Lesson 5

Saving Humpty Dumpty, Part I

FOCUS

For students to construct a sports surface (playground fall protection) from recycled shoe materials to see what effect the new mix and the old materials have on shock absorption and energy return.

CONCEPTS

- Materials have different properties and vary in their abilities to absorb forces or return energy.
- The materials used to make athletic shoes can be reused to make other useful products that take advantage of the material's abilities to absorb forces or return energy.
- The structure and concentration (density) of matter determine how it can be used.
- Products undergo scientific testing to determine how to reuse and recycle them.

LEARNING OBJECTIVES

Students

- use recycled shoe materials to create a model of a sports surface (playground fall protection)
- conduct an experiment to modify the shock absorption capacity of a sports surface, and
- predict how that capacity will be affected by the materials (and proportions of materials) used to make the model.

PREP TIME:

15 MIN. Gather lab materials into "sets," 1 per group

10 MIN. Set up teacher demonstration (see illustration)

5 MIN. Make copies of lab report worksheets

Note to teachers: There is enough Nike Grind in the kit for five teams to make recipes.

CLASS TIME: 45 MIN.

Teacher Tip

Collect empty water jugs early (1 per group of 4-5 students). Because the completed "playground fall protection" material takes 24-48 hours to dry, students will make both the basic sports surface and the "experimental sports surface" in this lesson to save time. Try to have a sink and/or countertop areas (or place desks together to create "counter" space) for separating and mixing materials.

Divide students into cooperative learning groups. One team will make the basic recipe, and others will make an experimental sports surface (see suggested recipes or have students design their own).

You may want to have students define and work with the terms "shock absorption," "cushioning," and "energy return" by using the examples of their athletic shoes. Why are some shoes made with more cushioning than others? (*One example:* David Robinson of the San Antonio Spurs needs more cushioning than Gary Payton, point guard for the Seattle Supersonics, because Robinson is bigger and lands harder.) Why is the cushioning distributed differently in running shoes than in cross-trainers, for example?

Subject Areas:

Science

Math

Skills:

Following directions, measuring, working with variables, hypothesizing

Key Vocabulary:

Shock absorption/cushioning, resilience/energy return, potential energy, kinetic energy, drop height (the height above the surface from which the test object is released).

Materials:

See following page.

Materials:

One group will make the basic recipe (and function as the "control" group), and the other groups will make the experimental surface. You will need:

Copies of lab report worksheets (see end of lesson) and graph paper for data tables and data graphs

Basic recipe for playground fall protection (for control group)

Ingredients:

2.5 cups foam granules
2.5 cups rubber granules
1 (one) 5-oz. jar non-toxic glue (such as Rite Aid School Glue)

Tools:

1 bottom half of 1-gal. water jug, cut just below the handle)
1 large spoon or paint stirrer
1 measuring cup
1 spatula

Suggestions for Experimental Surfaces

Ingredients:

- Have foam, upper fabric, and rubber available for students to mix in whatever combinations they decide, based on what they think the intended effect is.

Suggested variations on basic recipe:

- 2:2:1 40% foam (2 cups), 40% rubber (2 cups), 20% upper fabric (1 cup)
- 3:2 60% foam (3 cups), 40% rubber (2 cups)
- 2:3 40% foam (2 cups), 60% rubber (3 cups)
- 7:3 70% foam (3.5 cups), 30% rubber (1.5 cups)
- Less material 50% foam (2 cups), 50% rubber (2 cups)
- Nontoxic glue (such as Rite Aid School Glue)

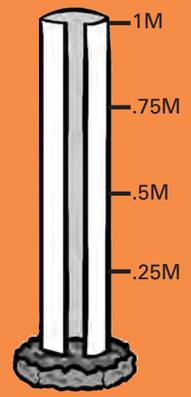
Tools: (same as above)

