Whatever Floats Your Boat

A Design Challenge

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Here's a simple design challenge, based on the PBS program *Design Squad*'s "Watercraft" activity (http://pbskids.org/designsquad/parentseducators/resources/watercraft.html) that will prove engaging to most technology and engineering students.

If time is tight, your students can probably complete the activity in about 40 minutes, although it also works well in a larger time block if you have more time available. (Each of our classes was a double period of about 78 minutes.) We conducted this activity with six full classes of 6th-grade students, with classes divided into teams of four students each.

We started the activity by reading students a quote from Albert Einstein: "Imagination is more important than knowledge." We then let the students discuss the need for imagination, particularly in invention. Imagination, many students agreed, is the source of ideas. Knowledge enables the idea to take shape.

From here we moved to having co-author Harry discuss aspects of his own life as an inventor, and the influence that Thomas Edison and his work had on Harry. We built on the Einstein quote, talking about Thomas Edison and his use of creativity, imagination, and out-of-the-box thinking. The students are always intrigued by visitors who bring credence from the "real world." Harry, a real-life inventor, particularly stimulates excitement about the process of invention.

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The Challenge

In the floating boat challenge, students are to build a boat that can float and support 25 pennies for at least 10 seconds—without leaking, sinking, or tipping over. Each team has access to the following materials:

- A 10" piece of plastic wrap
- 10 plastic straws
- Four 7-ounce paper cups
- 24" of duct tape
- 25 pennies

Students do *not* have to use all of the materials in constructing their boats. They must use the materials wisely, though: there are no replacements for tangled-up duct tape or cut up paper cups. Each team receives a tub of water that they can use to test the effectiveness of their boat.

Floating the Boats

When we ran this activity, in almost all cases, in spite of our warnings about supply use, the teams first attempted rather complex designs that used most of the materials. Leakage and tipping arose as major issues. In order to solve these problems, students found their way (with some prodding by both of us) to simpler approaches.

Thinking before acting is a concept that is foreign to most students this age, and that is what was missing in their work. We took this opportunity to emphasize how important it is for engineers to plan their work and manage their resources—which we note involves skills that all employers will look for in hiring employees. Many of the teams we worked with eventually matured to the realization that straws, plastic wrap, and some duct tape are a powerful paradigm for success.

Photo 1 (above)

Photo 2 (below)

Building a raft was a solution that many students initially gravitated to (Photo 1). Students found that stability was often a major problem with that approach.

Adding paper cups to the mix

offered a different path to success that other teams explored. Here we saw team approaches that used two cups linked in various ways, ranging from a canoe-like structure (Photo 2) to one that depended on the power of air (Photo 3). As you might expect, the Photo 2 approach heavily depended upon getting a good water seal between the cups!

An interesting and very stable three-cup solution was fielded by one of the teams (Photo 4). Other students opted for the unusual configuration shown in Photo 5, a four cup flexible floater.

Once students had success in floating a boat, we further challenged them to try to cut down on the materials they used. Success with fewer materials was more difficult, however, and depended a lot on the team's persistence. Here we discussed again Thomas Edison's famous quote about "10,000 ways that don't work" as related to his storage battery experiments and his long, hard struggle to find a durable light bulb filament that worked. One team found its way to reduce materials by cutting down the height of the cups, while holding onto the raft structure (Photo 6).

Photo 3 (above)

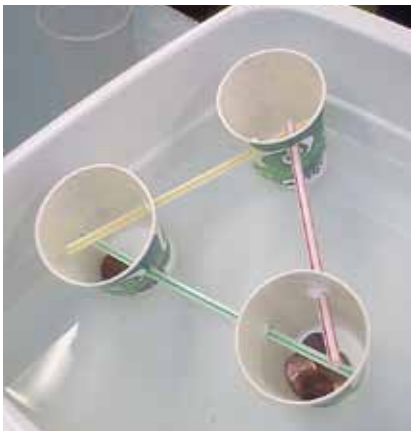

Photo 4 (right)

Photo 5 (below)

Photo 6 (below right)

The Students' Take

By the end of the activity, almost every team had some level of success. A survey of students' reactions to the activity revealed some insightful thinking:

"Making the boat was possible, but making it out of less materials for a second try was not so easy. This reinforced the concept of planning first and thinking like an engineer."

"The activity was fun and interesting as the team members had to learn to communicate and work together. Sometimes this is not easy!"

"It must have been hard for Thomas Edison to keep experimenting day after day to make something like the light bulb filament. Failure is part of the path to success, but staying on the path takes persistence and determination."

All of the students said that they would welcome more challenges of this type.

Additional Activity

A number of enterprising students added that they had some invention ideas and were interested in seeing where they could learn more about patents. On this topic, some possible sites your students might check out are:

www.uspto.gov
www.google.com/patents
www.freepatentsonline.com/

You can show them how to conduct simple patent searches via search terms. Patent searches are an art form, very dependent on the descriptors used for the search. Students might try using intuitive search terms to describe their ideas to see what patents pop up and what previous work may already have been done in that area. For example, if a student has an idea for using robots to clean large tanks filled with liquids, some initial search terms might be: "underwater robots;" "cleaning robots;" and "submersible robots."

Based on the enthusiasm that this challenge generated, we are planning to organize an after-school "inventors club" for interested students. We will start with brainstorming design challenges to stimulate outside-the-box thinking, then will progress so that interested students can take their raw ideas and learn how to transform them into plans, keep an inventor's notebook, and perhaps mock-up some prototypes. TD

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