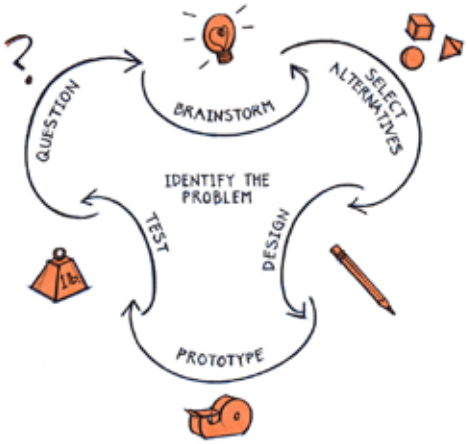
# Build:
## Tensegrity Sculpture Guidelines

THAYER SCHOOL OF ENGINEERING AT DARTMOUTH




Tensegrity structures use a combination of compression and tension to create stable, but flexible systems.

There are two parts to this building activity. Part I introduces you to tensegrity structures through building some basic models.

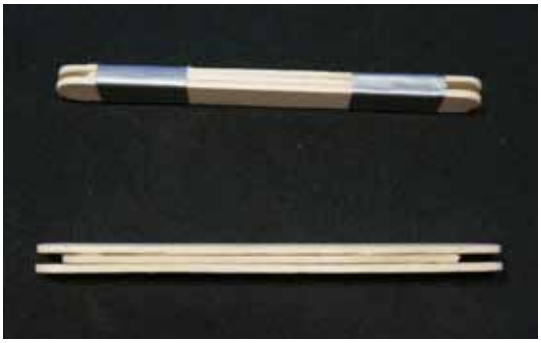
In Part II we encourage you to use the principles of tensegrity to build something of your choosing: a sculpture, a table, a chair, etc.

### Part I: Basic Tensegrity Structures

**Design Goal**: Build a 3-dowel and 6-dowel tensegrity to help you understand how the combination of tension and compression leads to a stable structure. Using the guidelines here, see if you can design and build one of your own! Think about tension and compression and how they are at play in these structures.

**Supplies**:

- 9+ wooden dowels with notches at each end: the dowels should be about 15cm long with notches that are ~1cm long cut into each end. We used a band saw to cut notches in our dowels but you should be able to carefully cut notches using a handsaw and vice. Alternatively, you can create “notched dowels” by gluing together three coffee sticks or popsicle sticks such that the outer two sticks are ~1cm longer than then inner stick.
- 9+ elastic bands; No. 33 rubber bands work well with the 15cm long dowels.
- Safety glasses or something to protect your eyes --- rubber bands under tension can and do snap sending pieces flying.

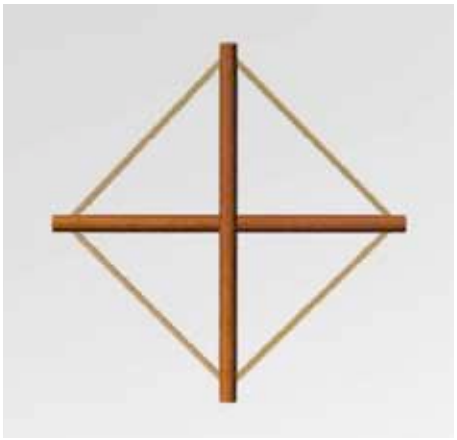


*Create “notched dowels” by gluing together coffee or popsicle sticks*

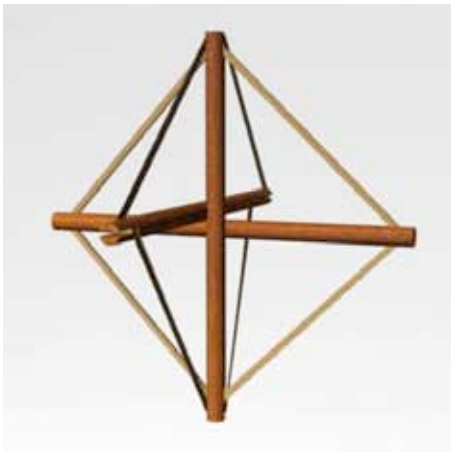
**Select Alternatives**: Be sure to select alternatives that meet your design goal. If you don't have dowels, popsicle sticks, or coffee stirrers --- what can you use that is strong enough to resist the compression in the structure and not buckle or break?