Materials for teacher demonstration

- Demo square of playground fall protection (provided in kit)
- A hard surface such as a desktop or floor
- 4 eggs (hard-boiled, no cracks)
- Two 1-meter measuring sticks or 2-meter tape measure (or 10'-12' tape measure)
- A strip of posterboard at least .5 meter tall x .5 meter wide to roll into a tube (instructions below; see illustration)
- Nike Reuse-A-Shoe Video

If you choose to use the open tubing (big enough to put a hand in), here's how to make it:

1. Cut poster board .5 meter tall and .5 meter wide.
2. Mark the poster from top to bottom in .25 meter increments, extending the lines from left edge to right edge.
3. Roll poster into an open tube, with markings on inside.
4. Connect the vertical edges of the tube from top to bottom with transparent packing tape, such that the packing tape provides a "window" through which to see the markings).



background

Some shoe manufacturers have found ways to recycle or downcycle their products. Nike downcycles athletic shoes from two sources:

- consumers who drop off their old, worn-out athletic shoes for recycling at retailers and groups participating in Reuse-A-Shoe Program;
- defective returns.

Downcycling athletic shoes is a four-step separation process:

1. Metal detectors separate any metal from the shoe.
2. A slicer separates the upper fabric, the midsole foam, and the outsole rubber.
3. Each component is then shredded in a granulator.
4. Midsole foam and outsole rubber pass to a sink-float water tank for separation. The heavier density of outsole rubber makes it sink, while the lighter density of midsole foam makes it float.

The shredded materials are now as close to their virgin state as possible, and the rubber and foam still retain some of their original properties of shock absorption and cushioning. Companies can use these materials to their advantage by making other sports products and surfaces with these features.

Discoveries that result in new uses for old products often happen when inventors share information about each other's work. For example, when Nike sent its ground-up shoe materials to a lab for testing, it was found that the material, when incorporated into a rubber surface, could provide equal or better performance or resilience than existing sports surfaces.

background

(Interview with Bill Malloch, 7/15/97.) Today, Nike is involved in producing basketball and tennis courts; soccer, football, and baseball fields; and tracks and playgrounds.

Discoveries also occur by testing ideas using controlled variables. This lesson asks students to

- create a sports surface with cushioning properties and
- test the surface to determine its cushioning properties.

The demonstration for this lesson models the experiment in the next lesson.

WITHOUT NATURE, THERE ARE NO DESIGN CRITERIA

The more one understands, the better one can design. Deep understanding leads to innovation, and projects can be driven by these new ideas. If a product is designed with nature in mind, there are no limitations: without taking nature into account, there are no design criteria.

For example, today's lesson demonstrates that an egg will drop due to gravity, and the egg, because of its fragile surface, is prone to breakage. Gravity and the egg's fragility provide the design criteria: we want to design a surface that will cushion the egg and prevent it from breaking. (***Source:*** Conversation with George Basile, Senior Scientist, The Natural Step, San Francisco, CA. August 18, 2000.)

Procedure

1. Tell students you are going to drop an egg from increasing heights at .25-meter intervals:
   a. first onto a desktop or hard floor surface
   b. then onto a square of playground fall protection

   Get the students into the activity by asking them to predict at what "drop height" the egg will break. Explain that an egg dropping "builds" kinetic, or moving, energy that is either absorbed or returned on impact with a surface. If the energy is absorbed, the egg will "sink" into the surface and not break; if the energy is returned, the egg will shatter on impact. The egg drop test can be used to give some information about the cushioning properties of the material tested.
2. Drop the egg. Have a student record the height at which the egg broke. Do the experiment again. Record the new break height. Average the two.
3. Now show the square of playground fall protection. Do the experiment again. What happens?
4. Explain that this surface is called "playground fall protection" and that it was invented as a response to real-world problems such as hard playgrounds. It is made from materials recycled from shoes.

5. Tell the students that companies sometimes create new products through working with other scientists and inventors who have experience with similar materials. For example, a Pennsylvania company that rolls and processes rubber into sheets for use as athletic mats was contacted to see how the rubber and foam in ground-up athletic shoes could be used to make another sports product that could take advantage of their cushioning properties.

