

Lesson 3: Turning Designs into Reality

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Lesson Snapshot

*Packing
Up for the
Moon*

*Lesson 3
Turning
Designs into
Reality*

Overview

Big Idea: Design is a creative planning process that leads to useful products and systems.

Purpose of Lesson: Fabricate a prototype of a lunar plant growth chamber (LPGC) for use on the lunar surface, then test, analyze and report.

Lesson Duration: Six hours.

Activity Highlights

Engagement: Students examine materials available for the construction of their lunar plant growth chamber prototype and identify additional items that may be needed.

Exploration: Students, working in design teams, develop detailed drawings of their lunar plant growth chamber, with parts and measurements labeled.

Explanation: The teacher explains how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions. Students identify the value of conducting a design review before beginning the construction of a solution.

Extension: Students, working in design teams, conduct a design review, develop a fabrication plan and fabricate a prototype of a plant growth chamber to be used on the lunar surface and, then, to test, analyze and report.

Evaluation: Student knowledge, skills and attitudes are assessed using rubrics for class participation, brief constructed responses, design development and for the display and presentation.

Lesson 3: Overview

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- Six hours.

Standards/Benchmarks

Technology: Standards for Technological Literacy (STL) (ITEA, 2000/2002)

- Students will develop an understanding of the characteristics and scope of technology. (ITEA/STL 3)
 - Management is the process of planning organizing and controlling work. (ITEA/STL 3EE)
- Students will develop an understanding of engineering design. (ITEA/STL 9)
 - Modeling, testing, evaluating and modifying are used to transform ideas into practical solutions. (ITEA/STL 9H)
- Students will develop the abilities to apply the design process. (ITEA/STL 11)
 - Apply a design process to solve problems in and beyond the laboratory-classroom. (ITEA/STL 11H)
 - Make two-dimensional and three-dimensional representations of the designed solution. (ITEA/STL 11J)
 - Make a product or system and document the solution. (ITEA/STL 11L)
 - Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints and refine as needed. (ITEA/STL 11K)

Science: Benchmarks for Science Literacy (AAAS, 1993)

- The Nature of Technology/Technology and Science (AAAS 3A)
 - Engineers, architects and others who engage in design and technology use scientific knowledge to solve practical problems, but they usually have to take human values and limitations into account as well. (AAAS 3A)
- The Physical Setting/The Earth (AAAS 4B)
 - The moon's orbit around the earth once in about 28 days changes what part of the moon is lighted by the sun and how much of that part can be seen from the earth—the phases of the moon. (AAAS 4B)

Mathematics: Principles and Standards for School Mathematics (NCTM, 2000)

- Representation
 - Use representations to model and interpret physical, social and mathematical phenomena.
- Measurement
 - Solve problems involving scale factors, using ratio and proportion.
 - Develop and use formulas to determine the circumference of circles and the area of triangles, parallelograms, trapezoids and circles and develop strategies to find the area of more complex shapes.
 - Understand relationships among units and convert from one unit to another within the same system.

Learning Objectives

Students will:

1. Develop a design proposal for a lunar plant growth chamber.
2. Develop a production plan for a prototype lunar plant growth chamber.
3. Explain that management is the process of planning organizing and controlling work.

4. Describe how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions.
5. Make two-dimensional and three-dimensional representations of the designed solution.
6. Apply the engineering design process to solve a problem.
7. Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.
8. Make, analyze and refine a prototype of a lunar plant growth chamber and document the solution.

Student Assessment Tools and/or Methods

1. Rubric for Brief Constructed Response Item

Why is it important to conduct a design review before beginning the construction of a product?

Category	Below Target	At Target	Above Target
Understanding	Response demonstrates an implied, partial or superficial understanding of the purpose of the system and how it operates.	Response demonstrates an understanding of the purpose of the system and what is required to operate it.	Response demonstrates an understanding of the complexities of the system and detailed requirements for operating it.
Focus	Lacks transitional information to show the relationship of the support to the question.	Addresses the demands of the question.	Exceeds the demands of the question.
Use of Related Information	Uses minimal information about requirements for the system.	Uses some expressed or implied information about requirements for the system.	Effectively uses expressed or implied information about requirements for the system.

