Dynamic Design: A Collection Process

Finding the Perfect Fit

TEACHER GUIDE

BACKGROUND INFORMATION

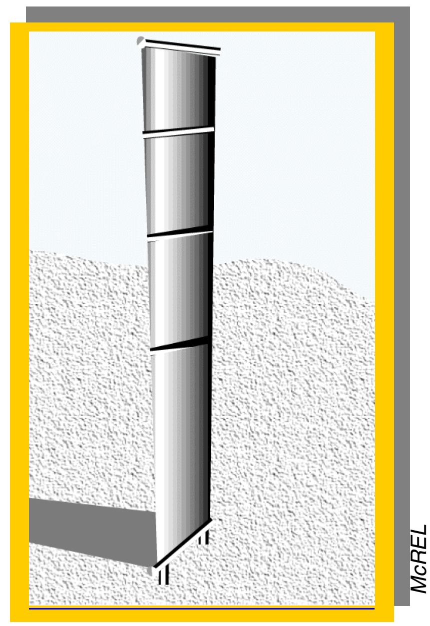
The sample return capsule (SRC) on the Genesis spacecraft contains wafers for collecting solar wind particles. The wafers are suspended over a frame. In this introductory activity students investigate different shapes that fit into a given space, which is the shape of the array frame that will be put into the canister in the sample return capsule. Students will experiment with different shapes to find the shape or combinations of shapes that cover the greatest background area. The greater the area that is covered, the more solar wind that will be collected.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5—8
Science and Technology
Abilities of technological design.
History and Nature of Science
History of Science

Grades 9—12
Science and Technolgy
Abilities of technological design.

(View a full text of the National Science Education Standards.)



Apollo-Type Solar Wind Collector Foil

NATIONAL MATH STANDARDS ADDRESSED

Grades 5—8
Math Standard: Mathematics as problem solving
Verify and interpret results with respect to the original problem situation.
Math Standard: Number and Number Relationships
Understand and apply ratios, proportions and percents in a wide variety of situations.
Math Standard: Geometry
Represent and solve problems using geometric models.
Math Standard: Measurement
Estimate, make, and use measurements to describe and compare phenomena

Grades 9—12
Math Standard: Mathematics as problem solving.
Apply the process of mathematical modeling to real-world problem situations.

(View a full text of the National Math Education Standards.)

MATERIALS

For each group of students:

- Student Text, "It Began With Apollo"
- Student Text, "Shaping Up"
- Student Sheet, "Finding the Perfect Fit"
- Student Activity, "Finding the Perfect Fit"
- Shapes: 20 each of triangles, squares, trapezoids, parallelograms, and rhombi

Option 1: Teacher-made, dye-cut shapes
Option 2: Pattern blocks

- One Centimeter Graph paper
- Colored Pencils or Markers

OR
Option 3: TesselMania® software (see alternative strategies tip)

PROCEDURE (Options 1 and 2)

1. Begin this session by having the students complete a Prereading Plan (PReP) that is described here. This strategy may be used to generate interest in content reading and assess levels of knowledge of the subject prior to reading the student text. First ask them for their *initial association with the concept.* Ask students to write the first thing that comes to mind when they hear the phrase "solar wind collection" on a piece of paper. If the students have not worked with the Genesis education module *Cosmic Chemistry: Sun and Solar Wind*, start with the phrase "solar wind." Once students have recorded their responses, move to the *reflections on initial association* phase. In this second step, list some of the responses from the initial association on the board and ask students, "What made you think of the response?" This will help students develop an awareness of their association. In the last section, *reformulation of knowledge,* the teacher should ask, "Based on our discussion and before we read the text, have you any new ideas about solar wind collection?" Through the use of PReP, teachers can assess which students have much, some, or little knowledge of the concept. Based on the class participation in this activity, the teacher should plan to either provide some background on solar wind or begin the design module by having students read the student text.

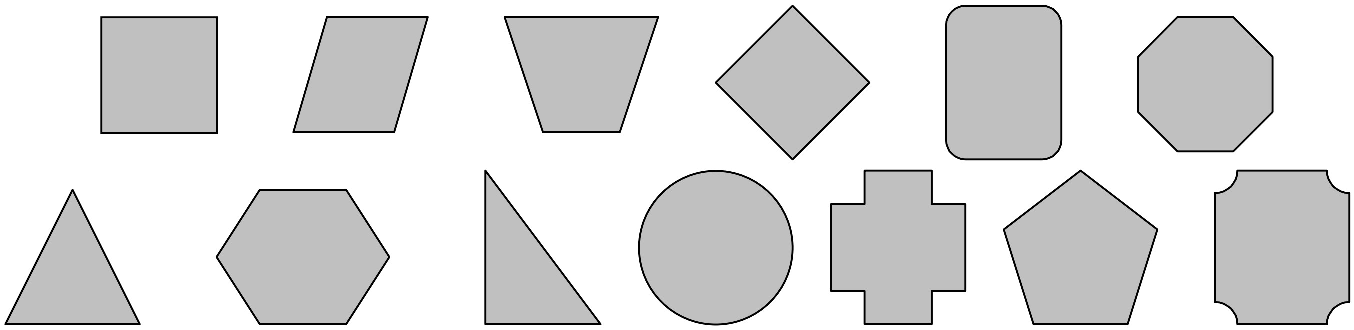
2. Explain to students that the first time solar wind particles were returned to Earth for study was during the Apollo missions. Ask students what they know about the Apollo missions from the early seventies. Explain that the solar wind experiments that were done during the Apollo missions provide a starting point for the Genesis solar collection mission. In other words, the fact that the solar wind experiments during Apollo were successful proved that the Genesis mission would be possible. Tell the students that an article about the Apollo solar wind experiments as a play can be read aloud in class.

