SKILLS MENU
- Identify a Problem
- Planning
- Building
- Testing
- Recording
- Evaluating
- Communicating

Bridging the Gap

In this investigation, you will build a model of bridge that will cross water. Building over water is more complicated than building over land. In addition to the normal forces acting on a bridge, other factors must be taken into account. Ships must be able to go underneath the bridge—should the main span be high, or is a mechanism that raises or moves part of the bridge the best choice (**Figure 1**)? If piers or towers are part of the design, how can they be built safely and economically in the water? There are also tides, currents, the possibility of ice damage, and even strong impacts if a ship were to collide with the bridge.

You will also measure the performance of your bridge by comparing the bridge's mass with the load it can carry.

Materials

- materials as available

Test

- mass balance
- other materials as needed

Problem

Your team has been hired to design a bridge that meets the needs of the town of Bridgeton. Bridgeton is growing rapidly and has decided to replace an old stone bridge over the canal that runs through the town. The town also plans to expand its harbour so it can handle freighters. These ships must get past the bridge to reach the harbour. Storms with high winds occur every summer in Bridgeton.

Design Brief

Design and build a model of a bridge over Bridgeton's canal (**Figure 2**) that carries two lanes of traffic and a pedestrian walkway, will withstand the dynamic loads caused by high winds and moving traffic, support the static loads created by its own weight and the weight of traffic, and allow ships to pass.

Design Criteria

- The bridge must span a 50-cm gap.
- Freighters must be able to pass safely through or under the bridge. (Use the same scale.)
- The bridge must safely withstand the loads created by high winds and by a traffic jam. You must provide an estimate of the factor of safety of the bridge.
- The bridge must be strong, but should also be as light as possible to conserve materials.

Build

1 (3A) Begin by thinking about how your design will provide a solution for Bridgeton, and how you can use the materials available.

2 (6C) Before starting to build, create a detailed diagram of your design and submit it for approval to your teacher. On your diagram, identify the loads that your bridge must support.

3 (5E) Build your bridge according to your design.

Test

4 (3F) As a class, create tests that will measure the safety of the bridges your class designs under high winds and under a traffic jam.

- Use those tests to determine if your bridge is safe. If the bridge has a structural failure, it is unsafe and must be redesigned and rebuilt.

(a) Record your observations during the tests.

(b) How could you make your bridge stronger?

SKILLS HANDBOOK: (3) Process of Design (6C) Scientific & Technical Drawing

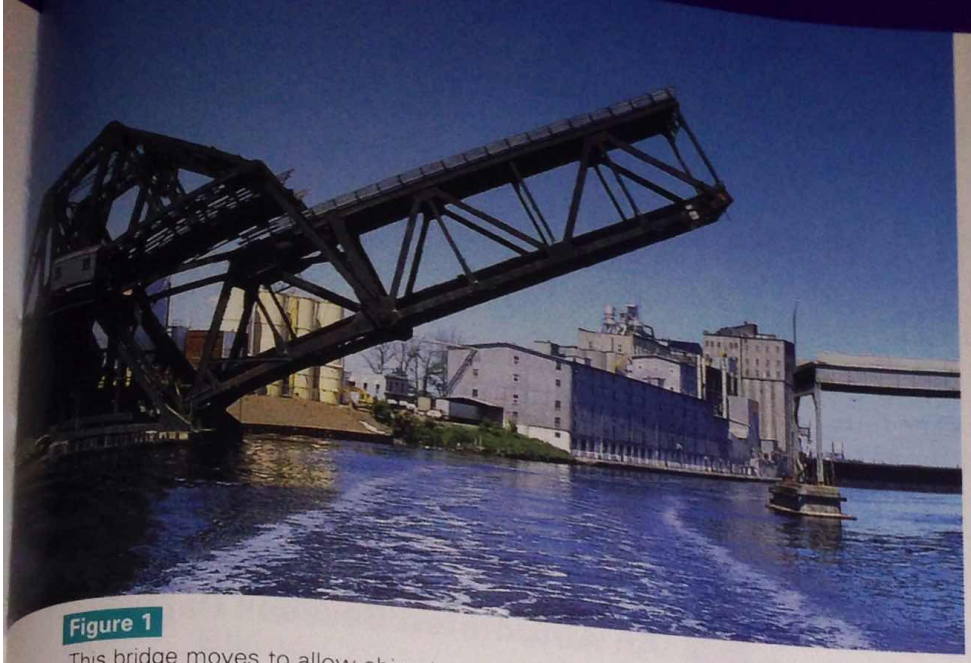

Figure 1
This bridge moves to allow ships into and out of a port on Kaministiqua River near Thunder Bay, Ontario.

Making Connections

1. You performed several tests on your bridge. What other tests would you recommend for models of a bridge before the actual bridge is constructed?

Design Challenge

What is the maximum load you expect for your chair? For your pack? Can you use the strength-to-mass ratio to improve the design of your product?

5 Create a test to study how your bridge performs when traffic is moving over it.

(a) Record your observations.

(b) How can you improve the stability of your bridge?

6 Create a test to measure the factor of safety of your bridge under a traffic jam. What is the load created by a traffic jam? What is the maximum live load the bridge can bear?

(a) Calculate and record the factor of safety of your bridge.

7 Measure the mass of your bridge. You will (5B) use the mass to calculate the performance of your bridge.

(a) Record the mass.

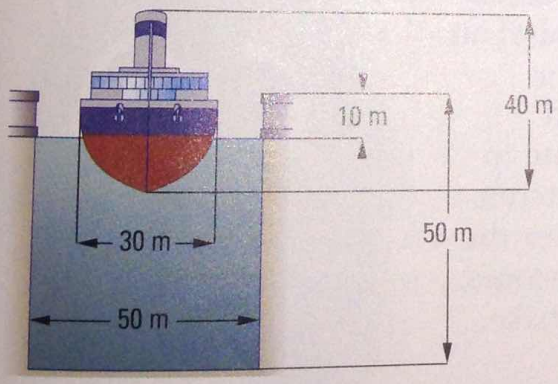

Figure 2
Your model should span 50 cm. On this scale, how large would the ship be?

Evaluate

8 Evaluate your bridge by doing the following.

(a) One way to measure the performance of your bridge is to calculate how strong your bridge is compared to its mass. A strong structure that has a small dead load is ideal. Calculate your bridge's strength-to-mass ratio.

Example:
Maximum live load: 3500 g
Mass of bridge: 1000 g
Strength-to-mass ratio: = 3500 g:1000 g
= 3.5:1

The bridge will safely support 3.5 g for every gram of its mass.

(b) Compare your bridge with your classmates' bridges. Use a chart to display the following information: structural form; material selection and use; forces; mechanisms; fastenings; factor of safety; strength-to-mass ratio. Which of the bridges do you think is the best design for the needs of Bridgeton? Explain.

(c) Using ideas from other bridges in your class and your own ideas, how would you modify your bridge to improve its strength-to-mass ratio, its factor of safety, and its stability?

(5E) Fabrication Techniques (5B) Working with Scales and Balances