**Design and Prototype**: Below are some guidelines for creating basic tensegrity structures. Start with these basic structures and then move on to more creative designs in Part II of this building activity.

## 3-dowel Tensegrity Structure

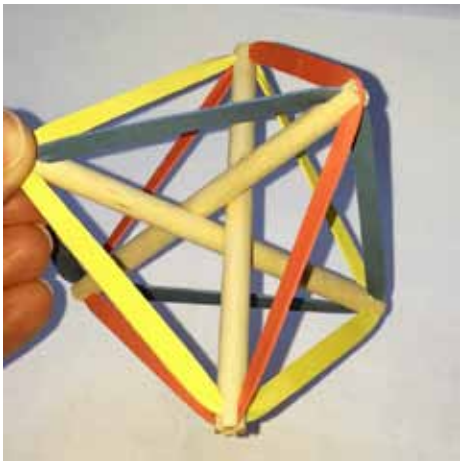


**Step one:** Place two dowels in a crossed shape (X-shape) and add one elastic band that goes around all four corners.



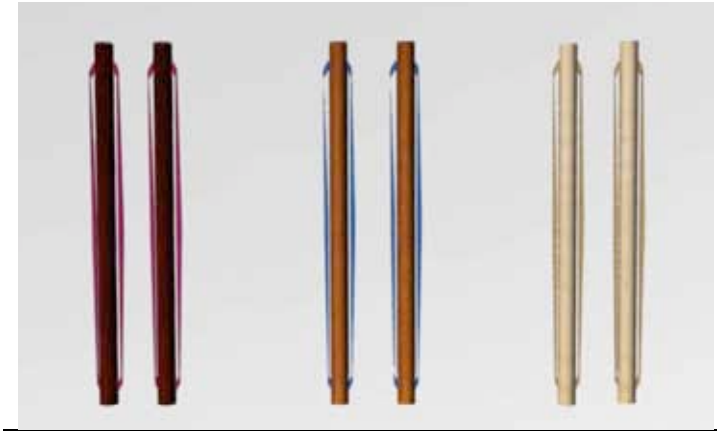
**Step two:** Place the third dowel perpendicular to the other two dowels and add an elastic band around the two ends of the new dowel and the two ends of one of the dowels in the X-position.

**Step three:** Add the last elastic band around the ends of the perpendicular dowel and the other dowel in the X-position. Each end of every dowel should have two elastic bands going through it. After putting it all together, even out the lengths of elastic bands so that the tension is evenly distributed.



**Step four:** Celebrate and show it off to your friends and family…because it's a REALLY cool structure! You can tell them how it works and why, tension and compression working together.

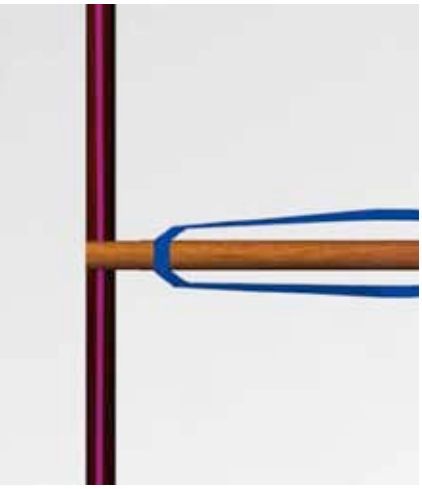
## 6-dowel Tensegrity Structure

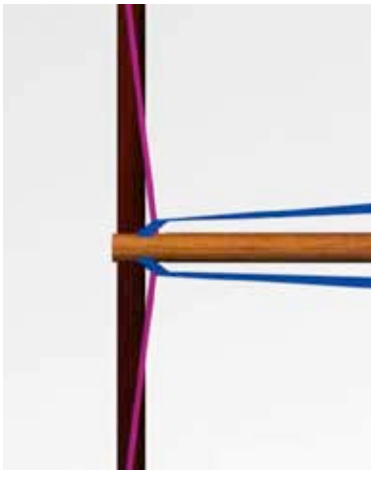


**Step one:** Put an elastic band around each of the six dowels. This will make the upcoming processes a little easier. Group the dowels into three groups, with two dowels in each group. We used three different colored bands.

