Lesson Plan
Revised 6/00

Lesson #7

Uphill Swim

Grade Level: 5-6

Teachers, this is a basic lesson plan that you may modify at your discretion.

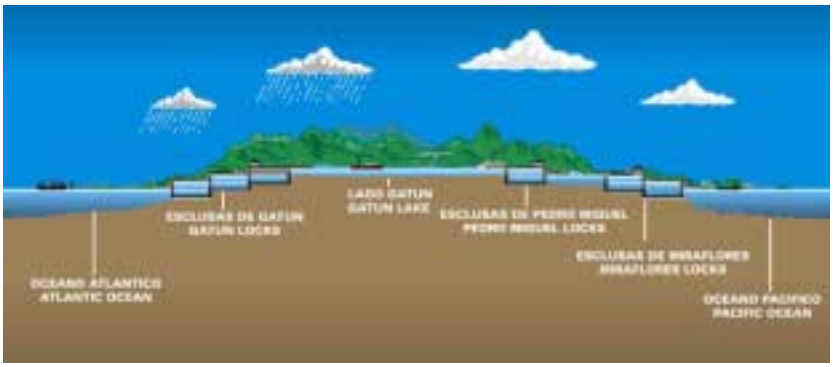
There is no video with this lesson.

Goal of this Lesson: Students will understand the concepts and engineering principles used in a canal lock system and apply those concepts to navigate a boat through a working model of a canal lock waterway.

Objectives: When this lesson is completed students should understand that: Water always flows downhill. When water levels in two separate but connected vessels are equal, water will not flow. When water levels in two separate but connected vessels are not equal, water will flow from the higher level to the lower level until equilibrium is established. The role of the civil engineer is to apply scientific principles in order to design, build, and operate facilities such as canal locks, reservoir dams, bridges, tunnels, and highways.

Materials list:

- 8 - Canal lock models
- 8 - Buckets/water containers
- 8 - Cookie sheets with 1/2 inch sides
- - Sponges
- 1 - Map of world



Cross section of the Panama Canal

Introduction:

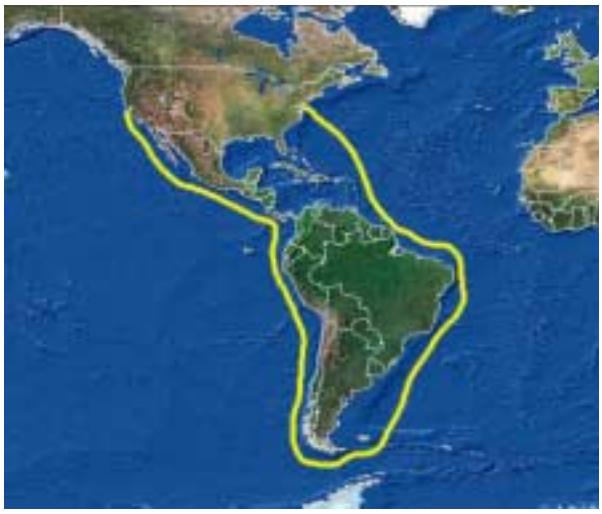
We've all heard the term "uphill battle"; less often do we hear "upstream battle". The difference between the two is that when going uphill it is possible to stop and rest without losing your position or rolling back down. When swimming against the current, if you stop your efforts, or even decrease them, you will be swept downstream. A canal lock system is one way engineers have come up with to solve the problem of making a boat float "uphill". The most well known lock system in the world is the Panama Canal.

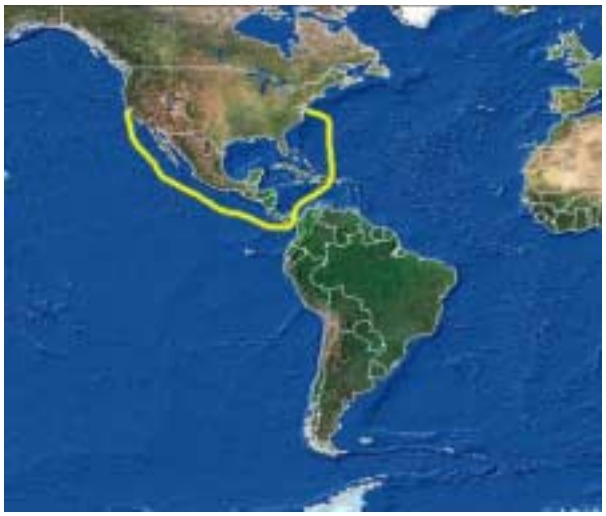
This lesson will introduce the concepts and engineering principals of a lock system and give your students a chance to try their hand at making a boat float "uphill" using a model canal lock.

