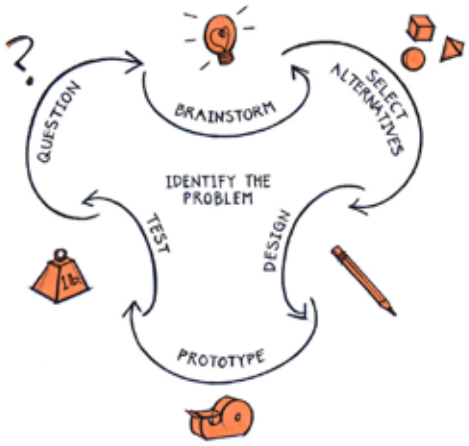
Build:
Truss Bridge Guidelines

THAYER SCHOOL OF ENGINEERING AT DARTMOUTH



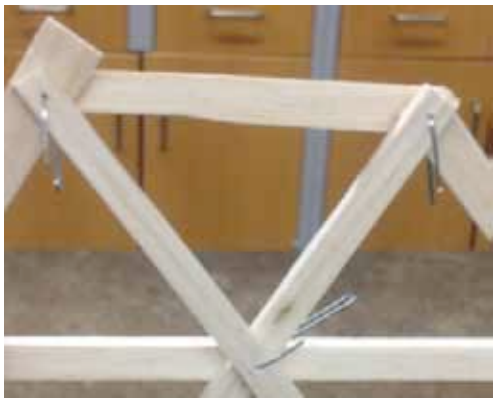
Design Goal: Design a truss bridge with the highest strength to weight ratio that is able to span at least 10 inches.

Supplies:

- Balsa wood strips: (for the design shown here we used ~250cm of 1.5cm wide balsa strips); alternatively you can use cardboard or popsicle sticks
- X Acto-knife or utility knife or scissors
- Ruler
- Marker
- Paper (4-5 sheets of regular paper)
- Glue (white glue or hot glue)
- Paper clips (10-24) [optional]
- Cardboard, foamcore, or wood for the bridge deck [optional]
- String

Question: Before you get started, you may want to investigate truss bridge designs. How are the members of trusses connected? What shapes are used?

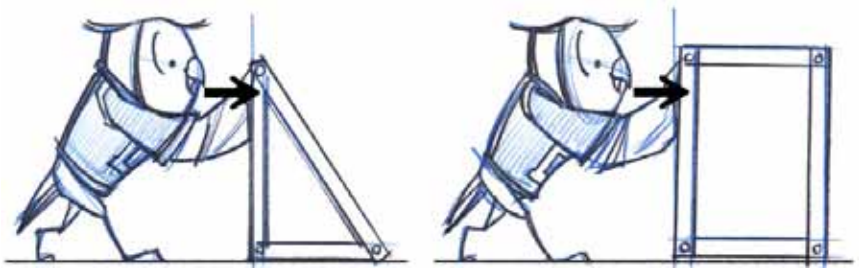
<u>Triangles versus rectangles with pinned joints:</u>



Pinned joints created using paper clips.

When analyzing truss bridges, we often refer to the connections as “pinned joints.” To better understand what a pin joint is, and why pin joints dictate the geometry of truss bridges, try this quick activity. Cut three equal sized pieces of balsa wood ~3” long. Using the tip of your exacto knife, poke a hole at either end of each piece of wood. Open up three paper clips and use the paper clips to connect the three strips into a triangle formation. Wrap the paper clips around the pieces to secure the joint. Using your fingers, test the strength of the shape. Does it feel strong? Do the sides of the triangle move? Now cut a 4th piece and poke holes in it. Undo one of the joints on the triangle and add the 4th piece so you have a square. Does this shape feel strong? Does it withstand the force or collapse?

Square or triangle?
Which is more supportive?

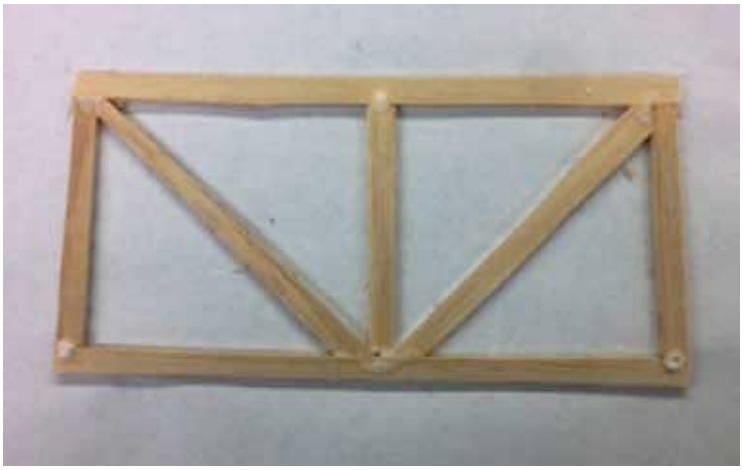


Brainstorm: There are lots of options for arranging the triangles to create trusses. Experiment with different lengths, heights, and shapes. Some trusses even have curved members!

