Dynamic Design: The Cleanroom

Mapping It Out

TEACHER GUIDE

BACKGROUND INFORMATION

Johnson Space Center

According to the Genesis Principal Investigator Don Burnett, the location of the wafers on the array is a minor issue. Questions that come to mind may include the following: What were the materials used? Where were they placed on the array? In what order were they placed on the array? What were the general rules for placement on the array? In this activity students will map out the actual placement of the wafers on the array by making a color key, then finding and coloring the locations on five arrays. Students will then look at the finished array frames and identify patterns of wafer materials. Students will also discover why the wafers have slightly different thicknesses.

Students will discover that the wafers are placed on the array frame with several guidelines. Most of the wafers are made from silicon. One of the guidelines is that the non-silicon wafers are closer to the center of the array. The materials that are more sensitive to contamination are located toward the center array to minimize contamination. Another reason the non-silicon materials are kept toward the center is that there is an increase in contamination toward the axis of the array. The axis location also has shadows that prevent the solar wind particles from embedding in wafers located at this area. Another general rule is that the wafers made from various non-silicon materials are spread out on the array. In other words, non-silicon wafers of the same material are rarely placed next to one another. The reason for this rule is so that in the event of a micrometeoroid collision with the array, some wafers of these diverse materials may survive even if others are destroyed. For more information on the threat of micrometeoroids with the Genesis mission see "Micrometeoroids and More" from the *Dynamic Design: A Collection Process* science module.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Properties of matter

Science and Technology
- Understandings about science and technology

Science in Personal and Social Perspectives
- Risks and benefits

Grades 9-12

Science As Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Structure and properties of matter

Science and Technology
- Understandings about science and technology

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

PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

Grades 6-8
Algebra
Understanding patterns, relations, and functions

Grades 9-12
Algebra
Understanding patterns, relations, and functions

(View a full text of the Principles and Standards for School Mathematics.)

MATERIALS

For each group of four to five students:

- Colored pencils or markers
- Five Student Reporting Sheets, "Mapping It Out: Collector Layout"
- Student Data/Reporting Sheet, " Mapping It Out: Material Chart"
- Student Activity, "Mapping it Out"
- Student Text, "The Solar Wind," from *Cosmic Chemistry: The Sun and Solar Wind*

Alternate Strategy Tip

For younger students you may want to have them work in groups of four. You could complete the fifth array as an example of how to complete the procedure by using an overhead projector and a transparency of the student recording sheet.

PROCEDURE

1. Distribute materials to the student groups.

2. Explain to students that they are going to map out the locations of the different materials that make up the collector array of the Genesis spacecraft. Explain that each array contains wafers made of the same materials and that the locations of these materials vary depending on the array. Explain that in this activity students will be mapping the locations of the materials.

3. Explain that each group will complete five array frames. The first task will be to make a color key for their work. Explain that they should develop the color key as a group so that they will be able to compare the arrays once each one is completed.

4. Allow time for groups to develop the color key and to complete the mapping activity on their recording sheets. You may want to spend some time explaining the concept of the size of a micron. Or you may have the students explore this on their own once they have completed the activity.

5. Have the students complete the questions at the end of the activity. Once students have had a chance to complete the questions, hold a discussion in which the students list the patterns they observed on the board.

6. Below are suggested answers for the student questions:

   a. Why do you think different materials are used for collecting solar wind particles? (Different materials are better for analyzing different types of solar wind particles.)
   b. Why is silicon the material that is used the most frequently? (Answers will vary. Students may suggest that the cost of silicon is lower than some of the other materials. Students who have completed the module *Dynamic Design: A Collection Process* may suggest that silicon is a good collector material for analyzing most atoms and isotopes from the solar wind.

c. Why do you think some wafers have one material on top of another material? (Answers will vary. Some students may suggest that the numbers of various solar wind particles from the top layer will be compared with the numbers for the bottom layer. Others may note that the wafers that have two materials involve materials that are costly).
d. Looking at your array, describe some patterns you notice in the placement of the materials. (Answers will vary. Students might suggest that for the most part the different materials are found closer to the middle of the array, and that silicon is frequently on the outside of the array. Others may suggest that aside from silicon, two materials of the same type are rarely next to one another).
e. Compare your array with one of the members in your group. Describe similarities and differences in the patterns of wafer materials. In what order were they placed on the array? (Answers will vary. Students answers should reflect a comparative description of their array with other group members).
f. Look at the five collector arrays at the same time. Describe any patterns that are seen in all five arrays. (Answers will vary. Students may have similar answers to those in question 4).
g. There is more contamination along the outside of the array. Why do you think the silicon wafers are found there? (Since there are more silicon wafers than other materials, there will be more samples of this material available so contamination is not as big an issue).
h. Notice that with the exception of silicon, different materials are rarely found next to one another. Knowing that micrometeoroids may potentially destroy a wafer while the collectors are deployed, explain the rationale for this arrangement. (In the event of a micrometeoroid collision with the array, some wafers of these diverse materials may survive even if others are destroyed).
i. Notice the thickness reading that you recorded on your sheet. Notice that on the other arrays the measurement is slightly different. Why do you think this is so? (Answers will vary. Students who have completed *Dynamic Design: A Collection Process* will remember that the science canister is snagged mid-air by a helicopter. In the event that this is unsuccessful, the canister will fall to the ground and the wafers will break into pieces. Having the wafers' thicknesses vary depending on the array that they are on, will help scientists know on which array they were originally located, so they could still get good data from the wafers).
j. How would the material used affect the assembly process of the array? (It would be important for the scientists who assemble the array to have a map showing the locations. They would have to be familiar with this map so that the wafers are placed in the intended area of the array). Are there any materials that you would want to be especially careful with during assembly? Explain. (Students may suggest that the wafers that have diamond, gold, or sapphire should be handled carefully as they are more expensive than others are.)

7. For students wanting more information about why an array is being designed and built, refer them to "The Solar Wind" student text from the *Cosmic Chemistry: The Sun and Solar Wind* module. This background may lead students to conclude that silicon's high melting point was a reason it was chosen as wafer material.