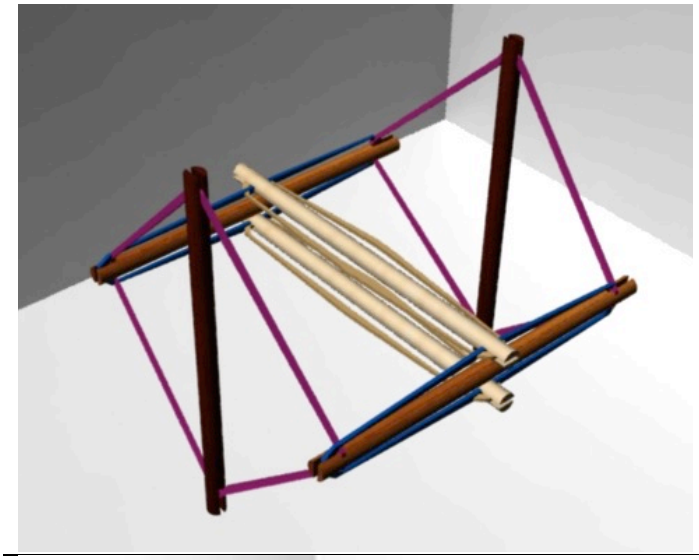
**Step two:** Place two dowels from the same group parallel to each other. Add one dowel from a different group perpendicular to and in the middle of the two dowels, so that it looks like an H.

**Step three:** Take off the elastic band from one end of the perpendicular dowel, insert the elastic band from the parallel dowels, and then close the bond by re-inserting the original elastic band. Do the same to the other end of the perpendicular dowel. This helps keep the band in place.

