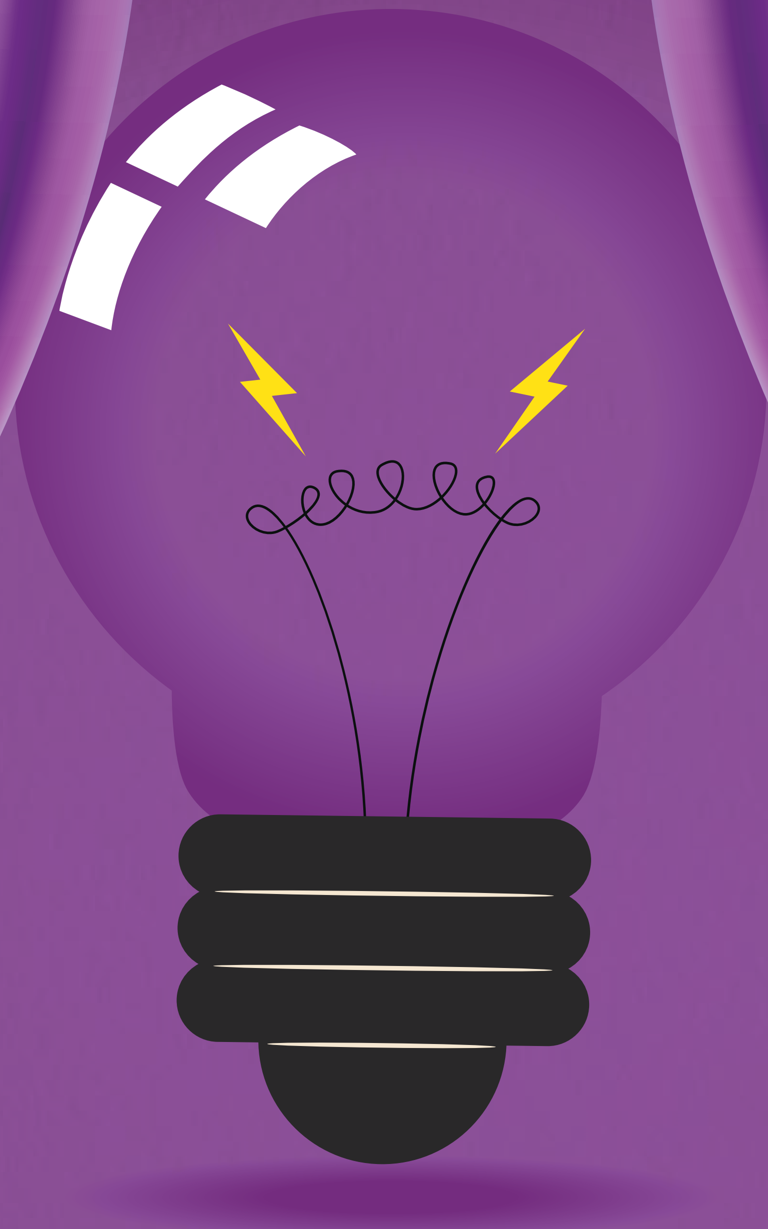

SCIENCE FAIR WARM-UP

» LEARNING THE PRACTICE OF SCIENTISTS «

Grades 8–12

JOHN HAYSOM

NSTA press
National Science Teachers Association

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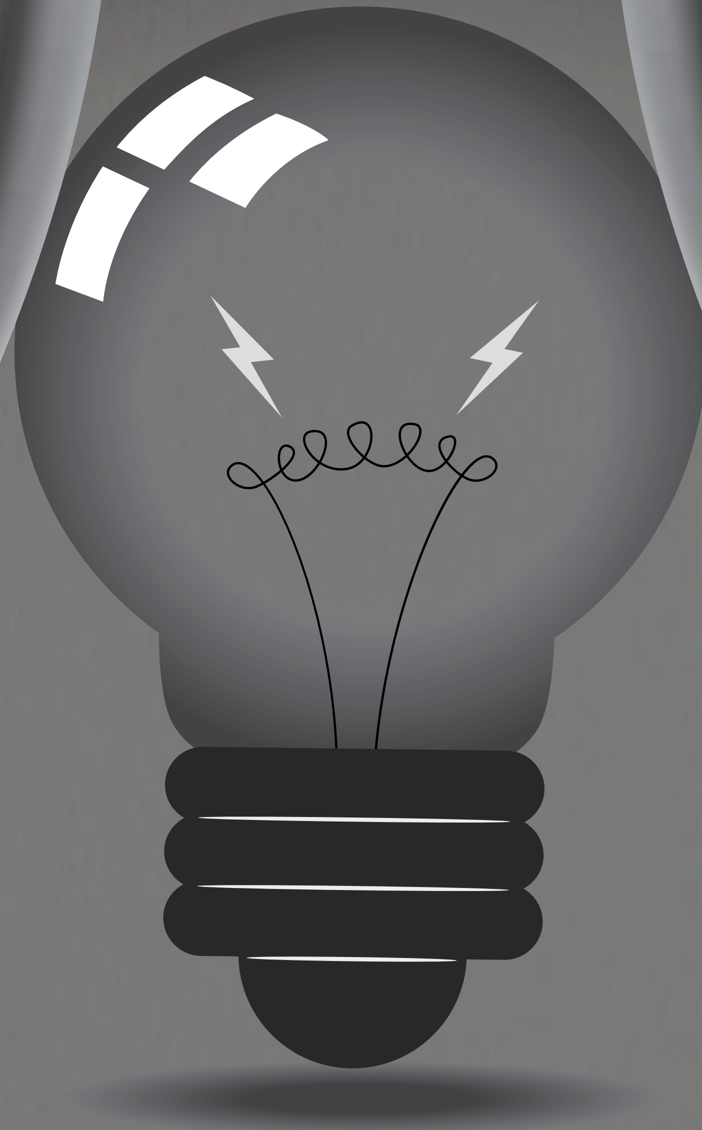

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Contents

LET'S GET STARTED! WHICH PROJECT SHOULD WE CHOOSE?
HOW 'BOUT THE ONE ON NAILS?— YOU LIKE WOODWORKING TOO.

I'LL BET THIS NAIL HOLDS BETTER THAN THE LAST ONE.
I'LL MEASURE IT.

Contents


THIS SIMPLE APPARATUS WORKS GREAT!
YES, BUT DOES IT ALWAYS GIVE THE SAME RESULT?

Be Safe!

As you embark on your science fair adventure, some of the steps and activities will be new to you. Keep yourself and your classmates safe by studying this list of safety precautions.

1. Do not touch animals unless instructed to do so by your teacher. Otherwise, you should stick to observing them.
2. Use caution when working with sharp objects such as scissors, razor blades, electrical wire ends, knives, and glass slides. These items can be sharp and may cut or puncture skin.
3. Wear protective gloves and vinyl aprons when handling animals or working with hazardous chemicals.
4. Wear indirectly vented chemical-splash goggles when working with liquids such as hazardous chemicals. When working with solids such as soil, metersticks, and glassware, safety glasses or goggles can be worn.
5. Always wear closed-toe shoes or sneakers in lieu of sandals or flip-flops.
6. Do not eat or drink anything when working in the classroom or laboratory.
7. Wash hands with soap and water after doing activities dealing with hazardous chemicals, soil, biologicals (animals, plants, etc.), or other materials.
8. Use caution when working with clay. Dry or powdered clay contains a hazardous substance called silica. Only work around and clean up wet clay.
9. When twirling objects around the body on a cord or string, make sure fragile materials and other occupants are out of the object's path.
10. Use only non-mercury-type thermometers or electronic temperature sensors.
11. When heating or burning materials or creating flammable vapors, make sure the ventilation system can accommodate the hazard. Otherwise, use a fume hood.
12. Select only pesticide-free soil, which is available commercially for plant labs and activities.
13. Many seeds have been exposed to pesticides and fungicides. Wear gloves and wash hands with soap and water after any activity involving seeds.
14. Never use spirit or alcohol burners or propane torches as heat sources. They are too dangerous.
15. Use caution when working with insects. Some students are allergic to certain insects. Some insects carry harmful bacteria, viruses, and other potential hazards. Wear personal protective equipment, including gloves.
16. Immediately wipe up any liquid spills on the floor—they are slip-and-fall hazards.

