

## Structures

We often pass over bridges and hardly observe their structures. Recent bridge designs--which often have tall columns and a triangular cable arrangement attached to the roadway--are particularly striking. Ordinary examples of compelling bridge designs include the Golden Gate bridge of San Francisco and similar suspension bridges, which also have a great appeal. Further examples include railroad bridges, built more than 100 years ago: they often have an exposed structure which is not as arresting as modern bridge designs, but nonetheless are still interesting structures to analyze. There are also the intriguing and visible structures of tall telecommunication towers. All of these have structural designs based on similar physical concepts. Building models of these types of structures can be an engaging project for middle school students.

There are a variety of materials students can use in building models of structures, such as bridges. Some curricula call for using balsa wood and glue. This approach can be time consuming and not as instructive as using other kinds of materials. In contrast, plastic drinking straws can offer some advantages. However, nowadays there is a movement to eliminate plastic straws, so recyclable straws can be used instead. If care is taken, most of these can be recycled. When constructing a bridge or tower with straws, one can test the structure in the process of building it. Pressing down on one part will show some straws bending, which indicates those straws are under compression. If a joint pulls apart, it indicates there is tension at this point. Thus, one can get a sense of how forces are acting on a model as it is being built. In the outline below, I suggest using paper clips as joiners. Using tape instead of straws limits what can be discovered when the structures are tested.

A variety of art projects can also be done with drinking straws and connectors. Simple geometric shapes can be constructed and hung from string. More elaborate sculptures could be made, such as geometric domes or mobiles. A variation on this project is to use string or elastic string as part of the sculpture. A particularly interesting sculptor who used a combination of metal tubes and cables is Kenneth Snelson. His work can be found on the internet. Students could view his sculptures and make an attempt at something similar.

## ART

### **Open Exploration**

After showing students how straws can be joined together with paper clips, they can try out some simple quick designs to get a feeling for what can be done with these materials.

### **Planned Sculpture**

Students plan ahead for either a group or individual project making a sculpture that incorporates triangular segments or triangular patterns.

### **Making Sculptures with Straws and String**

After viewing the sculptures of Kenneth Snelson, students can be challenged to make similar kinds of sculpture on a small scale.

## DESIGN ENGINEERING

### **Building a Model House**

Students can build a model house of a certain height and width. After construction, they test parts of the house by hanging a cup and adding nails until this section breaks or is about to break.

They discover that triangular arrangements give stability and strength.

### **Building a Model Bridge**

Students can build a model bridge spanning a certain distance using triangular arrangements incorporated into the overall structure. They test their bridge by placing a cardboard (cutout?) inside the model and add nails until the bridge fails.

This challenge will introduce students to concepts of tension and compression, as well as the concept of stable equilibrium. They are also introduced to the concept of truss systems.

### **Building a Model Tower**

Students are challenged to see what is the tallest tower they can build using triangular arrangements within the structure.