6. Ask the students to imagine they, too, work for a shoe company and want to explore making a better cushioning product from used shoe materials. One (control) group will create a square of playground fall protection and test its shock absorption and energy return. Other groups will change the basic recipe by one ingredient or feature to see if they can make a surface with better performance properties. In the next lesson, they will test their surfaces.

7. Make the following assignments:
   - one ("control") group makes the basic recipe
   - other groups make surfaces (and construct hypotheses based on the questions below) from the "experimental" recipes:
     a. What effect does changing the amount of foam have?
     b. What effect does changing the amount of rubber have?
     c. What effect does adding upper fabric have?
     d. What effect does making the surface "thinner" have? "thicker"?
     e. What effect does changing the amount of glue have?

Using the lab reports and instructions provided (page 47), students make their sports surfaces. Label each container by group. Make sure the group's record-keeper has worked with the group to write down how the recipe has changed and complete sections I-IV of the lab report (at end of lesson).

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Enrichment

1. Allow time in next lesson (Lesson 5: Saving Humpty Dumpty, Part 2) to consider the variables introduced in each experimental recipe and how each affected the properties of the resulting materials. Connect these ideas:
   - how materials must be separated so that original properties (shock absorption, energy return) of the shoe components can be recovered;
   - how separated materials can be combined in new ways and modify the properties of the resulting surface; and
   - how density (how thickly the molecules in the material are packed) affects the properties of the final product.
2. Using recycled shoe materials, design an experiment for creating a product that needs less shock absorption and more energy return, such as a basketball court or running track.
3. Some communities use sand in playgrounds rather than asphalt or playground fall protection material. Compare the shock absorption properties of sand to the square of playground fall protection. Based on your experiment, what are the advantages and disadvantages of each surface? If the community decides to change from asphalt to a fall-protected surface, what happens to the used asphalt? What are the environmental impacts of making this change?

Resources

The Consumer Products Safety Commission has pamphlets and reports about playground and other product safety issues. To find them, go to the publications page on their Web Site *http://www.cpsc.gov/cpscpub/pubs/pub_idx.html*.

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Student Lab Report

GROUP MEMBERS: _____

_____

BASIC FALL PROTECTION RECIPE

Ingredients:

2.5 cups foam granules
2.5 cups rubber granules
1 (one) 5 oz. jar non-toxic glue (such as Rite Aid School Glue)

Tools:

1 bottom of 1 gallon water jug, cut just below the handle
1 large spoon or paint stirrer
1 measuring cup
1 spatula (or use the paint stirrer)

Directions:

1. Combine midsole foam and rubber granules with glue in water jug.
2. Mix well. Pat down evenly with spatula.
3. Leave, uncovered, in a well-ventilated area and let dry for 48 hours.

1. ***Your Recipe*** (circle one): Control (basic) Experimental

   If experimental, list your recipe here:

   _____

   _____

   _____

2. ***Background Information:*** We know

   _____

   _____

   _____

3. ***Problem to Solve:*** How does varying the recipe affect the shock absorbtion of the surface?

   _____

   _____

   _____

   Hypothesis: We predict _____

   _____

4. ***Experiment:*** This is what we did

   _____

   _____

   _____

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Student Lab Report

5. ***Results:*** (Use graph paper to make tables and graphs as in A and B, below.)

A. Data Table

		Other Surfaces Tested		
Test Object Drop Height	Control Recipe (basic)	Experimental (list type of mix)	Asphalt (or other)	Your playground *Circle one:* grass / mulch / sand
#1				
#2				
Average (A + B) ÷ 2				

B. Data Graph

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C. Analysis

6. Conclusion

a. Our hypothesis was (correct, partly correct, incorrect). *Explain.*

b. Answer to problem based on data.

c. How you used data to come to your conclusion.

d. What was challenging in this experiment?

e. Is there another way to design this investigation?

f. Ideas for further research?

Nicolas Vouilloz:

8-time world champion downhill mountain biker who's used to overcoming obstacles.