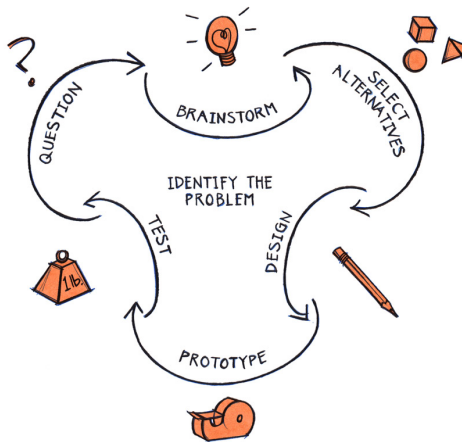


Build: Cardboard Shelf or Beam Guidelines



THAYER SCHOOL OF
ENGINEERING
AT DARTMOUTH



Design Goal: A shelf is really just a beam! Design a shelf to support books or your prototypes from this course or anything else you want to store or display. Be creative!

Supplies:

- Cardboard
- Glue, duct tape, and/or string
- Cardstock, thin cardboard, paper for small prototyping

*** Try finding “found” or recycled materials to upcycle into a new shelf!

? **Question:** : What type of supports will you use for your shelf: will you model your shelf as a simply-supported, propped cantilever, or cantilever beam? What size does your shelf need to be to support the objects you’ve selected? What will you use for the supports? Blocks of wood? Cinder blocks? Books? How will you design your shelf/beam? What shapes can you use to increase the moment of inertia?



Simply-supported



Propped cantilever

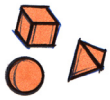


Cantilever

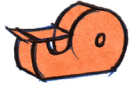


Brainstorm: Come up with LOTS of ideas. Sketch ideas and be creative.

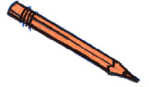




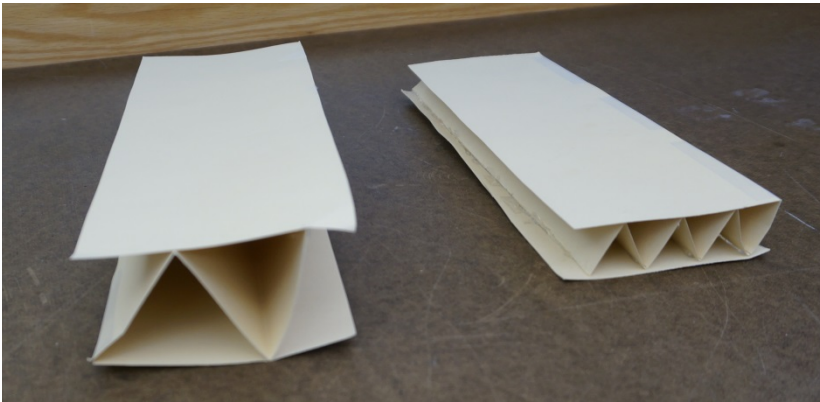
Select Alternatives: Be sure to select alternatives that meet your design goals: is your shelf large enough? Able to support enough load? Creative?



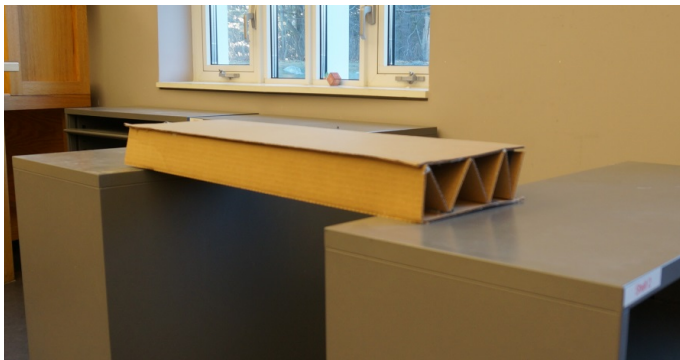
Design and Prototype: I recommend sketching and building small-scale prototypes before building your final shelf. I often use manila folders or poster board to build small-scale prototypes of my design ideas. The more time you spend experimenting and building the more successful you'll be with your final design.