2. Optional Rubric for Class Participation

Teacher's Note: Teachers may choose to use this rubric as a way to assess students, with or without making it a basis for student grades.

Category	Below Target	At Target	Above Target
Preparation	Rarely prepared. Minimal effort to participate.	Prepared for class. Attempts to answer teacher-generated questions.	Well prepared for class. Attempts to answer teacher-generated questions and adds additional information to class when relevant.
Curiosity	Rarely demonstrates curiosity.	Usually demonstrates curiosity.	Consistently demonstrates curiosity.
Motivation for Learning	Rarely demonstrates motivation for learning.	Usually demonstrates motivation for learning.	Consistently demonstrates motivation for learning.
Use of Time	Gives up easily; is not engaged. Has difficulty remaining on task.	Makes good use of class time to work on assignments and projects.	Makes excellent use of class time to work on assignments and projects.

3. Rubric for Oral Presentation

Category	Below Target	At Target	Above Target
Organization	Audience has difficulty following presentation because student jumps between topics.	Student presents information in logical sequence that audience can follow.	Student presents information in logical, interesting sequence that audience can follow.
Subject Knowledge	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student is at ease with expected answers to all questions, but fails to elaborate.	Student demonstrates full knowledge (more than required) by answering all class questions with explanations and elaboration.
Graphics	Student occasionally uses graphics that rarely support text and presentation.	Student's graphics relate to text and presentation.	Student's graphics explain and reinforce text.
Eye Contact	Student occasionally uses eye contact, but still reads most of report.	Student maintains eye contact most of the time but frequently returns to notes.	Student maintains eye contact with audience, seldom returning to notes.
Elocution	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation.	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation.

Resource Materials

Print Materials

1. *Teachers and students investigating plants in space: A teacher's guide with activities for life sciences* (EG-1997-02-113-HQ). (1997). ASIN: B000H48XM6. Retrieved July 6, 2007 from <http://education.nasa.gov/edprograms/core/home/index.html>
2. *Fundamentals of space biology: research on cells, animals and plants in space* New York: Springer.
3. Pierce, A. & Karwatka, D. (1999). *Introduction to technology*. New York: Glencoe/McGraw-Hill, (pp. 157-180).

Audiovisual Materials

1. *JFK moon speech at Rice University*. (1962, November 12). Retrieved from <http://www1.jsc.nasa.gov/er/seh/ricetalk.htm>

Internet Sites

1. *Technical drawings of NASA spacecrafts*. (n.d.). Retrieved July 6, 2007 from <http://www.hq.nasa.gov/office/pao/History/diagrams/diagrams.htm>
2. *Educational plant growth hardware* (Space Garden and BPSe). (n.d.). Retrieved July 6, 2007 from <http://www.orbitec.com/outreach/index.htm>
3. *Space agriculture in the classroom* (n.d.). Retrieved July 6, 2007 from <http://www.spaceag.org/>
4. *Orthographic drawings* (n.d.). Retrieved March 1, 2007 from <http://www.cdli.ca/depted/g7/ortho.htm>
5. Ryan, V. (2002). *Frist angle: Orthographic projection*. Retrieved March 1, 2007 from <http://www.technologystudent.com/designpro/ortho1.htm>

Lesson 3: Modified 5-E Lesson Plan

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Engagement

1. The student design teams examine the material resources available for the construction of prototypes.
2. Students identify additional resources that may be needed to model parts of the design and create a plan for how they will acquire the resources.

Exploration

1. The student design teams reexamine the selected approach and create detailed drawings that include the following:
 - a. Labels of important parts and systems
 - b. Stowed (stored) and deployed (not stored) configurations
 - c. Arrows that represent motion
 - d. Measurements such as length, width and height