Lesson activities:

Procedure:

1.Using a map (if available) or your own illustration on the chalkboard, Show students the shipping route from San Francisco to New York Harbor, circumnavigating South America. Emphasize the distance and difficulties (i.e. time, fuel, food & supplies for crew members, weather on Cape Horn, navigation hazards, etc.)encountered by traveling this route.





2. Point out that if the Isthmus of Panama were not in the way, it would save ships tremendous time and resources when traveling to the East Coast.

3. In 1534, Charles V of Spain ordered the first survey of a proposed canal route through the Isthmus of Panama. Discuss with your students the difficulties and potential problems of digging a sea-level waterway between the Atlantic and Pacific (you may also want to mention some unintended effects this might have on marine life due to the cold Pacific waters entering the warmer Atlantic, for example: the disruption of tides, increased erosion, mixing of vastly different ecosystems, etc.). It was not until 1880 that a waterway across the isthmus was started. The effort was undertaken by the French, but after 20 years of hard work, disease and finances ended their efforts.

4. One of the problems with the French plan was that they were trying to dig a trench that would connect the two oceans. The amount and type of material to be moved made this a virtually impossible feat at the time. In 1903 the United States began working on a project to create a waterway that would connect the Atlantic and Pacific Oceans. The U.S. plan involved building a canal lock system to lift boats over the mountain range that separated the two oceans. The project took ten years and 387 million dollars to complete. The Panama Canal was officially opened on August 15, 1914. In all, this 50 mile stretch of water had claimed the lives of thousands of men and cost some $639 million.

5. For this Jr. Engineering activity students will attempt to move a boat up and down a model of a canal lock very similar to the ones used in actual waterways such as the Panama Canal and Columbia River. It is highly suggested that teachers read the detailed instructions for operating the lock before conducting this activity Click here. For students, it tends to be much more exciting and engaging to let them figure out how to operate the lock system on their own. Provide them help when they need it, but avoid the temptation to tell them how it is done. Rather, help them think their decisions and the possible outcomes of their choices. For those who readily achieve the task, have them try to move two boats at the same time;one starting in lock #4 going down, and one starting in lock #1 going up (remember, only one gallon of water may be used to do this).

Achieving the Objectives:

1.*Water always flows downhill*. This idea is somewhat self-evident and axiomatic, but just in case there are those who do not believe, have them fill lock #1 and then try to fill lock #4 using the water in lock #1.

2.*When water levels in two separate but connected vessels are equal, water will not flow*. Since the water levels in this situation are at equal elevation there is no up or down hill. The water cannot move.

3.*When water levels in two separate but connected vessels are not equal, water will flow from the higher level to the lower level until equilibrium is established*. To illustrate this principle fill lock #2. Once it is full, close the inlet and drain valves, then open valve #1. Water will begin to drain from lock #2 to lock #1 until the water level in the two locks become equal (see objective #2).

4. *The role of the civil engineer is to apply scientific principles in order to design, build, and operate facilities such as canal locks, reservoir dams, bridges, tunnels, and highways*. Civil engineers work on a variety of projects that help to better our lives. The are responsible for making sure that structures and facilities are safe and usable. When it came time to build the Panama Canal, civil engineers were tasked with designing and building a system that would safely and efficiently create a shipping lane that would connect the two great seas. Details of how this was achieved can be found in the *links for additional study* section.

For detailed instructions on how to operate the Jr.Engineering lock system model refer to the online instruction at http://www.juniorengineering.usu.edu/lessons/less7a.htm.

Extension activities: Some fun and challenging math problems associated with the Panama Canal.

- How to calculate the cost for you to swim the Panama Canal (note: this is monetary cost, not physical).
- Special problems encountered when sending a submarine through the canal.

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