it would be an architecture that is open to those processes themselves, an adaptive, responsive environment, that does not crystallize into a single, inflexible form, but is able to reconfigure itself over time, and adjust to the multiple permutations of programmatic use that might be expected of it" (Leach 2004: 35). Using dynamism to improve efficiency, multi-functionality and adaptability of space has become a design pre-requisite in order to cater to the rising need of spatial flexibility and re-configurability.

Tensegrity systems which can be essentially characterized as regular and irregular tensegrity structures are systems with complex structural behavior based on the morphology and connection logic. While conventional analog modeling and solving methods for analyzing and predicting the behavior of regular tensegrity structures is possible; for irregular tensegrity structures, these methods prove highly complex, tedious and laborious to understand, analyze and design irregular tensegrity structures. The research involves use of evolutionary algorithmic approach for designing various configurations, simulating its behavior and its multiple stable states and digitally testing the structural performance under material constraints provides for a more coherent process of design development for such complex systems.

Tensegrity structural systems constitutes 3-dimensional stable mechanical structures that maintain its stability due to an intricate equilibrium of forces established between the rigid and disjoint compressive and continuous tensile components. However, the prediction of stable configurations that result from the connectivity patterns between the compressive and tensile components is highly challenging. This research involves use of evolutionary algorithmic approach to thoroughly investigate a set of arbitrary tensegrity structures which are difficult to design using traditional methods and determine new irregular forms with optimal architectural relevance. The procedure involves use of dynamic relaxation methods for simulating the material properties and system performance to obtain stable forms based on the input mechanical constraints and kinetic freedom. The rigorous analysis, evaluation, elimination and selection procedure aims at achieving optimal set of digitally developed and tested modules provide for the basis for next stage of design development and complexity based on organization logics of the emergent design.

The assembly logics are eventually re-embedded in the digitally iterative design process to essentially have the resultant design reflective of a highly engineered system performance evolved into highly developed spatial architectural design. Thus the research focuses on two aspects of study, with the primary focus being proposal of a structurally adaptive system through various material tests, physical models and digital structural analysis and; the other aspect of the research aiming at studying digital simulations of system behaviors, and developing design solutions through digital algorithmic processes for optimal material usage, structural performance and fabrication feasibility.



1 Modular reorganization to form architecturally habitable and re-configurable spaces and structures

WORKS CITED

Leach N. 2004. Swarm Techtonics. Digital Techtonics.

DISHITA TURAKHIA, after graduating from AA, London, worked briefly with PLP architecture in London as a computational designer where she worked on resolving various projects using computational approach. She has conducted building technology workshops "para-CENTRIC" in architectural institutions in Mumbai that involved teaching the basic parametric design digital, designing and fabricating structures. The climatically responsive canopy and semi-pavilion built during these workshops have been exhibited at kalaghoda art festival, 2010, Mumbai. She also had a paper published and presented at CAADRIA 2013, Singapore. She continues to independently research in dynamic architecture while also practicing and heading her own architectural firm in Mumbai.