Explanation

1. The teacher explains that:
 - Modeling, testing, evaluating and modifying are used to transform ideas into practical solutions. Testing and evaluating are repeated after each modification.
 - Management is the process of planning organizing and controlling work. “Management is sometimes called getting work done through other people. Teamwork, responsibility and interpersonal dynamics play a significant role in the development and production of technological products.” (ITEA, 2000/2002)
 - Planning and reviewing a design before fabrication will improve the quality of a product by reducing the chance of omission or error in the design. Safety concerns may also be identified.
2. The teacher leads a discussion about what a design review should look like for the lunar plant growth chamber project.
3. The teacher discusses with the students why it is necessary to build scale models (save materials, cost, storage and work space).
4. The teacher describes what it means to build to scale.
5. The teacher demonstrates drawing techniques. (see *Sketching and Drawing*)
6. The teacher explains that a production plan should include the following:
 - Materials list including quantities and sizes
 - Tools and processes that will be needed to shape the parts
 - Assembly plan showing the order in which parts should be connected
 - Assignment of duties among design team members
7. The teacher demonstrates fabrication techniques (see *Modeling Ideas*) and reviews safety practices.

Extension

1. Design teams present plans to other groups and make necessary adjustments.
2. Upon completion, the design team develops a production plan and obtains approval from the instructor before beginning construction.
3. Students construct and analyze the prototype and present the solution to the class.
4. Students are given basil seeds to test their prototype.

Evaluation

1. Student knowledge, skills and attitudes are assessed using selected response items and rubrics for class participation, brief constructed responses and the oral presentation.
2. The rubrics are presented in advance of the activities to familiarize students with the expectations and performance criteria. They are also reviewed during the activities to guide students in the completion of assignments.
3. The teacher may wish to develop a collection of annotated exemplars of student work based on the rubrics. The exemplars serve as benchmarks for future assessments and may be used to familiarize students with the criteria for assessment.

Lesson 3: Lesson Preparation

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Teacher Planning

The laboratory-classroom should provide a flexible, resource-rich learning environment that includes areas for lectures and demonstrations, small group meetings and research activities. The teacher provides examples of available fabrication materials that the students can examine and with which they can experiment. Additional quantities of materials are made available upon completion of student fabrication plans.

Tools/Materials/Equipment

- Chalkboard or overhead projector
- Teacher rubric included in lesson
- Cardboard, tag board and/or foam core
- Tape
- Cool melt glue guns
- Plastic wrap or clear trash bags
- Waxed paper
- Craft sticks or various size wood scraps
- Various hardware: nuts and bolts, screws, nails, paperclips
- Scissors
- Plastic bottles
- Graph paper (regular and isometric—see *Sketching and Drawing*)
- Scroll saw
- Drill press
- Hand tools

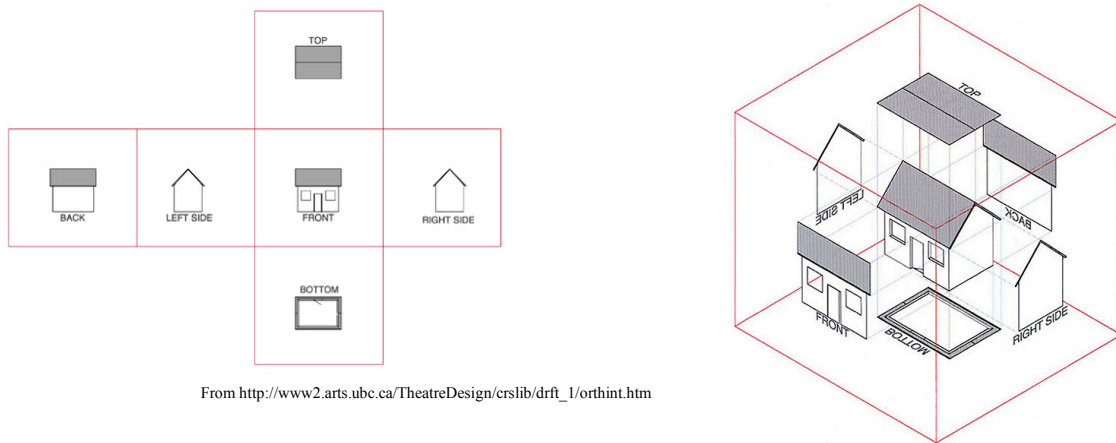
Classroom Safety and Conduct

1. Students demonstrate respect and courtesy for the ideas expressed by others in the class.
2. Students show respect and appreciation for the efforts of others.
3. Students use tools and equipment in a safe manner and assume responsibility for their safety as well as for the safety of others.

