Rapid Prototyping of 12-Bar Tensegrity Robots

Mallory Daly | BEST Lab Seminar | October 21, 2016

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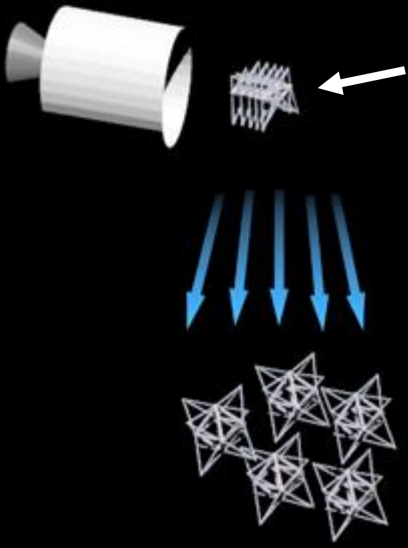
Motivation for Tensegrity Robots

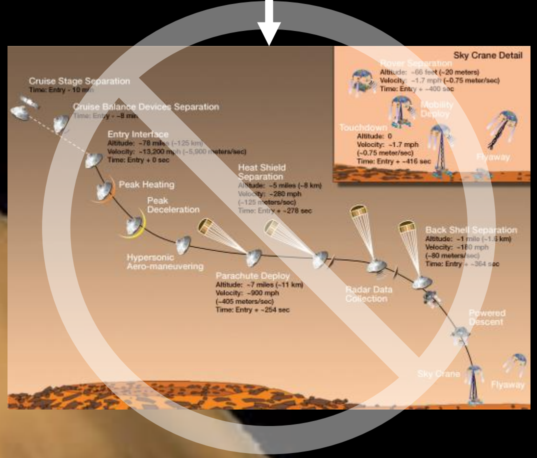


They can be packed into tight spaces

They can absorb an impact

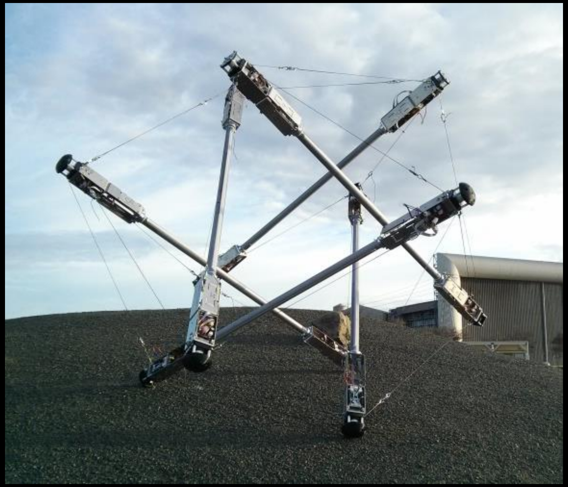
They can move across a surface by actuating their cables

They act as both a lander and a rover, making them cheaper and less complex than traditional surface exploration methods

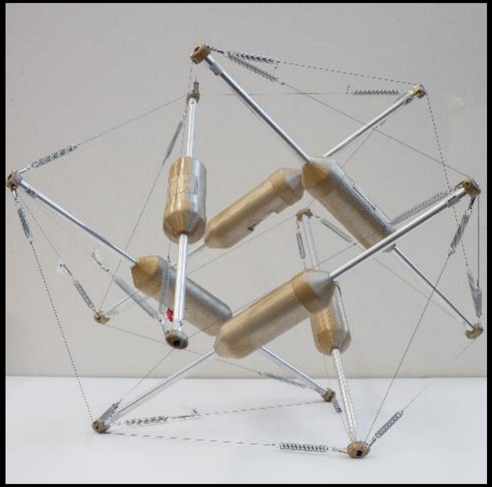


Structural Limitations of Six-Bar Tensegrities

- Impact orientation sensitivity [1]
- Limited actuation schemes [2]
- Limited internal volume for a payload



