Portable Regatta

Teaching Elementary Fluid Dynamics

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Introduction

This proposal is intended to satisfy the need for a portable teaching aid, to help elementary or junior high school age students learn about engineering. It must engage the students in an entertaining learning activity, while still managing to teach something meaningful. Our device teaches students problem solving and optimization skills, as well as elementary fluid dynamics, such as conservation of mass flow rate. We also make good use of rapid design and rapid prototyping technologies, and perhaps the students can learn from this as well.

Problem

Students today do not begin to learn about engineering (as opposed to science) until they enter college. While not everyone will be an engineer, some basic background knowledge in problem solving can benefit everyone. Although theoretical exercises are critical in the learning process, a hands-on approach is an excellent teaching aid. Unfortunately it is not always accessible to have this hands-on experience due to complications beyond control, such as bulky or expensive equipment.

Objectives

The RFP is for a portable device that can be transported easily in a compact car, and can allow a visiting engineer or professional teacher to give a lesson allowing hands-on activity and keep the students engaged in the classroom activity. This device, if used properly, hopefully will motivate a new generation of students to seek out careers in engineering, or even if they are not interested in such a career, to broaden their horizons.

Solution

We are developing a device that can be transported from school to school and used in a relatively short amount of time (one class period – about an hour). This device will teach students engineering, while at the same time entertain them.

Our device consists of an inclined plane, with removable sections allowing two streambeds to be created. These removable sections have varying shapes and sizes, each one allowing a different maximum flow rate, and providing a different stay time within the section. Water is poured into the top of the streambed, and then runs down. Students will race small boats down the streambeds, which will provide a visual indication of the flow rate.

The structure of the inclined plane will be made out of wood. The actual "sockets," where the inserts go, will be made out of blue-foam for waterproofing reasons. The inserts themselves will be constructed with the fused deposition rapid prototyping process. This process forms several thin layers of plastic and then builds a shape out of these layers. This technology allows for easy manufacture and results in a waterproof product with close structural tolerances.

A pump and motor will be fitted for automatic operation. However, for much lower costs and increased durability, a jug can be used to pour the water into the top of the streambed and collect the water at the bottom.

In the classroom setting, the activity will include a handout containing a brief introduction to the fundamentals of fluid dynamics. Basics such as

flowrate = velocity x cross-section

will be introduced and explained by the teacher. After this activity, the class will divide up into teams of five students. Each student will pick an insert to use, and the group, as a whole will decide upon the order. In a single-elimination format, the groups will compete head-to-head with the first boat to reach the bottom advancing. Eventually, a single group will emerge victorious and be awarded a prize. Depending on the age or maturity level of the class, everyone else can be given prizes as well.

Plan

The following tasks must be completed by the final deadline.

Proof of Concept – Done!
CAD Layout of inserts
Production of inserts
Detailed design of structure
Final assembly and test

The CAD layouts of the inserts must be completed by Wednesday, April 15th, to allow for the turn-around time for the shape-deposition process. Mike & Jake will do these. The wooden frame must be completed by April 26th, which will also be built by Mike. The lesson plan will be written by Christine and will be completed by the 26th. Everything must be assembled by the group as a whole and tested before April 28th.

Budget

Water – zero cost
Blue Foam – zero cost
Pump - $25
Wood - $15
Hardware - $20
Rapid Prototyping Parts –???

Diagram