Sketching and Drawing

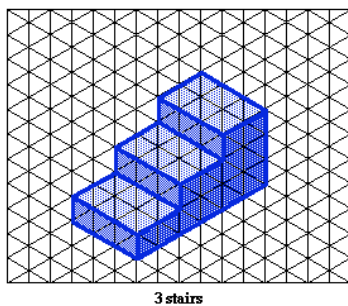
Sketching is a quick way to record ideas about shape and relative sizes of parts in a design. It is an ideal way to record thoughts while brainstorming possible solutions. Sketches should include some labels and notes about possible sizes of parts. Sketching on graph paper is recommended.

Orthographic Projection is a way of drawing different views of the same object. Usually a front, side and plan view is drawn so that a person looking at the drawing can see all the important sides. These are useful when a design has been developed to a stage whereby it is almost ready to manufacture. One view cannot provide all of the information needed to describe the object.

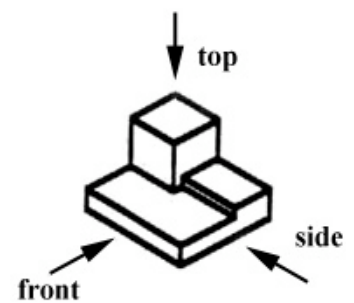
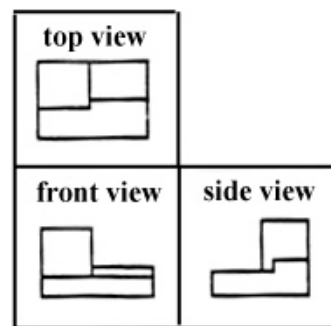


From http://www2.arts.ubc.ca/TheatreDesign/crslib/draft_1/orthint.htm

Isometric Drawing is a form of 3-D drawing in which there are three types of lines: vertical lines, 30° lines to the right and 30° lines to the left. Isometric graph paper makes it easy to draw neat, accurate images of design ideas. See the next page for a sample.