SUPERball at NASA Ames [3]



TT-3 at UC Berkeley [4]

Research Hypothesis

12-bar tensegrity structures, which are the next-largest, symmetric structures, offer the following advantages:

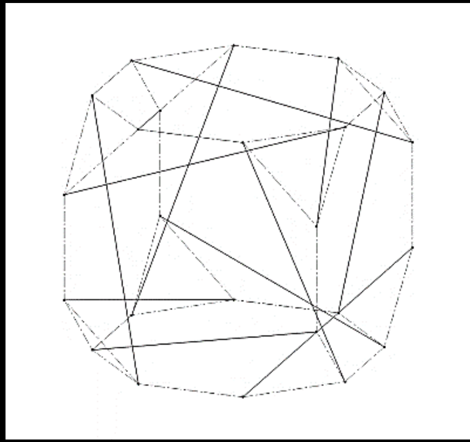
1. Several 12-bar forms → more choices for evaluation
2. More spherical geometry → better impact characteristics
3. More cable actuation schemes → better actuation characteristics
4. More internal volume and structural support → larger payload capability

Research Method

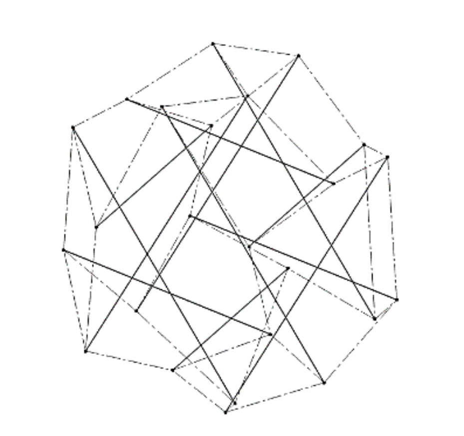
- Goal: Use rapid prototyping to evaluate the claims made in the research hypothesis
- Rapid prototyping approach
  1. Create structural 12-bar prototypes to select forms of interest ✓
  2. Actuate the cube and octahedron 12-bar robots
  3. Make analog structural robots to use in drop tests
  4. Evaluate using design metrics:

Impact	Actuation	Payload
• Deformation • Orientation sensitivity	• Power / step • Energy / linear distance	• Maximum mass for impact and actuation

