

## Designing, Building, and Testing the Bridges

The students should be placed in teams of two or three. Each child should receive a folder containing the pages located in the Engineering Portfolio section before the building process begins. It is highly recommended the students complete the Engineering Team Information and Engineering Worksheet 1 before they begin to design and build their bridges.

### Challenge Problem

Design and build a bridge that will hold the most amount of weight.

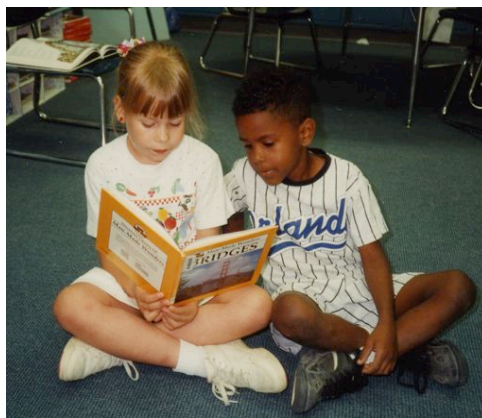


### Designing the Bridges

Teams need to decide what type of bridge they will be building. On a sheet of paper, the students should sketch and label the bridge they intend to build. The following parts need to be included in each team's design and actual bridge: *piers* and a *roadway*. Some teams may include *abutments*.



The teacher should provide plenty of books and pictures around the room to help students visualize the different types of bridges.



## The Bridge Store

It is highly recommended the teacher set up a store for students to purchase their materials. The following items are recommended for this engineering challenge. Items may be added or deleted to this list. This buying process will enhance the students' math skills immensely. (See the *Store* section for more information.)

coffee stirrers

construction paper (4" x 14" and 3" x 4")

masking tape (Give teams enough to wrap around the platform or several coffee stirrers/straws that have been placed side by side.)

modeling clay (non-drying)

straws



When teams have finished their sketches they are ready to purchase their materials. In order to make sure the students are purchasing the correct materials have them bring their sketches to the store.

This is a perfect time to enhance the students' ability to recognize coins and determine the value of mixed coins. If teams need change, have them determine the amount they should receive.



There is a store graph in the Engineering Portfolio. Each day the students should fill in their graph with the items they purchased from the store.



## Building the Bridges

The ideal amount of time for students to build each day is 30 to 45 minutes. It is recommended students have at least two weeks to design, build, evaluate, and redesign their bridges.

Each team will build their bridges in a different order. Remember, this is a discovery time for students. You need to provide the requirements and allow the students to progress with their bridges as they see fit. They definitely have an image in mind, so let them investigate with the materials.

The following information provides the teacher with an idea as to how the building process may evolve.



Piers are an important part of the bridge. They are what will hold the roadway up. Coffee stirrers, straws, and construction paper rolled into cylinder shapes create great piers. The modeling clay can be molded nicely around the coffee stirrers, straws, and construction paper to hold up the piers. It is highly suggested the teacher not allow students to use the modeling clay as piers. The bridges are too difficult to test if the piers are made solely out of the clay. The modeling clay is too strong. Therefore, the teacher may want to limit the amount of clay used to hold each pier. If a team's roadway is able to touch the clay, they need to use less clay around their pier(s).

The teacher will want to limit the amount of piers the students use under their roadway. If they have too many it is difficult to test the strength of the bridge's roadway. Nine piers are a good amount.



The piers need to be placed in rows with enough space for a "boat"/"car" to go through. The students need to realize that piers are not scattered under roadways. They do have spacing so boats/cars can pass under them. Notice the spacing the team above has between their piers.

Some teams will build high piers at first. They need to be reminded that the roadway has to touch the landmasses. Cars do not drive into space!

Some teams will discover having several pieces of coffee stirrers together will create a stronger pier. Other teams will place coffee stirrers inside the straws to provide more strength. These are excellent designs. Other students may place clay inside the straws. The teacher needs to remember that the clay is very strong and it may be difficult to bring the bridge to a “breaking” point.