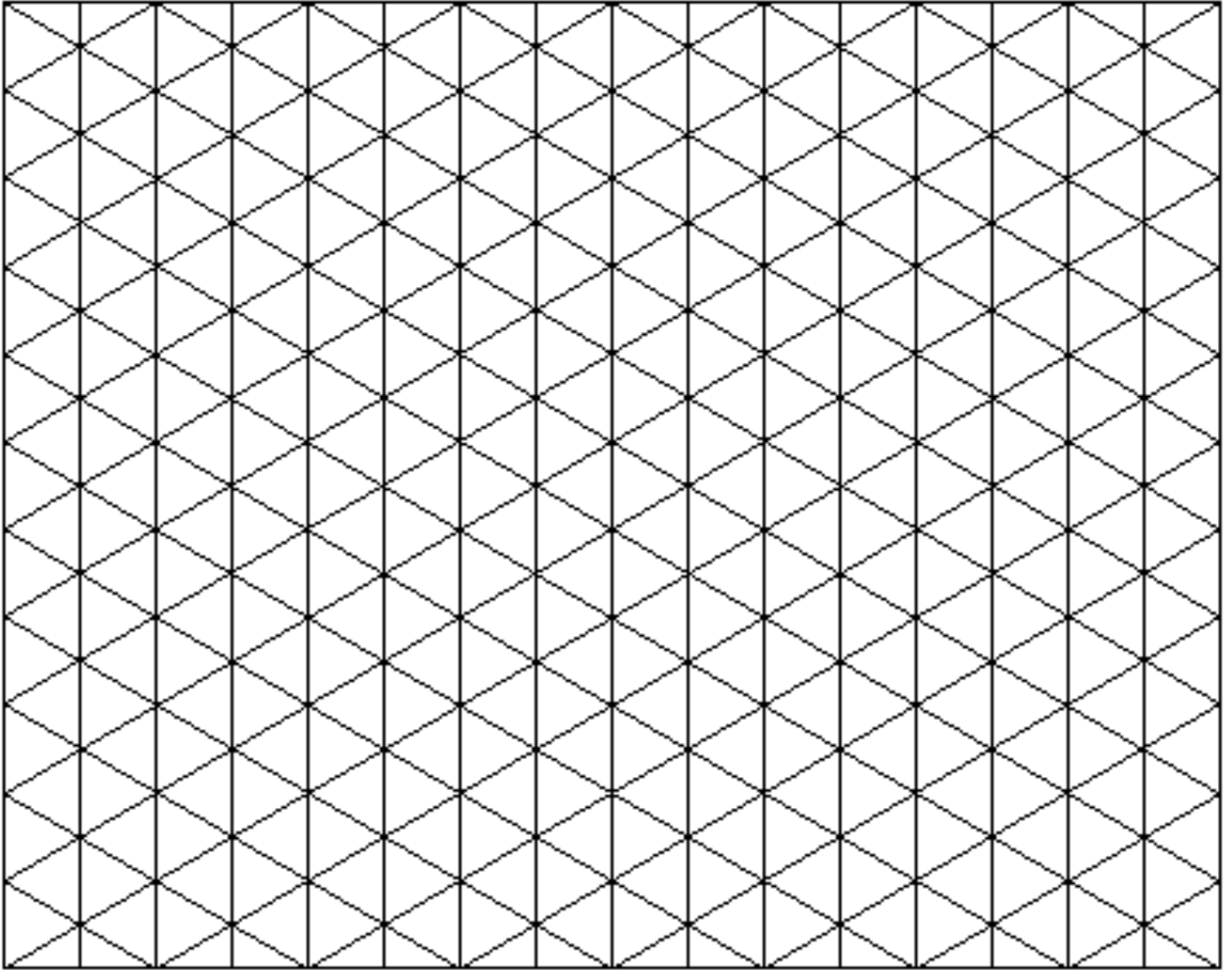


<http://mathforum.org/workshops/sum98/participants/sanders/IsomExamples.html>



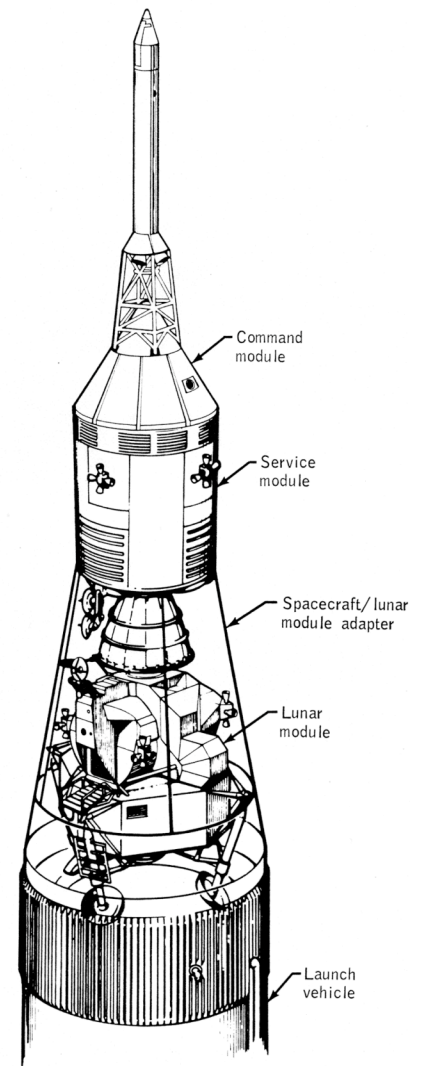
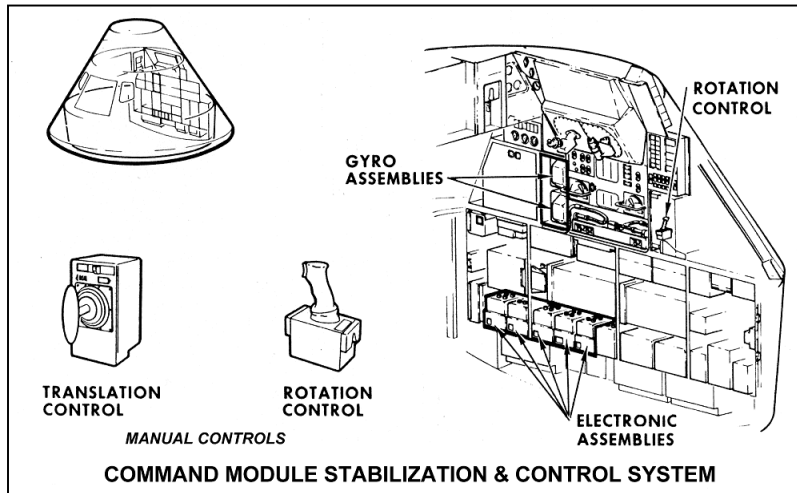
http://pergatory.mit.edu/2.007/Resources/drawings/images/fig_02.jpg