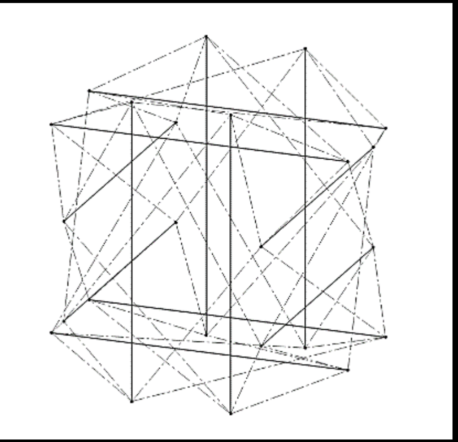
Different 12-Bar Structures



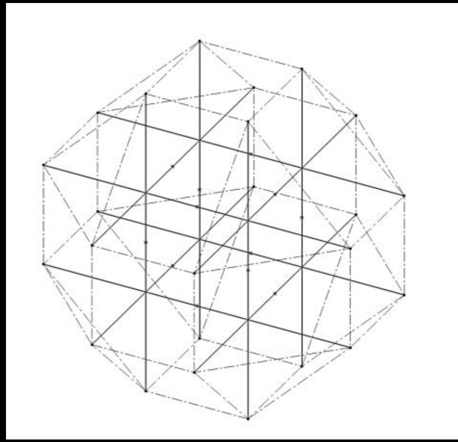
Cube



Octahedron



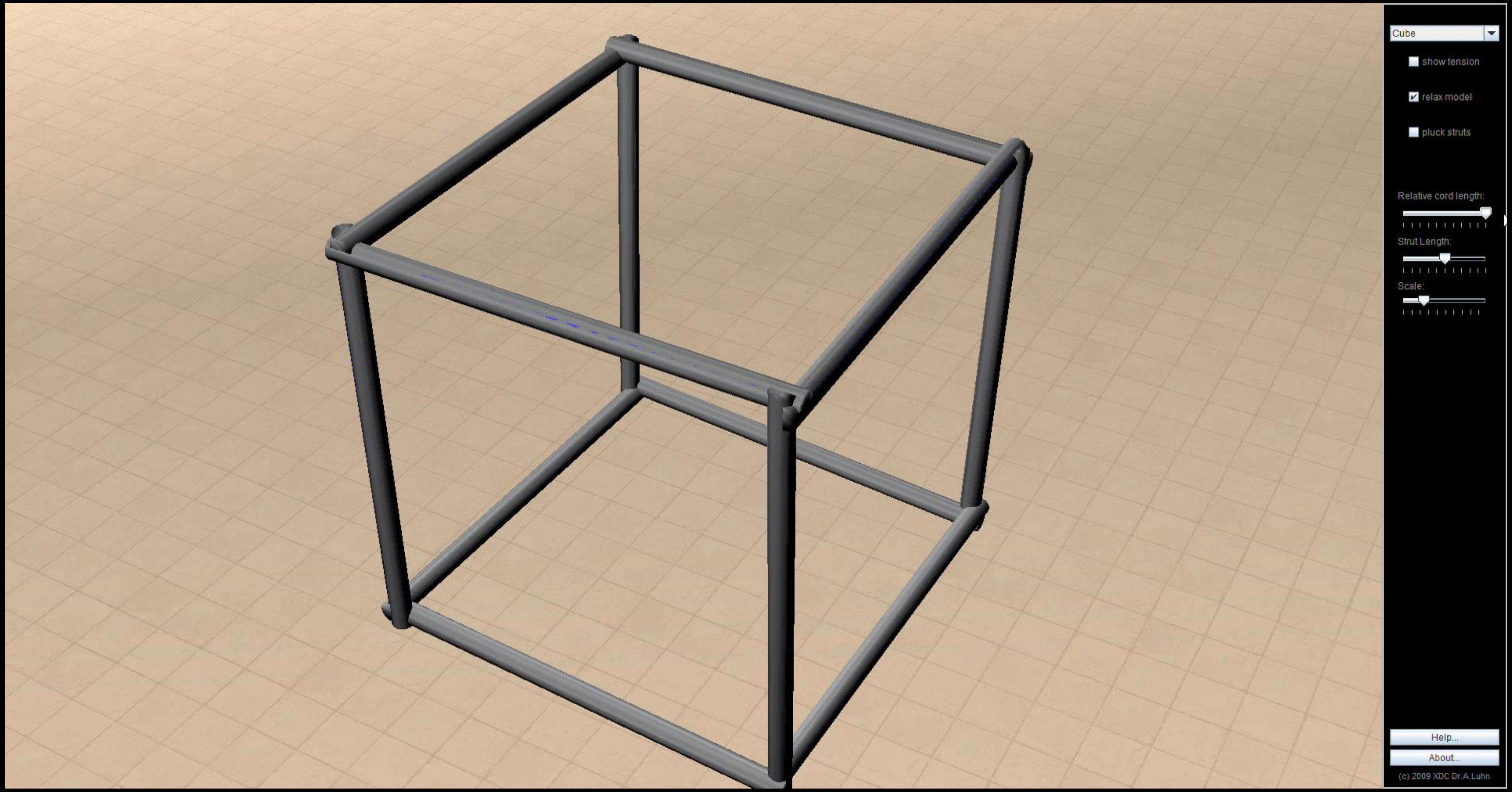
Double Six



Rhombicuboctahedron

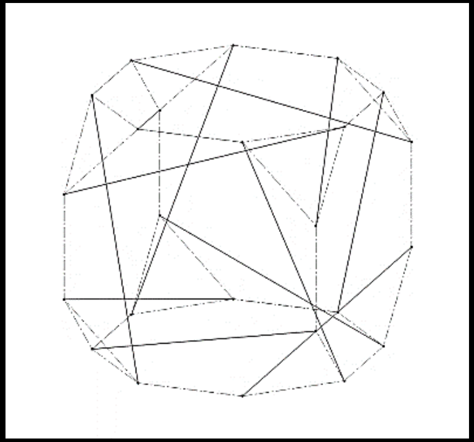
Names of Cube and Octahedron from [5] and Double Six from [6]. Name of Rhombicuboctahedron from external geometry.

Cube Evolution

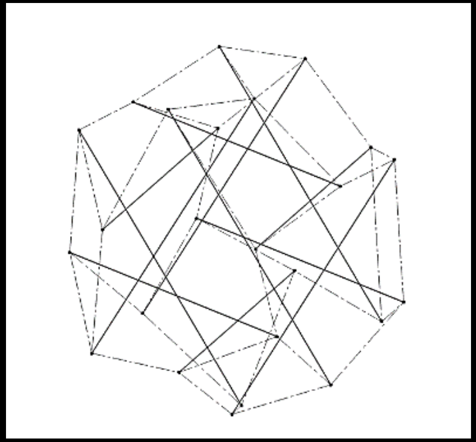


Created using Virtual Tensegrities Application [5]