3. Set the stage for this activity by having the students dramatically read the Student Text "It Began with Apollo." This text describes the Apollo mission experiments with Solar Wind Collectors (SWC). These lunar experiments represent the first time that solar wind particles were collected and returned to Earth for study. Students will read journal accounts from astronauts on the Apollo 11 and 12 missions. Assign students to read the different statements as in a play. There will be at least one narrator and one person each for astronaut: Buzz Aldrin, Mission Control Capsule Communicator Bruce McCandless, astronauts Alan Bean, Pete Conrad, and Mission Control Capsule Communicator Ed Gibson. Once the students have read the text, ask them to answer the questions about how the astronauts collected solar wind particles and to recommend design changes as they see fit. If students ask for help, refer them to the text. Answers for the first question may include the materials that the SWC was made from, how many sections there were, and what the various parts were. For question 2, students may suggest that extending the telescopic pole, unrolling the foil, and fastened to a hood near the bottom, the pole was planted into the ground with the correct side facing the sun. Retrieval was supposed to work like pulling up a window shade. Most missions had trouble with retrieval, although they were all successful. For question 3, answers will vary. Students may suggest that the tape be looked at, and perhaps design some tests that test the mechanism in the lunar-like environment. Other students may suggest including a larger bag in case this problem happens again.

4. Explain to the students that unlike the simple foil experiments that were completed on the Apollo mission, the Genesis mission will have five collector arrays, each consisting of a frame and solar wind collecting wafers. Explain that in this science module, they will study how the design affects a mission and discover some of the challenges associated with

collecting solar wind particles. Tell students that they will begin by studying how different shapes of solar wind collector wafers might fit into a frame.

5. Distribute Student Sheet, "Finding the Perfect Fit" to the student groups. Explain that the goal will be to use any shape or combination of shapes to fit the background frame.



6. Students will start by tracing the background frame onto a piece of graph paper and calculate the area using the counting squares method. Students count the number of squares inside the outline of the background frame.

7. Next students will fit the shapes into the background frame. They may choose as many different ways as possible. Students may use partial shapes to fill in gaps. When the group members have found an arrangement they think is best, they should trace the shapes onto the graph paper using colored pencils.

8. Using the method described in student activity sheet procedure 2, students should calculate the area of the background frame that they were able to cover. Students should also calculate the percent of the frame covered and the total number of covering pieces used. Percent of frame covered = (area covered by shades / total area of frame) X 100.

9. Each group's completed sheet can then be posted on the wall so other groups may review it. Tell groups to review the work done by other groups and to answer the questions as they complete this review. Discuss the following questions once students have completed them:
   1. a. Which shapes best fit into the background frame? Why? Question 1 answers will vary, students should reflect the fact they tried several shapes.
      b. What shapes do not fit well? Why not?
   2. What other shapes would you like to try? Why? Answers will vary.
   3. Would some shapes cost more than others to produce? Why or why not? Students may suggest that shape makes no difference; only the amount of material would change the cost. Others may explain that shapes that have more "corners" would cost more to cut.
   4. What factors beside cost should be considered when designing a collector wafer? Answers will vary. Some students may suggest that purity of materials is the most important for getting good results.
   5. Which of the above factors are most important? Which are least important? Why?

10. Students should read the Student Text "Shaping Up." This text has information about shapes found in nature. It begins with a short description of the honeycomb found in a beehive. Students are asked to think of other places in nature where hexagons occur. The benzene ring in organic chemistry is given as another example. The text concludes by describing the solar collector wafers and array that will be part of the sample return capsule on board the Genesis spacecraft.

11. Preview the next activity by telling students that two arrays will collect bulk solar wind. Ask them to brainstorm how the other arrays might be used to analyze specific regimes of solar wind, such as noble gas elements, oxygen, nitrogen, or alikali metals. This is what will be modeled in the next exploration activity.

> Alternate Strategies Tip
>
> This same activity can be adapted and completed by using a commercial or freeware software package on tessellation.

REFERENCES

Books:

Hutchins, R.E. (1966). Insects (pp. 216-217). Englewood Cliffs, NJ: Prentice Hall.

The University of Chicago School Mathematics Project. (1998). Everyday Math (p. 85). Chicago: Everyday Learning Corporation.

Wilbraham, A.C., Staley, D.D., & Mata, M.S. (1997) Chemistry (4th ed.). (p. 700). Menlo Park, CA: Addison Wesley.

World Wide Web:

http://www.beloit.edu/~biology/zdravko/voronoi.html
Shapes in Nature

http://www-sn.jsc.nasa.gov/explore/data/apollo/part1/swc.htm
Solar Wind Composition

http://www.hq.nasa.gov/office/pao/History/alsj/frame.html
Apollo Lunar Surface Journal

http://www-curator.jsc.nasa.gov/curator/genesis/Collectors.htm
JSC Contamination Control for Genesis

http://tlc.ai.org/escher.htm
The Access Indiana Teaching and Learning Center, M.C. Escher