Sketching and Drawing
Isometric Graph Paper



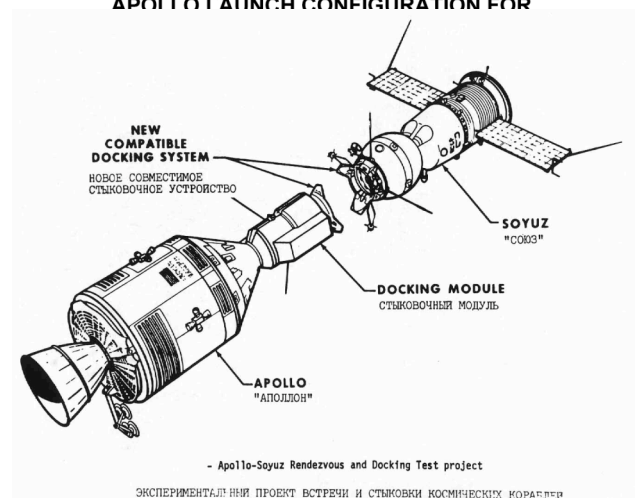
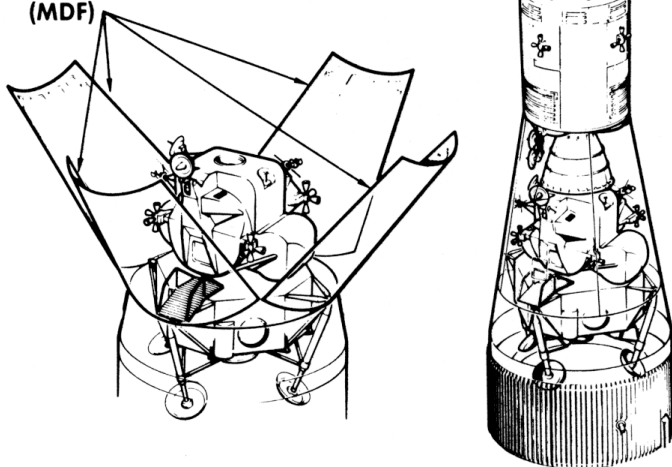
Sketching and Drawing

These are some of the many diagrams that may be shown to students as examples of how information can be shared graphically.



APOLLO SPACECRAFT/LM ADAPTER

PANEL SEPARATION BY EXPLOSIVE CHARGES (MDF)



Teacher's Note: Source: <http://history.nasa.gov/diagrams/apollo.html>

Modeling Ideas

The prototypes should show how the plant growth chamber deploys, or opens, once it is on the surface of the moon. They should also have pieces that represent the different systems needed to sustain plant life (light, water, etc.) and a method for astronauts to access the chamber.

Solid portions of the model can be made from cardboard and poster board. These materials work well because they are easy to cut and fold. A cardboard box can be cut at the corners so the sides can fold in or out.

Some solutions may involve a plastic bubble inflating to provide growing space. Wooden or wire supports may be inserted into the structure to hold the plastic in place. Explain to the students that they will not use the wire supports in the actual solution.

Plastic bottles may be used to represent storage units for water, pumps, carbon dioxide and lights.

Lights are likely to be in the form of banks of LEDs (light emitting diodes). Wooden or cardboard blocks may be dotted with small red and blue circles in order to model this.

Plants can also be modeled using colored paper. Lettuce can simply be depicted by a crumbled piece of green paper, while tomato plants can be a stick with green leaves attached.