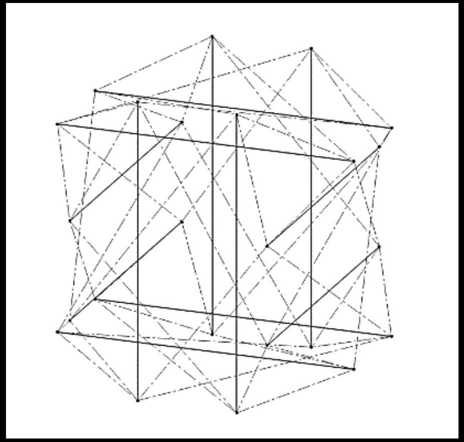
Different 12-Bar Structures



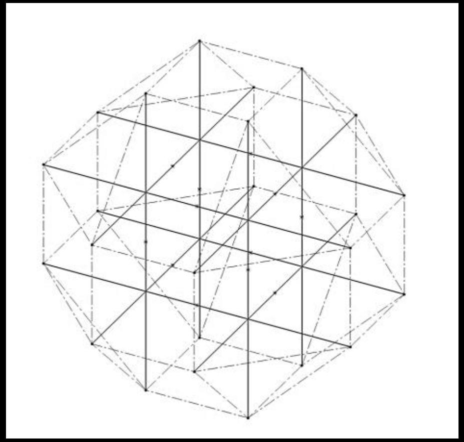
Cube



Octahedron



Double Six



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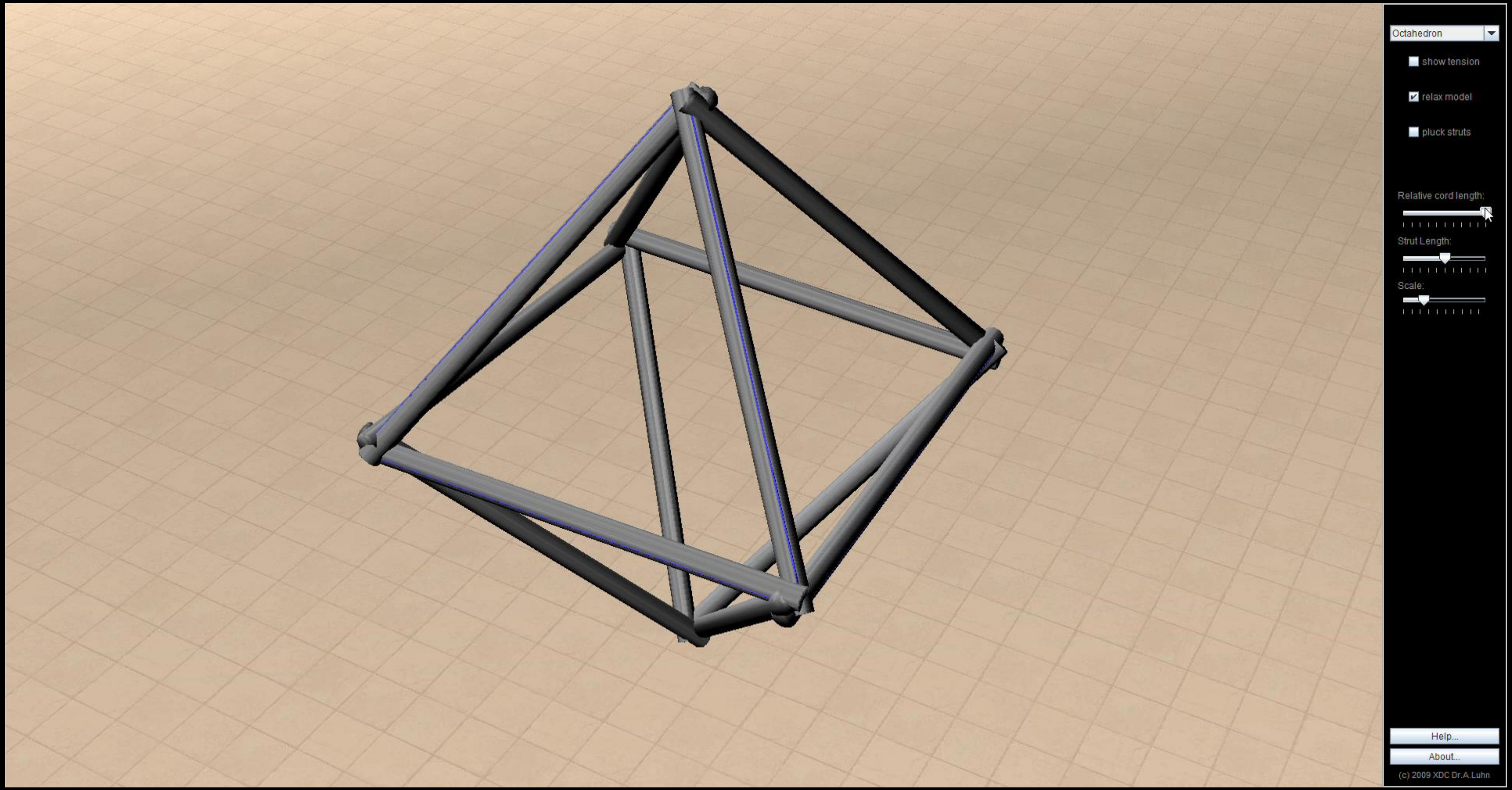
Octahedron Evolution