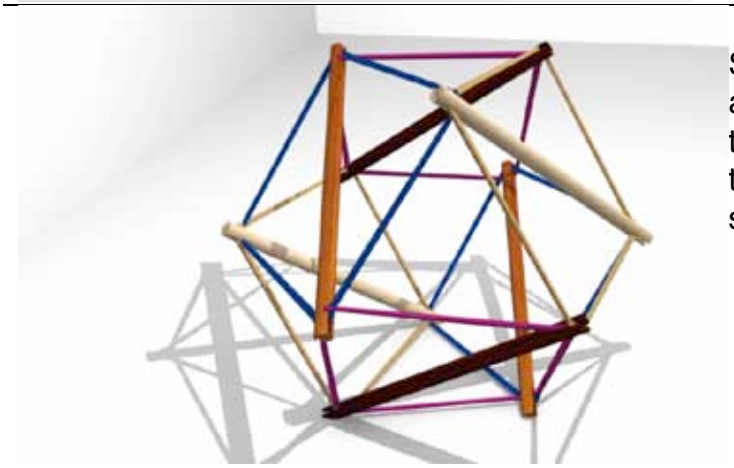




**Step four:** Flip over and repeat with the other dowel from the same group.

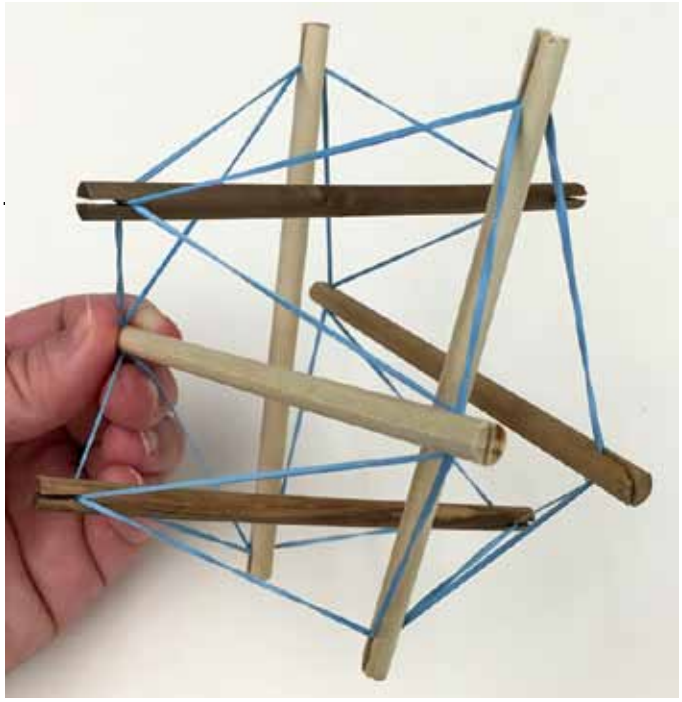


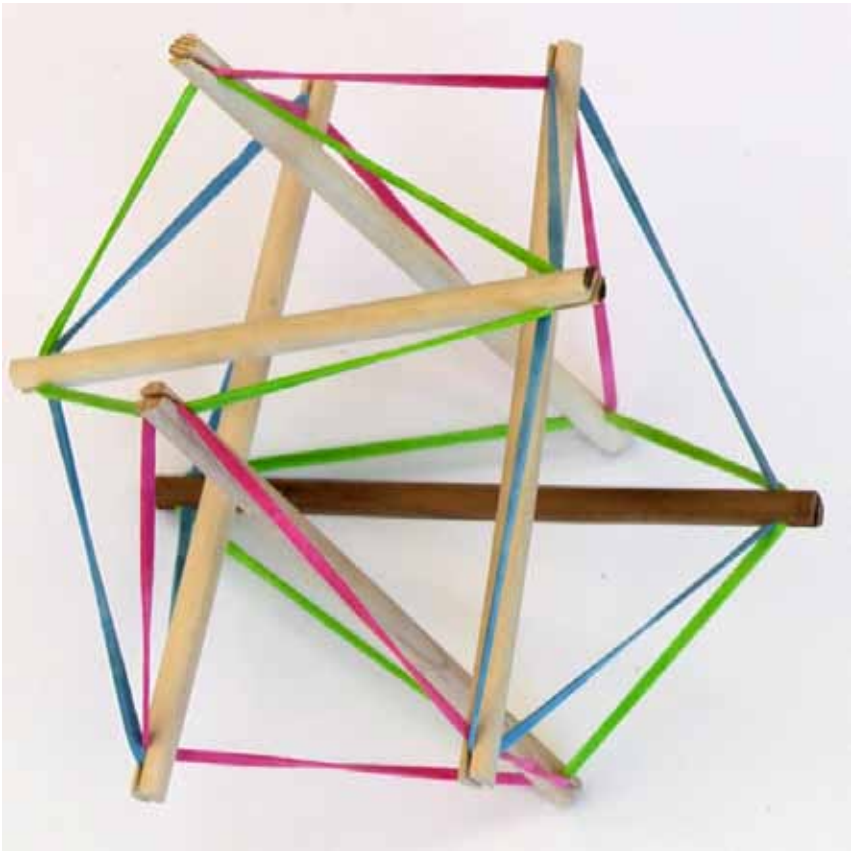
Step five: Add the last group of dowels so that they are perpendicular to all four dowels that have already been put together. Do the same as you did with the first four dowels, adding the connection in the middle of the loose elastic bands.



Step six: Add the last elastic band connection and adjust lengths in between to balance out the tension. The last step will be a little hard because there is a lot of tension and compression built up, so be careful!

Here are a few we made. The elastic bands are slightly different in how much give they have, so it was difficult to get it even. Be mindful of this in your final sculptures. Also be mindful of flying dowels and elastics when they inevitably snap on you!





Move on to designing and building a tensegrity sculpture, piece of furniture, or functional art piece!

**Tensegrity Sculpture**

**Design Goal**: Once you've built a couple of basic tensegrity structures you can go ahead and design more complex structures or structures that support loads - like Owl's tensegrity table. Decide what you want to design.

**Question**: Research different tensegrity structures. What do they have in common? What makes a tensegrity structure stable? Which designs to do you like? Why?

**Brainstorm and Select Alternatives**: Brainstorm different designs for tensegrity structures. Do your structures serve a purpose or are they sculptural?

**Design and Prototype**: Do some idea sketching on paper and try some prototyping or testing of various materials/tensions before making the full-scale sculpture.

**Test and Reflect**:


- How do the different components act in a tensegrity structure?
- Can your tensegrity structure support a load?
- What happens if you remove an elastic band from one end of a dowel?

*Here is a tensegrity chair that Professor May and her kids built! All it needs is a pillow top to be comfortable. It was tested did support a person.*