Science Modules

This module focuses on the relationship between basic design concepts and the collection process that will be used in the Genesis mission. If you are using Genesis science modules for the first time, read the User's Guide thoroughly before you begin. (*View User's Guide as PDF.*)

The following classroom materials are available in Portable Document Format (PDF) for your browsing and printing convenience. The files are print-optimized, and should be printed to achieve maximum resolution. **Adobe's new Acrobat Reader 4.0 is required** to view and/or print. To install the FREE reader, visit the Adobe Web site.

Take a look at additional science modules that are available on the Genesis Web site. All technical terms in the science modules are compiled in the Glossary for easy access.

Technology Applications are available for this module.

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Genesis mission collector arrays and concentrator.

Dynamic Design: A Collection Process

The goal of this module is to involve students in a data collection process using the Genesis solar wind collectors as an example. Through an active hands-on approach, students will work in production design teams to explore how the Genesis spacecraft will collect bulk solar wind with the collector arrays. When students investigate different wafer materials and the concentrator, they will model the process of analyzing specific regimes of solar wind.

During the briefing exercises students learn about the Apollo solar wind experiments by reading actual accounts of the astronauts in Apollo 11 and 12. Students then investigate how different shapes might fit into the Genesis array frame. During the explorations of the *Dynamic Design: A Collection Process* module, solar wind will be modeled with different foods and ultraviolet sensitive beads. Students experiment to find out how solar wind must embed into the wafers, which act as boxes holding the elements and isotopes for analysis. Through laboratory investigations, product design teams study different types of contamination. In the final assessment, students will work in design teams to construct collection wafers to withstand the impact of a drop test.

- **[Module Planning Guide]**

It Began With Apollo

- Student Text
- PowerPoint Presentation
- PowerPoint as PDF
  - Teacher Guide for PowerPoint
  - Teacher Notes for PowerPoint

Finding the Perfect Fit

- Teacher Guide
- Student Activity
- Student Sheet

Shaping Up

- Student Text

Briefing

The goal of "Finding the Perfect Fit" is to increase student interest in the history of solar wind collection. During the Apollo missions in the late sixties and early seventies, solar wind was collected with foils that were exposed to the solar wind for varying amounts of time. The foils were then stowed and returned to Earth for analysis. The student text, "It Began With Apollo," takes students on a journey to the past and to the moon. Students read the dialogue between Apollo astronauts and mission control, which highlights the struggles and successes of this experiment. In the activity students fit different shapes representing wafers into a background frame—similar to what is used in the Genesis mission. The student text, "Shaping Up," centers on examples regarding hexagons in nature.

Curriculum Connections

- Mathematics and science
- Using models of processes and procedures
- Analyzing collection techniques
- Dealing with contamination
- Parabolic mirrors in everyday life

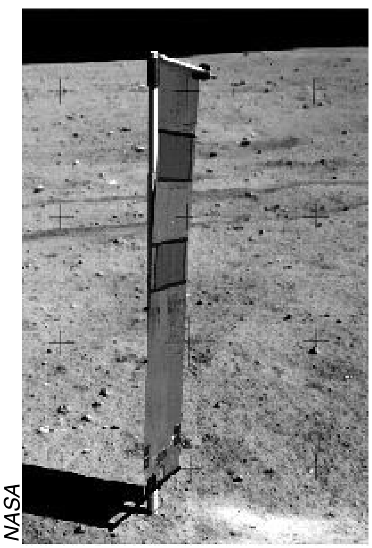
Skills and Processes

- Work in production design teams to model scientific processes and develop strategies to solve problems

Learning Objectives

- Recognize that scientists know of others' work and build on one another's ideas.
- Understand the influence on scientific knowledge of developments in technology.

NASA



Apollo 16 solar wind collector (1970) on the moon.

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Genesis mission solar wind collector (2001).