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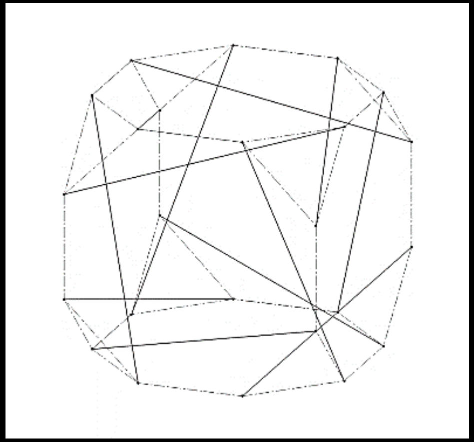
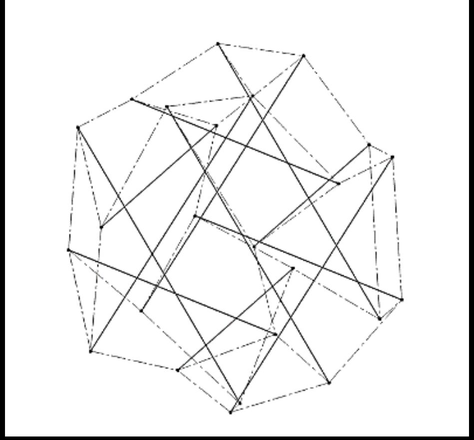
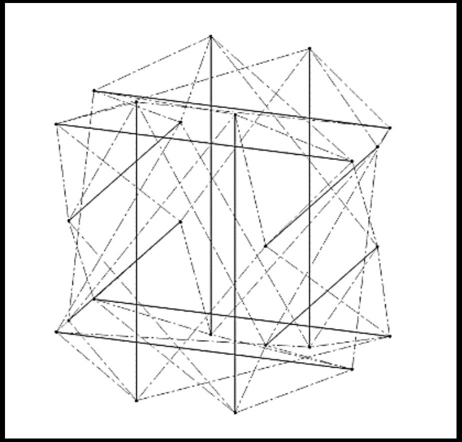
Different 12-Bar Structures



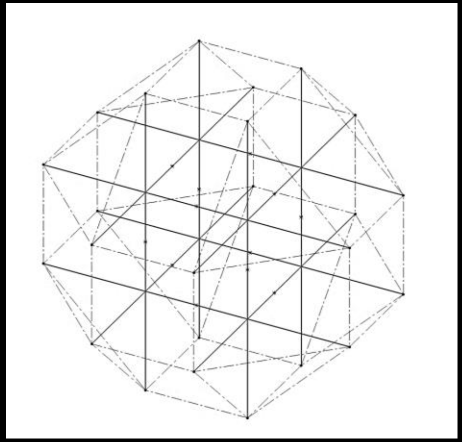
Cube



Octahedron



Double Six



Rhombicuboctahedron

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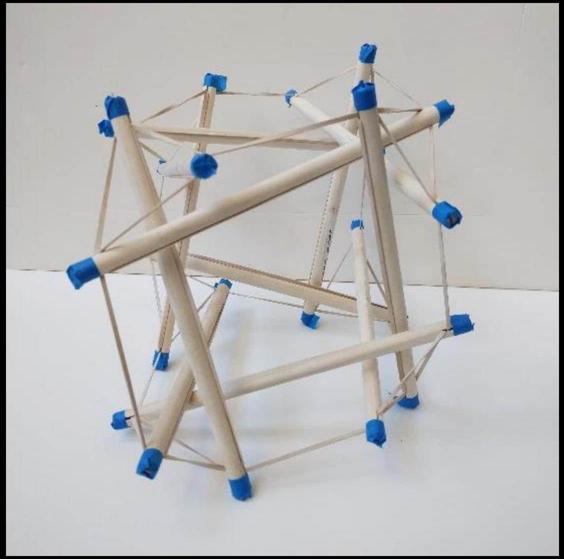
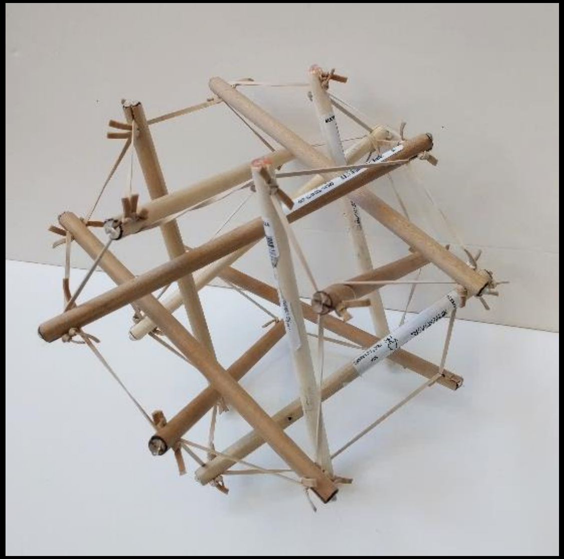
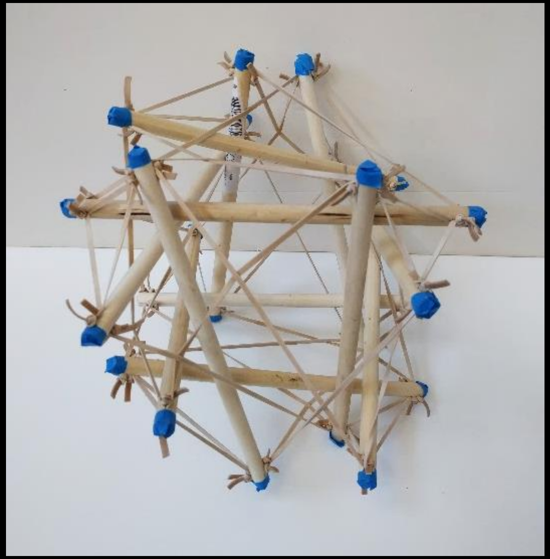
Initial Structural Prototypes