The roadway needs to extend from one landmass to the other. (Please see the wooden platform pattern in this section.) Teams need to determine which materials will make the best roadway and how they can connect them together to hold the most weight.



This team is measuring the distance between the landmasses and then determining the length of a coffee stirrer. They are deciding how many coffee stirrers it will take to go across the “water”

This child is connecting two straws together to see if they will reach from landmass to landmass.



This roadway is being made with coffee stirrers.



This roadway is being made with straws.



This team has put construction paper over their pieces to create a sturdier roadway. They are using masking tape on the ends to hold their roadway securely to the wooden platform.

### **Testing the Bridges**

The teacher needs to make sure the students have plenty of time to test their bridges. The testing is critical to their success during the problem-solving process. An area should be set up. Books are the best way to measure the amount of weight each bridge holds. Before testing, one of the books needs to be weighed so students can determine the amount of weight their bridges held during the testing.



The platform needs to be placed on a desk. One team member needs to place a book on the bridge. The teacher and students need to make sure the book is not resting on the landmasses. They also need to make sure the book is balancing without assistance. If the book does not balance independently the team needs to revise their bridge. If it is balancing other books can be added.

While one team member adds the books the other team member needs to observe what is happening under the bridge. He/She needs to look at the piers and roadway carefully. He/She needs to determine what parts need to be strengthened.



The teacher wants to observe this process, also. The testing process should not take the bridges to the breaking point because then the students have to start all over again. If the piers begin to bend or a piece of the roadway touches the “water” the testing needs to stop. It is recommended the teacher have the student who is watching point out the parts that are weak. The teacher also wants to stand closely to make sure the books do not slide off and hit the students. It is best if the store and testing areas are close to one another so both can be monitored.

Students do need to document how much weight their bridges hold in their Engineering Portfolio. Make sure students bring their folders back during the testing process. If the students’ weight improves the teacher may want to pay that team some money. This will encourage teams to compare their numbers as they build and test



The final bridge testing is a destructive testing. The students' bridges will be damaged or destroyed. The teacher needs to make sure he/she has explained this to the students.

The team's bridge which holds the most amount of weight is declared the winner!

The teacher may want each student or team to receive the following checklist to assess his/her (or their) bridge.

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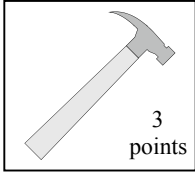
### Bridge Construction Checklist

- The roadway goes from one landmass to the other.
- The roadway does not touch the "water".
- The roadway does not have big gaps in it. A car will not fall through!
- There are not more than nine piers.
- The piers are spaced so a boat/car go can through.

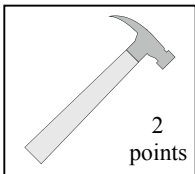
Name \_\_\_\_\_

The rubric below can be used to assess the construction of each bridge.

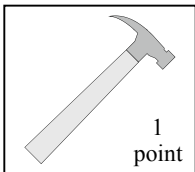
## Bridge Construction Rubric



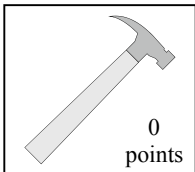
The bridge meets all the construction guidelines.



The bridge meets most of the construction guidelines.



The bridge meets some of the construction guidelines.



The bridge doesn't meet any of the construction guidelines.

## The Wooden Bridge Platform

This is half the pattern piece. The length of the platform should be 16 \_". The width should be 3 \_". The thickness of the wood should be approximately \_".

This can be the water!

Each team will need a wooden platform. Teams will build their bridges from landmass to landmass. High school technology centers, high school, or middle school technology education teachers may be able to help build these platforms. Also, many parents are more than willing to help with this endeavor!

This is a landmass. Two of these need to be cut per platform. They need to be nailed on opposite ends of each other. They are 3 \_" x 3 \_".



The first group of students who use the platforms can paint them! Have them paint the landmasses green and the water blue.