Chapter 5:

Variables and Their Controls

***ISOLATING VARIABLES: REDUCING COMPLEXITY

The Best Design for the Hull of a Racing Dinghy

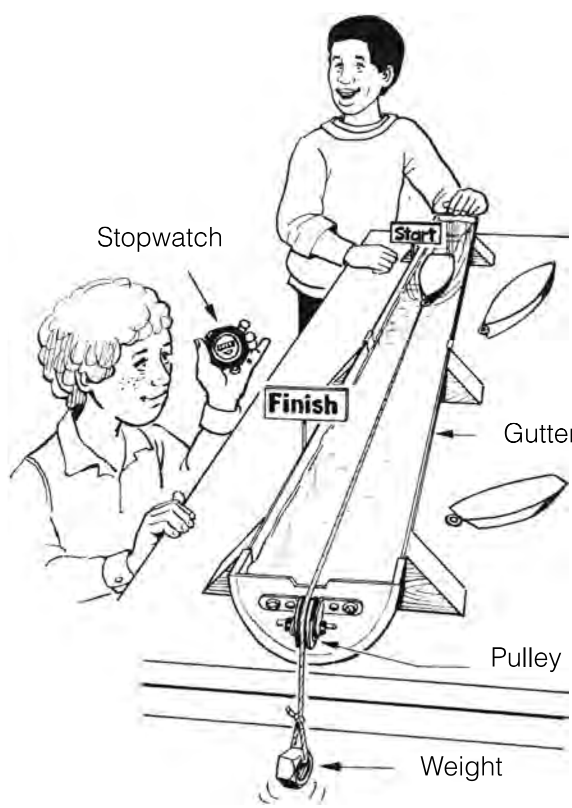
Terry and Tom were sailing fanatics. Their ambition was to design and build their own racing dinghy. Right now, they were concerned about hull designs and producing the most hydrodynamic shape—the shape that minimized water resistance. They decided to investigate. They had been warned that this would not be an easy task, but they did not give up!

The breakthrough came when Terry had a brilliant idea for testing the effect of different shapes. "We could make a tank out of gutter and pull along model boats with a weight," Terry suggested.

"And we could time how long it takes to go from one end to the other," Tom added.

"Then we could try out all sorts of shapes," Terry said.

This was indeed a breakthrough. The apparatus worked beautifully. But designing the apparatus was just the beginning. The challenge now was to plan a series of experiments to find out all they could about the effects of shape on water resistance or drag.



Your Task

Put yourselves in Terry's and Tom's shoes. What experiments would you do? Get together with one or two friends and design a series of experiments.

Chapter 5

How Scientists Approach Challenging Problems

Determining the best hull design is a challenging problem. How might scientists go about designing a hull that minimizes water resistance?

Scientists proceed systematically. Drawing on their experience, they would probably begin by trying to make a list of all the factors (variables) that could possibly affect the speed at which the boat travels, such as the following:

- Weight of the boat
- Length of the boat
- Angle of the bow
- Height of the waterline (how much of the boat is in the water)
- Seawater or freshwater
- Smoothness of the surface

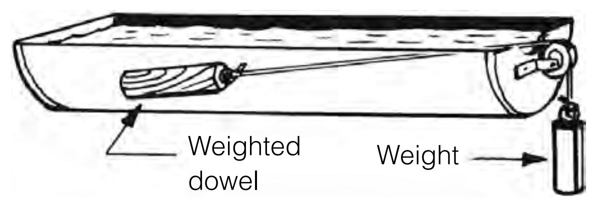
Can you identify any more? You likely could identify as many as 10 variables that might make a difference as to how fast the boat travels.

It's evidently a complicated problem—complicated in at least two ways:

a. There are many variables. Scientists would probably try to reduce the number of variables by working first with simple shapes in artificial situations. Once they have understood how simple shapes behave, they would then be in a better position to tackle more difficult problems.