Modeling Solar Wind Collection
- Teacher Guide

Sticky Situation
- Student Activity

Better Beads
- Student Activity

Invisible Analysis
- Student Activity

Continuous Collection
- Student Text

Exploration

Students will complete three hands-on activities that give them an experience in modeling solar wind collection. A text relates general procedures of various collection techniques. Students choose wafer shapes from the Briefing activity and use hexagons to model the design of the Genesis solar collector. Students will test the collectors by measuring the mass of sand they collect. Students use ultra violet sensitive beads to represent wafer material and solar wind particles. Students will discover that all materials collect all solar wind materials, yet some materials allow for better analysis on certain regimes of solar wind than others. "Invisible Analysis" challenges students to "detect" solar wind particles without the use of their eyes, modeling the fact that the solar wind particles will be analyzed with instruments, not visual inspection. "Continuous Collection" uses analogies from life science and physical science to relate to solar wind collection of the Genesis spacecraft.

Curriculum Connections
National Standards Addressed

Grades 5-8

Science as Inquiry
- Abilities necessary to do scientific Inquiry

Physical Science
- Motion and Forces

Science and Technology
- Abilities of technological design

Science in Personal and Social Perspectives
- Science as a Human Endeavor Natural hazards
- Science and technology in society

History and Nature of Science
- Science as a Human Endeavor
- History of Science

Student Mission

Students will work in Product Design Teams (PDT) to test collector models for contaminants' ability to withstand micrometeroid impacts. Wafer collectors will be designed to withstand an impact should the planned recovery system fail.

Enough is Enough
- Teacher Guide
- Student Activity

Caution: Contaminants!
- Student Activity

Micrometeoroids and More
- Student Text

It's a Hit
- Student Activity

Development

Students will conduct a laboratory investigation to develop their understanding of contamination issues related to collecting solar wind. Students will investigate contamination issues related to collecting solar wind. Sand will be used to represent solar wind and students will use a hand lens or dissecting microscope to quantify the amount of contamination. Micrometeoroids as contaminants will be investigated in the student text, "Micrometeoroids and More," and the activity, "It's a Hit." In the latter, students will conduct an experiment modeled after one done at Johnson Space Center where wafers were tested against simulated micrometeoroids.

Curriculum Connections
National Standards Addressed

Grades 9-12

Science as Inquiry
- Abilities necessary to do scientific inquiry

Science and Technology
- Abilities of technological design
- Understandings about science and technology

History and Nature of Science
- Science as a Human Endeavor
- Nature of Scientific Knowledge

Concentrate
- Teacher Guide
- Student Activity

The Concentrator
- Student Text

Parabolic Problem
Algebra Enrichment
- Teacher Guide
- Student Activity

Hot Dog Cooker
- Student Activity

Interaction and Synthesis

Students interact with peers to accomplish the tasks assigned in the Exploration and Development sections above. Each activity contains work to be done in groups, with the whole class participating in preliminary and summary discussions. Students will learn how the Genesis solar concentrator works. They then build a model to demonstrate the process.

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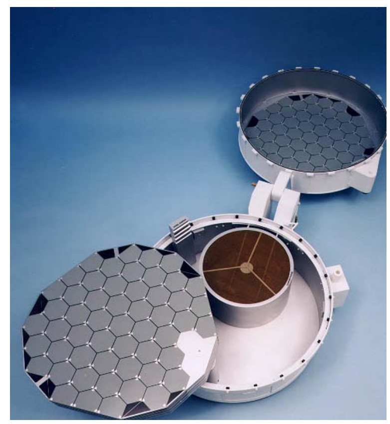
The concentrator

All Cracked Up
- Teacher Guide
- Student Activity

Assessment

After two years of collecting solar wind particles, the sample return capsule (SRC), which contains the canister containing the collector wafers and concentrator, will be captured in mid-air with a helicopter. In the event that the helicopter is not able to do this, the SRC will impact the ground. Genesis scientists have tested this impact and have designed the SRC to minimize wafer breakage. Students work in Product Design Teams to complete a design of collector wafers that will withstand an impact. A drop test will be performed and design changes made.



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The solar wind collector arrays and concentrator.

This education module, *Dynamic Design: A Collection Process*, was developed by educators at Mid-continent Research for Education and Learning.

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Meet Roger Wiens in an interview that is featured in our People section.

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