The Tensegrity-Factory Challenge

An opportunity for teachers, designers, and whole-systems thinkers everywhere

Needle Tower (1968)

Background

In 1947, Kenneth Snelson invented floating compression sculptures. Throughout his career, Snelson has created beautiful works that challenge our presumptions about structure. Buckminster Fuller called them tensegrity structures, and that name has stuck.

In 1975, Buckminster Fuller wrote “Synergetics: Explorations in the Geometry of Thinking”. Among other topics, Synergetics describes how tensegrity behaves under structural stress: how its nonlinear behavior is distinct from the physics of compression-based structure.

In the mid-1980s, Harvard Professor Donald Ingber discovered that our cellular structure is based on tensegrity. His article “The Architecture of Life” is a wonderful tutorial on tensegrity and several of its uses in nature.

Over the last 30 years, Stephen M Levin MD has researched and published a variety of papers on the application of tensegrity to our musculoskeletal structure. Levin is instrumental in explaining the stress-strain response of tensegrity and how it is critical to the energy efficiency of living structure. This model is a radical departure from the tightly-coupled “levers and hinges” model for our posture and movement.

The Riddle of Tensegrity

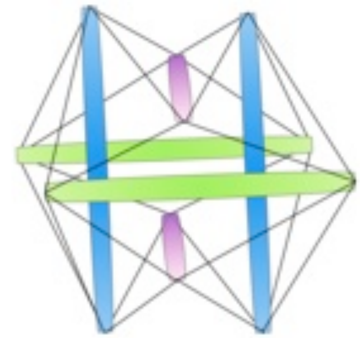
Tensegrity is an important physical principle: it challenges our presumptions that structure must always carry its loads compressionally. Tensegrity structures with sufficient tension behave in a nonlinear fashion described by Fuller. It appears that all natural structures using tensegrity have high tension.

Tensegrity is remarkable, but it is not mystical. Snelson’s sculptures are viewable at the Hirshhorn and other museums around the world. The text of Fuller’s “Synergetics” and tensegrity construction plans are freely available online. Ingber’s article was published in the January, 1998 issue of Scientific American Magazine. The book “Anatomy Trains” is a highly-regarded tensegrity-oriented mapping of long lines of tension in the human body. Tensegrity models are available from a variety of Internet sites, and an infant’s tensegrity model, the Skwish toy, is sold by toy stores throughout the US and Europe.

The riddle: why is tensegrity little-known in our civilization? Why do few teachers discuss tensegrity, and why are so few of us using it to investigate nature’s structure and to create new manmade structure? Three possible reasons:

- “Synergetics” is a difficult text; few have thoroughly read Fuller’s book. Many readers of “Synergetics” do not explore its concepts with physical models.
- Research papers cite Fuller’s invention of the word tensegrity but rarely cite the actual behavior that Fuller documented. Few science texts have ever covered the dynamic behavior of tensegrity structures.
- While Snelson’s sculptures have high tension, virtually all of the handheld models use rubber-band or other highly elastic tension elements. These models do not have the nonlinear stress-strain response first described by Fuller.
- Writer and mystic Carlos Castaneda noted that he “borrowed” the word “tensegrity” to promote and market a pattern of dance/movement originated by Native American shamans. This “borrowing” has muddied the word’s meaning; many do not realize Castaneda’s definition is unrelated to Fuller’s original definition.

The Challenge



A tensegrity icosahedron

The Tensegrity-Factory Challenge: create and sell kits for building high-tension tensegrity icosahedron models. Kits should be easy to assemble within about 30 minutes using hand tools.

Traditional low-tension tensegrity kits use six struts and six rubber bands (or stretchy fabric loops). Those low-tension kits are easy to assemble with no tools; the challenge is to make a high-tension kit that is easy to construct. Consider also creating and selling a jig or other parts to aid in the construction of the models—a tensegrity factory.

One general approach is to create the 24 tensile elements by drawing a single thread twice through each end-point. A threading pattern for the tensegrity icosahedron is included in the notes. Each end-cap could have 1 or 2 holes for the threads. Those end-caps would be crimped after all the lines were in place and the tensions were balanced.

While threading the tensegrity, the struts need to be rigidly held in place. A cube with semicircular grooves along its faces may work well (see notes). The small cube would be at the center of the structure; the struts can be held to the cube faces with velcro bands. After assembly, the cube would be removed. If the cube broke down in three slices, the parts could be disassembled to allow their removal from the center of the structure.

A second general approach is to first completely assemble the webbing for the icosahedron then attach the struts to that webbing. There is a commercial product that works this way (see notes). There are a hybrid approaches between the single-line and completely-preassembled-webbing ideas.

Non-Factory Tensegrity Models

An alternative challenge: create tensegrity art or large tensegrity models. Necklaces built with a teeny tiny high-tension tensegrity icosahedrons (TTHTTIs) would be instructive and wonderful. A halloween costume flaunting a tensegrity icosahedron at every major joint would put Edward Scissorhands to shame. Huge tensegrity models that can be rapidly assembled would be terrific. See the notes for some general information.

Benefits

A tensegrity factory and kits could be used in classes or workshops: every student could take home their own model. With inexpensive models, students could explore tensegrity dynamics with models using line with different elastic materials or models deliberately created with out-of-balance tensions. An explosion of tensegrity models with high tension would naturally promote understanding the behavior of this kind of structure. Promoting one kind of synergetic model would ignite interest in other aspects of Buckminster Fuller's "geometry of thinking".

We are surrounded by tightly-coupled "levers and hinges" structures but rarely see loosely-coupled structure. Tensegrity is an excellent example of a loosely-coupled structure. Since nature often uses loosely-coupled structure, tensegrity gives us a new means to understand nature.

All tensegrity models are cool; tensegrity models built with high tension are supremely cool. With their own tensegrity models, students can demonstrate principles that many of their science teachers have never ever seen.

Further Information

This document is available online at http://tensegrity-factory.com/factory.pdf . References and notes are available at http://tensegrity-factory.com/notes.pdf . If you have questions or comments, please visit http://tensegrity-factory.com , send a message to info@tensegrity-factory.com or follow @maketensegrity on twitter.