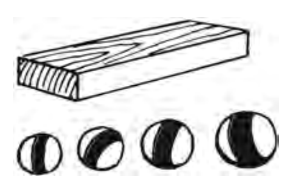
b. Some of the variables are connected to one another. For example, the length of the boat and the angle of the bow are related to one another. If at all possible, scientists would like to study the effects of each separately. *Can you identify any other variables that are connected to one another? Are there any at all that are separate from others?*

Take a look at the test rig in the picture. It shows a length of completely submerged (weighted) dowel rod being towed through the water. Scientists may well find experimenting with this rig to be an attractive idea. It offers the opportunity to control many of the variables. Then follow these steps:



1. Refer back to your original list of variables and tick those that are possible to control.
2. Which variables can you vary systematically?
3. Design a set of experiments that allows you to investigate the effects of manipulating just one variable. Be careful to control any other variables that might have an effect.

Now consider these questions: What next? What about the other variables in your initial list? Are there any other simple shapes worth testing? *What would be the value of experimenting with shapes such as those shown in the picture?*

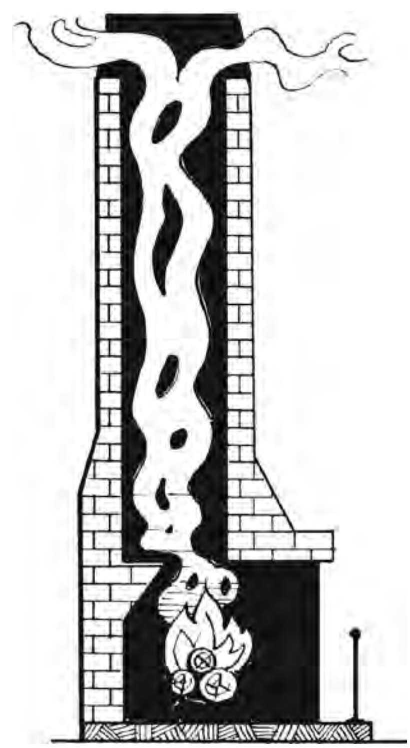


What next? Slowly, persistently, and systematically, the scientists would edge toward a greater understanding of the way shapes move through water. It is a task that involves clear thinking about variables and imaginative thinking about the design of experiments that will enable the effects of an isolated variable to be studied.

Back to the Project

1. *The Perfect Coffee Filter:* Two young scientists had given themselves the task of improving the design of the coffee filter. How do you suggest they should proceed?

2. *Smoking Chimneys:* Refer to Starting Point 12. Now examine the design of the chimney shown in cross section in the picture. What factors might influence the airflow up the chimney? How does the apparatus design shown in Starting Point 12 reduce the complexity? Do you have any suggestions about how to improve the apparatus? What experiments would you carry out?



Index

Index

Index

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Even science fair enthusiasts may dread grappling with these two questions:

1. How can you organize many students doing many different projects at the same time?
2. How can you help students while giving them the freedom of choice and independence of thought that characterize genuine inquiry?

Answer these questions—and face science fairs without fear—with the help of the *Science Fair Warm-Up* series. To help you meet your teaching goals, the series is based on the constructivist view that makes students responsible for their own learning, aligns with national standards, and addresses the *Framework for K–12 Science Education*.

This book, for grades 8–12, further develops the ideas about the practices of scientists that were introduced in the first two books. In addition, many of the problems students will encounter are very challenging, so much so that the problems have been used with both grade 8 students and university science graduates in field testing. In addition to offering original investigations, the book provides problem-solving exercises to let students hone the inquiry skills to carry projects through independently.

Science Fair Warm-Up will prepare both you and your students for science fair success. But even if you don't have a science fair in your future, the material can make your students more proficient with scientific research.

"An exciting publication that engages students and fills a need for innovative and conscientious teachers. Students and teachers are likely to encounter real science with the ideas, approaches, and questions the materials encourage." —Robert Yager, Professor Emeritus at the University of Iowa and past president of NSTA

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