Cube

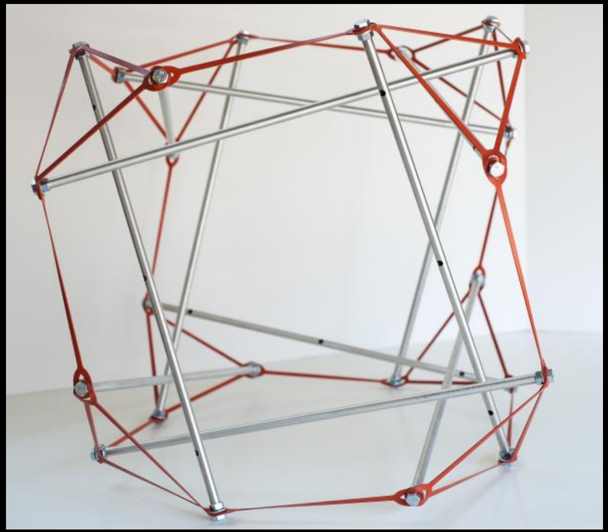


Octahedron

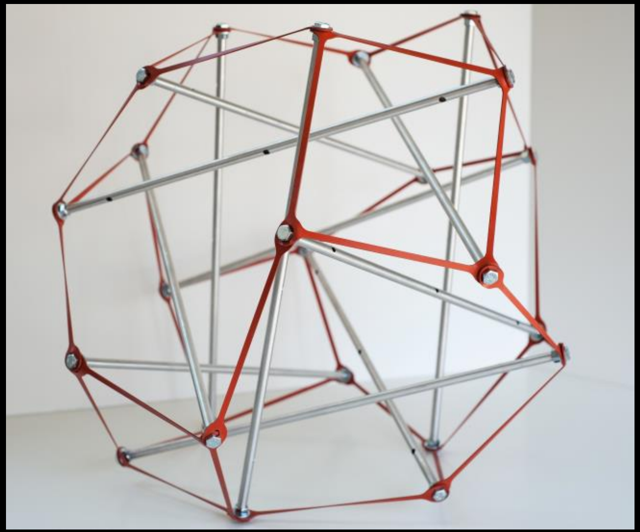


Double Six

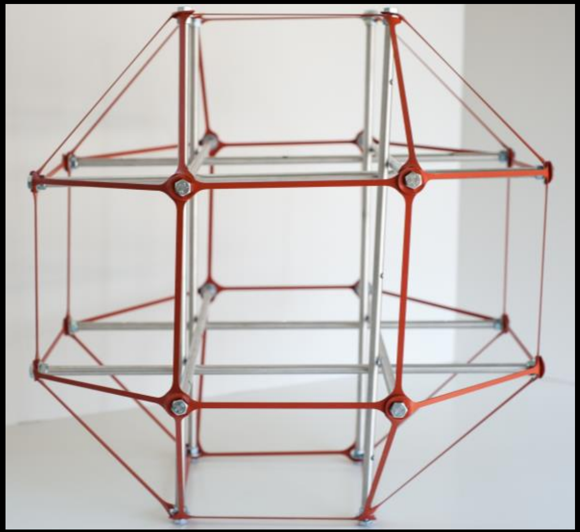
Current Structural Prototypes



Cube



Octahedron

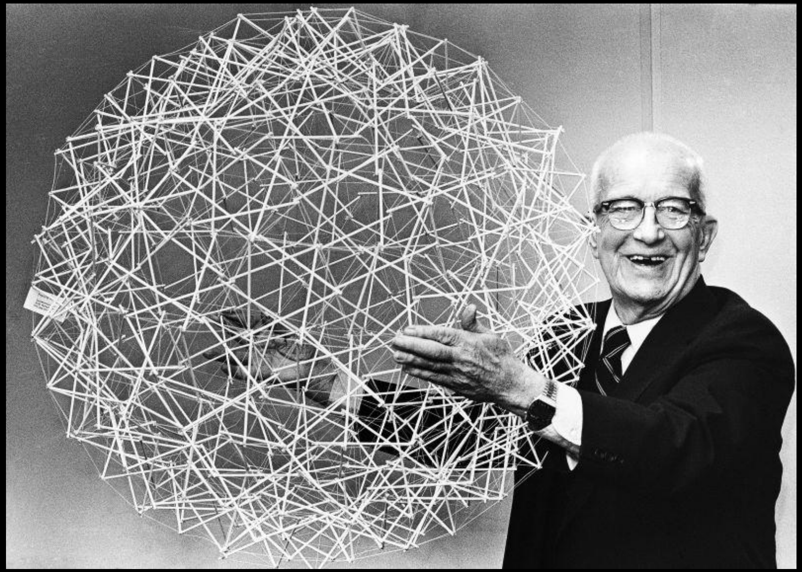


Rhombicuboctahedron

Questions?

Mallory Daly

mallorycdaly@berkeley.edu



Acknowledgments

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Citations

[1]	A. Agogino, V. Sunspiral, and D. Atkinson, "Super Ball Bot - Structures for Planetary Landing and Exploration," 2013. [Online]. Available: https://www.nasa.gov/spacetech/niac/2013phaseII_sunspiral.html. [Accessed 17-Oct-2016].
[2]	K. Kim, A. K. Agogino, D. Moon, L. Taneja, A. Toghyan, B. Dehghani, V. Sunspiral, and A. M. Agogino, "Rapid Prototyping Design and Control of Tensegrity Soft Robot for Locomotion," in *International Conference on Robotics and Biomimetics*, 2014, pp. 7–14.
[3]	"Human Exploration Telerobotics 2 (HET2) SUPERball Bot – Structures for Planetary Landing and Exploration," 2016. [Online]. Available: http://futuristicnews.com/human-exploration-telerobotics-2-het2-superball-bot-structures-for-planetary-landing-and-exploration/. [Accessed: 17-Oct-2016].
[4]	K. Kim, L. Chen, B. Cera, M. Daly, E. Zhu, J. Despois, A. K. Agogino, V. Sunspiral, and A. M. Agogino, "Hopping and Rolling Locomotion with Spherical Tensegrity Robots," 2016.
[5]	Luhn, Achim. "Virtual Tensegrities Application," 2012. [Online]. Avilable: http://www.xozzox.com/downloads.html. [Accessed 17-Oct-2016].
[6]	Snelson, Kenneth. "Double Six," 1967. [Online]. Available: http://www.kennethsnelson.net/sculpture/small/doublesix.htm. [Accessed 17-Oct-2016].