Learn by Doing: Engineering Activity

Design and Build a Bridge

To build the longest, strongest, and tallest bridge out of marshmallows and raw pasta!

Details:

Design and construct a 'pasta'-bridge that can carry passengers (pennies) from one side of the 'river' to the other. The only requirements for the bridges are that they ***must span a minimum of 12 inches*** (from end to end) and they must have a ***minimum load-bearing capacity of 10 pennies***. As long as these two requirements are met, the bridge can be whatever you design!

Materials:

- 8 large marshmallow piers
- 30 small marshmallow gusset plates
- 24 linguine (flat, wide noodles) trusses and/or deck beams
- 24 spaghetti (round noodles) trusses and/or deck beams
- 2 sheets cardstock bridge deck
- 1 roll penny passengers

Designing & Building Your Bridge:

1. Decide first which aspect of the design you or your team finds most important. Do you want to build the longest bridge or the strongest bridge? Do you want to use materials sparingly and have left-over materials or do you want to incorporate everything in the design?
2. Measuring twice and cutting once is the best plan for engineers: devise a plan before you start building! Sketch out your ideas on a piece of paper, keeping your materials limitations in mind. Look at the examples of bridge shapes and designs on the following pages.
3. Think about the best process for assembling the bridge, then build it on a solid surface.
4. Once complete, use a ruler or measuring tape to carefully measure the height and length.
5. Test your bridge's load-bearing capacity by pulling two chairs together (or other things that have a flat surface some distance from the ground and are the same height as each other) and positioning them so that they have a 12-inch gap between their edges. Place your bridge between the two chairs and begin carefully placing pennies on the deck. Keep a careful count of how many pennies your bridge supports before it breaks!

Measuring Your Bridge's Success:

If you are competing with friends to see who can build the best bridge, you can score your bridge:

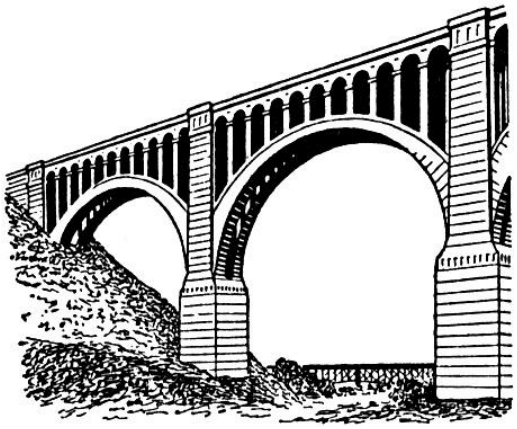
1. Length of span (4 points for each inch over 12 inches)
2. Height of bridge (2 points for each inch of height)
3. Load-bearing capacity of span (1 point for each additional 5 pennies supported, beyond the minimum of 10: 15 pennies = 1 point, 20 pennies = 2 points, 25 pennies = 3 points, etc.)
4. Material usage (2 points for each leftover material, not including the cardstock)

REMEMBER TO HAVE FUN AND GOOD LUCK!!!

Bridge the Gap

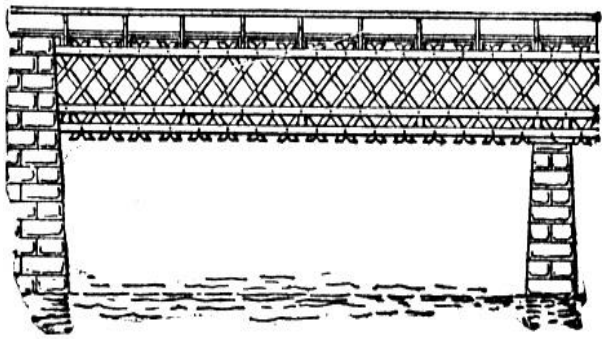
Think about the places you have been in the past month. Is it possible to get to any of these places without crossing a bridge? Much of the population in New England lives near a river, stream, or lake, and bridges were built to keep communities connected across these boundaries.

Bridges fall into three different types: **arch bridges**, **beam bridges**, and **suspension bridges**. All three have some similar features. Each has a **deck** (the horizontal surface you drive on) supported by **piers** (the vertical parts). The **span** is the distance between the piers. **Abutments** support the bridge on either side of the span and connect to the ground on either side. The type of bridge selected for a site will depend on the distance the bridge needs to cover, how much weight the bridge must support, and the natural factors (e.g., wind, earthquakes) the bridge must survive.



An arch bridge has a deck supported by an arch underneath. The arch is built from either side with a **keystone** placed at the center of the arch. The Romans were famous for creating bridges using this design. Some examples of their work still stand today. These bridges are good for shorter spans.

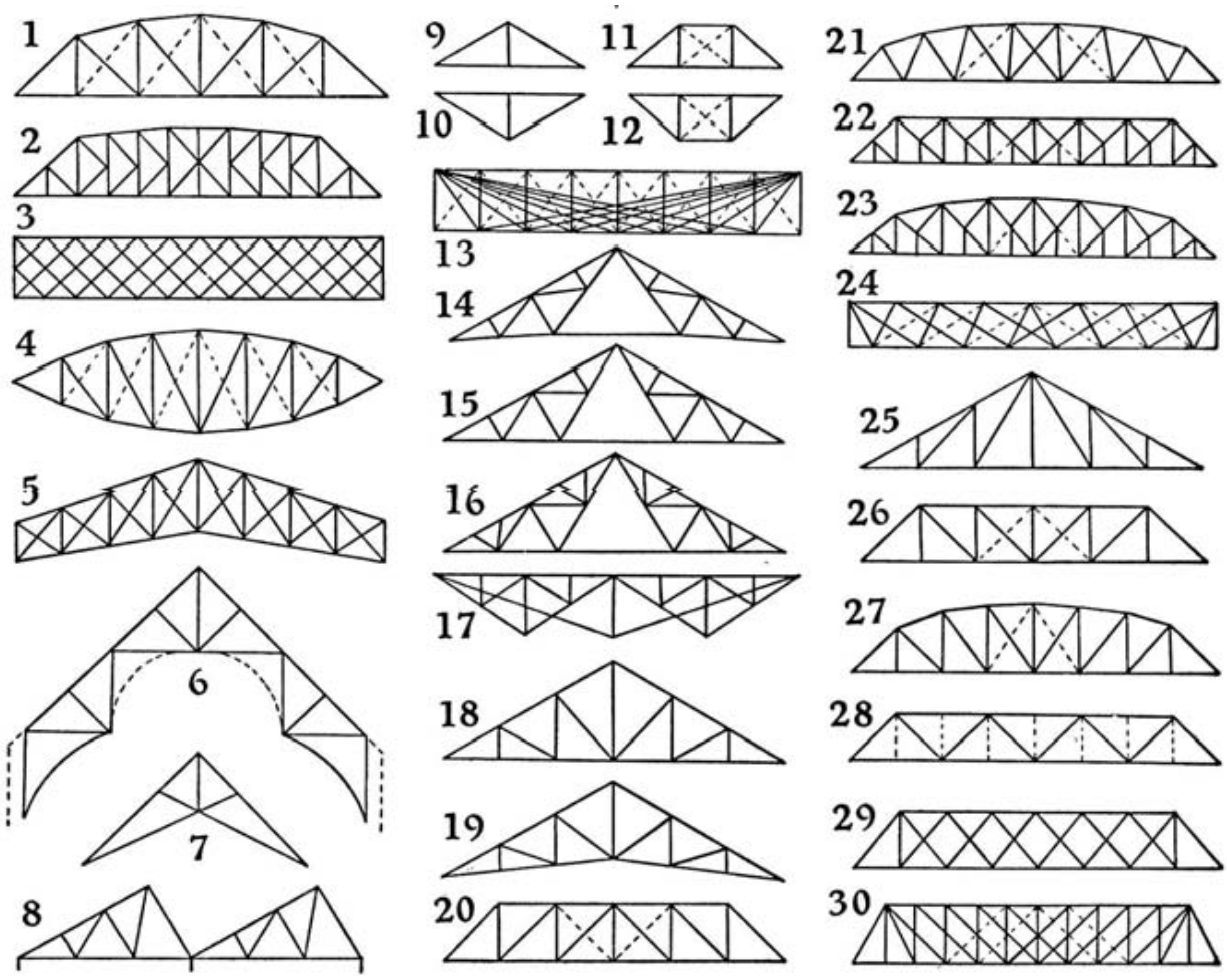
A beam bridge is a horizontal deck surface supported by piers or supports on either side of the stream. One important example of a beam bridge is a truss bridge. A **truss** is a structure made up of triangles. The triangular shape makes a truss very strong to support its weight. Historically, these trusses were made from wood and, to prevent decay, the bridge would be covered. Now, trusses are made of steel to withstand the weather.



The last type of bridge is a suspension bridge. This type has a horizontal deck suspended from cables that are connected to tall piers. These bridges can span up to 7,000 feet in length. The Incas created suspension bridges made with rope before European colonization occurred in the 1500s. More recent examples of suspension bridges include the Golden Gate Bridge (in San Francisco, CA), the Brooklyn Bridge (in New York, NY), and the Tacoma Narrows Bridge (in Tacoma, WA).

Bridges must be very strong. First, a bridge must support its own weight, called **dead weight.** It must support also vehicles and people moving over it every day. This is called the **load**. A bridge must be able to withstand the forces of tension and compression acting on it. **Tension** is the force that pulls apart or lengthens a part of the bridge, and **compression** shortens or pushes on a part of a bridge. Finally, a bridge must handle the wind, rain, or other natural forces in the area where it is located.

Truss bridges are a great place to start as you think about how to balance these competing forces and demands. Shown below are a variety of different truss styles. You might notice that all of these use triangles in their design: in building, triangles have proven to be the strongest shape because any added force is evenly spread through all three sides!



Notes:

Visit http://www.nitscheng.com/about-us/educational-offerings/introduce-a-girl-to-engineering-day for additional resources and similar event information!