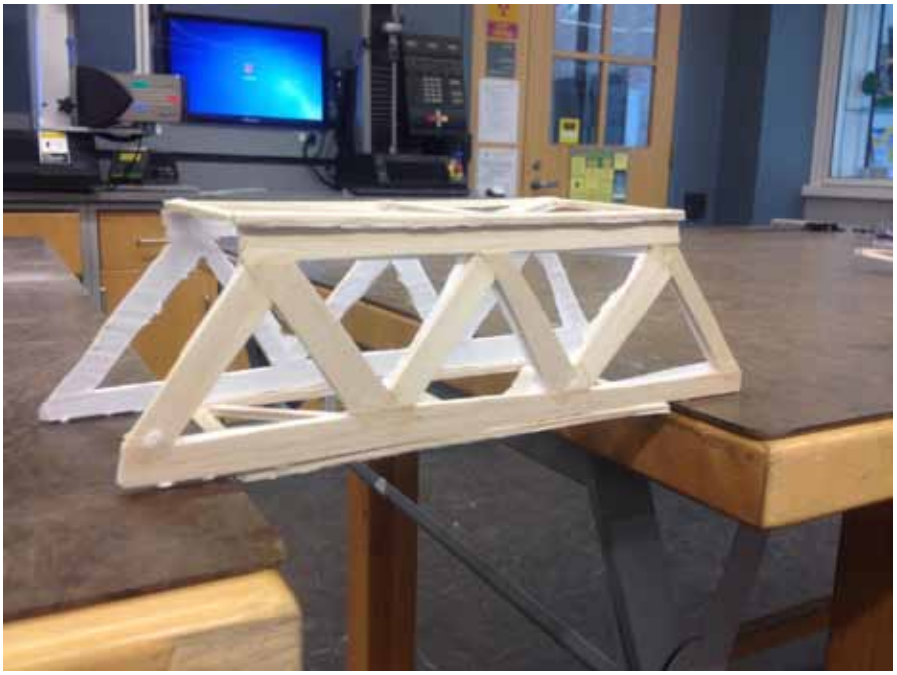
Select Alternatives: Remember you are trying to design the bridge with the highest strength to weight ratio, not necessarily the bridge that can support the most load. You want the bridge that can support a high load with the least amount of material so you'll want to use the materials efficiently.

Design and Prototype: Our final prototype is made of balsa wood but we recommend building several preliminary prototypes using paper or cardboard to test your ideas. Remember that your bridge will be three-dimensional – using triangles both vertically and horizontally will result in a stiffer and more stable bridge. You can build your truss using pinned joints using paper clips but a somewhat easier approach is to glue the individual wood pieces to a piece of paper (a gusset-type approach) as described below.

To build your bridge for testing, first sketch the truss design you wish to build. Include the necessary dimensions to span the 10 inches. Cut the longest pieces first and place them on their positions on your sketch. Cut the vertical pieces next and lay them down as well. You can accurately cut the diagonal pieces by laying the long strip in its position on the paper and marking the angle of the cuts. Once all the pieces are cut, glue the pieces onto the piece of paper in their position. Add extra glue at the joints. Leave that side to dry on the paper and build the other side. While those dry, design and construct the bottom and/or top for your bridge. Interestingly, you may want to use triangles between the two sides here too so the bridge can't sway side to side, but remember your bridge likely needs to let vehicles through.



Once each piece of the bridge has dried, cut the bridge out of the piece of paper using an X-Acto knife. Glue the two sides of your bridges to the bottom of your bridge and then glue on the top. You may want to support the sides with a mug or a brick or something to keep it vertical while the glue dries.



Once the glue dries, test your bridge - first with your hands and then try to apply weight to the bridge. Are there places it feels weak? How can you strengthen bridge? Building good connections between the truss members for your final prototype is very important.

Test and Reflect:
To test out your designs you will want to elevate the ends of the bridge using books, bricks, chairs, etc. The span is the distance between the two supports on the sides. Test your beam bridge by placing the load (bricks, books, weights, etc.) on the bridge deck or hanging them from below. Remember to weigh your bridge before you test it and calculate the strength to weight ratio (load carried at failure divided by the bridge weight).

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