Small-scale prototypes (I the prototypes to explore cross-sectional height and number of triangles):



Full-scale prototypes



Simply-Supported Beam



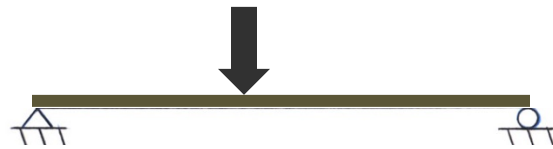
Cantilever Beam

The books at the left provide the 'fixed' connection, you could also use duct tape to create a fixed connection.

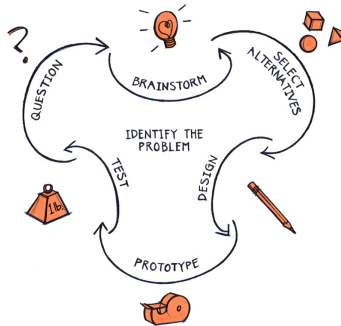


Test and Reflect: Test your design by putting objects on it. How much load can your shelf support? Is it the right size? Are the supports you selected able to support the load? Fixed connections used in cantilever beams can be tough – if you used a fixed connection, what did you do? Remember to reflect on your design: What worked? What didn't? What factors seem to affect the strength and stiffness of the shelf?

Loaded Beams (beams are loaded with books):

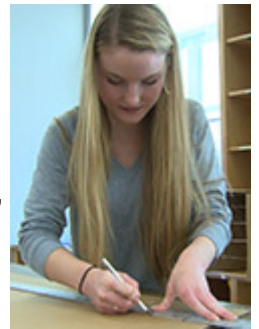


Reflect on your design: what worked? What didn't?
How might you improve your design?

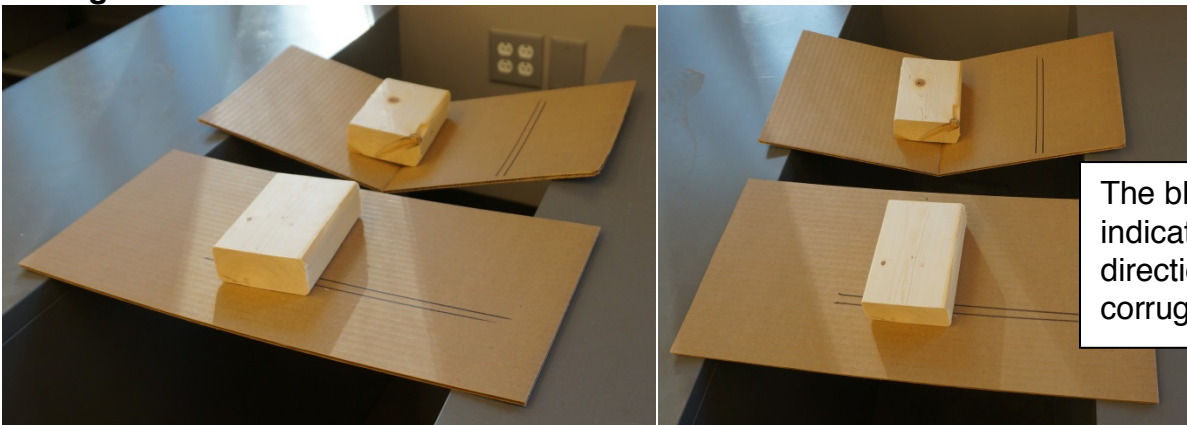


Tips for Building with Cardboard:

- Use an X-Acto knife or utility knife with a sharp blade – if you start getting rough edges when cutting, it is time to change the blade.
- Use a ruler, the wider the better, to help cut straight lines and protect your hands.
- Rather than trying to cut the cardboard all the way through on the first pass, make several passes using light pressure.
- Score cardboard by cutting only through the top layer to create bends and corners in cardboard.
- Pay attention to the orientation of the corrugations in the cardboard: cardboard can be quite strong in one direction (parallel to the corrugations) but quite weak in the other direction (perpendicular to the corrugations). Experiment a bit with pieces of cardboard to determine the stronger direction.



Corrugations:



Scoring:

