Bridge Project

**Grade Level:** 4th - 6th; **Type:** Physics, Engineering

**Objective:**

This project explores the basic physics of bridges. The goal is that the student will develop an understanding through experimentation of which shapes are the most structurally strong, and that many factors are taken into account in engineering and building. The project provides a practical application of physics to a real-world context.

**Research Questions:**

- What forces act on a bridge?
- What are some of the different types of bridges?
- What are tension and torque? What do they have to do with bridges?
- Which shapes and designs are the strongest?
- How can bridges be built to deal with weather and other wear?
- What is your hypothesis for each bridge you will build? Which material and shape will work the best?

Bridges are used for pedestrians, cars, trains, etc. They must span over short or long distances and withstand the forces of nature. There are several types of bridges that are each designed for particular strengths. For example: a beam bridge can take great weight over a short distance, truss bridges take advantage of the strength of the shape of a triangle, while suspension bridges can handle torque and tension across a long distance. When engineers design a bridge they must take the many forces that will act upon the bridge into account. Through hands-on experimentation the concepts of physics inherent in bridge building become clear. This experience gives students a better understanding of a human-made structure that they encounter in cities and towns on a regular basis.

**Materials:**

Materials are readily available at a craft store and grocery stores.

- Popsicle sticks
- Toothpicks
- Spaghetti
- Hot glue gun
- Items of equal weight that can be used to test strength of bridge (i.e. cans of soup, wooden blocks, small weights, phone books)
- Notebook
- Camera (optional)

**Experimental Procedure:**

1. Draw a bridge design in your notebook. Now choose materials you will use to build several versions of your bridge. For example, you may use spaghetti, toothpicks and Popsicle sticks as suggested in the materials list. You may decide to use different materials.

2. Your three different bridges should span the same distance, so choose how long they will be.
You can set up 2 chairs to set your bridge across.

3. Using your drawing, your imagination and creativity build three different bridges of the same design and length to span across the two chairs. Please have an adult help you if you decide to use a hot glue gun!

4. In your notebook keep track of the following: How much of each material you used; what challenges you came across and hypotheses you may have about how well each bridge will work.

5. You may wish to take a photograph of your bridges before you begin to add weight, and then continue to take pictures throughout the experimentation.

6. Test each bridge by adding one “weight” at a time. Continue until the bridges break. Record how much weight each bridge could handle.

7. After you have experimented with your own creative designs, research some of the different types of bridges that people around the world have built. Choose one design that you will build out of your craft materials. For example, you might choose a truss bridge. So you will then build one truss bridge out of spaghetti, one out of toothpicks, and one out of Popsicle sticks.

8. Remember to keep track of the following once again in your notebook: How much of each material you used; what challenges you came across and hypotheses you may have about how well each bridge will work.

9. You may wish to take a photograph of your bridges before you begin to add weight, and then continue throughout the experimentation.

10. Try out your new bridges. How do these compare to your original designs? Be sure to record your results! What forces are acting on your bridge? See Figures 1 and 2 below for some ideas.

11. You may wish to build more bridges to test other forces, like tension and torque! How can you test these forces?

12. You will want to include in your project write-up whether your hypotheses were correct, why you think they were correct or not and what you would do differently if you were going to repeat your experiment in the future.

Figure 1

Image from: http://www.pbs.org/wgbh/buildingbig/bridge/susp_forces.html
Figure 2

Image from: http://www.carondelet.pvt.k12.ca.us/Family/Math/03210/page4.htm

**Terms/Concepts:** Force; Load; Pressure; Tension; Torque; Truss bridge; Arch bridge; Suspension bridge; Beam bridge; Hypothesis

**References:**

- Macaulay, David. Building Big. Sandpiper, Boston. 2004