

Engineering By Design
Advancing Technological Literacy
A Standards-Based Program Series

MS

Packing Up For The Moon

Human Exploration Project Engineering Design Challenge

A Standards-Based Middle School Unit Guide



Packing Up For The Moon

Design, Build and Evaluate

International Technology Education Association
Center to Advance the Teaching of Technology & Science

Inspiration + Innovation + Discovery = Future



Preface

Packing Up for the Moon A Standards-Based Middle School Unit

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Preface

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The ITEA-CATTS Human Exploration Project (HEP)

People, Education and Technology

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Preface

In May 2005, ITEA was funded by the National Aeronautics and Space Administration (NASA) to develop curricular units for Grades K-12 on Space Exploration. The units focus on aspects of the themes that NASA Engineers and Scientists—as well as future generations of explorers—must consider, such as Energy and Power, Transportation and Lunar Plant Growth Chambers (the STS-118 Design Challenges). Moreover, the units are embedded within a larger model program for technology education known as Engineering byDesign™.

The Human Exploration Project (HEP) units have several common characteristics. All units:

- Are based upon the Technological Literacy standards (ITEA, 2000/2002).
- Coordinate with Science (AAAS, 1993) and Mathematics standards (NCTM, 2000).
- Utilize a standards-based development approach (ITEA, 2005).
- Stand alone and coordinate with ITEA-CATTS Engineering byDesign™ curricular offerings.
- Reflect a unique partnership between NASA scientists and engineers and education professionals.
- Incorporate leading-edge insight and practical experiences for students on how NASA works and plans.

These unit guides are designed to be practical and user-friendly. ITEA welcomes feedback from users in the field as we continually refine these curricular products, ensuring that the content remains as dynamic as the technological world in which we live. Please email ebd@iteaconnect.org or call 703-860-2100.

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A National, Standards-Based Model for K–12 Technological Literacy

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Unit Resource Quick Links

Moon ABCs Fact Sheet

*Understanding the Role of
Plants in a Lunar Base*

KWL Chart

Design Brief

Engineering Design Process

*Lunar Plant Growth Chamber
Design Steps*

Sketching and Drawing

Modeling Ideas

Packing Up for the Moon

A Standards-Based Middle School Unit

Unit Overview

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*Unit
Overview*

Design is a creative problem-solving process that leads to the development of new products and systems. In this unit, students will learn about and apply this process in developing a lunar plant growth chamber design. The criteria and constraints for this system are based on the unique conditions of the lunar environment and the current transportation technologies available. The current focus of NASA is reviewed as well as the new systems that are being developed for future missions. The science of the lunar environment and basic plant needs are presented.

Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Big Idea

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

Standards

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

- Students will develop an understanding of the characteristics and scope of technology. (ITEA/STL 3)
- Students will develop an understanding of the attributes of design. (ITEA/STL 8)
- Students will develop an understanding of engineering design. (ITEA/STL 9)
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving. (ITEA/STL 10)
- Students will develop the abilities to apply the design process. (ITEA/STL 11)
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/STL 12)

Science: Benchmarks for Science Literacy (AAAS, 1993)

- The Nature of Technology/Technology and Science (AAAS 3A)
- The Physical Setting/The Earth (AAAS 4B)
- The Living Environment/Flow of Matter and Energy (AAAS 5E)
- The Human Organism/Basic Functions (AAAS 6C)

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

- Measurement
- Representation

Benchmarks

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

- Management is the process of planning organizing and controlling work. (ITEA/STL 3EE)
- Design is a creative planning process that leads to useful products and systems. (ITEA/STL 8E)
- There is no perfect design. (ITEA/STL 8F)
- Requirements for a design are made up of criteria and constraints. (ITEA/STL 8G)
- Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. (ITEA/STL 9G)

- Modeling, testing, evaluating and modifying are used to transform ideas into practical solutions. (ITEA/STL 9H)
- Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it. (ITEA/STL 10G)
- Apply a design process to solve problems in and beyond the laboratory-classroom. (11-H)
- Specify criteria and constraints for the design. (ITEA/STL 11I)
- Make two-dimensional and three-dimensional representations of the designed solution. (ITEA/STL 11J)
- Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints and refine as needed. (ITEA/STL 11K)
- Make a product or system and document the solution. (ITEA/STL 11L)
- Use computers and calculators in various applications. (ITEA/STL 12J)

Science: Benchmarks for Science Literacy (AAAS, 1993)

- 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 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)
- Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight. (AAAS 5E)
- To burn food for the release of energy stored in it, oxygen must be supplied to cells and carbon dioxide removed. Lungs take in oxygen for the combustion of food and they eliminate the carbon dioxide produced. (AAAS- 6C)

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

- Use representations to model and interpret physical, social and mathematical phenomena. (NCTM Representation)
- Solve problems involving scale factors, using ratio and proportion. (NCTM Measurement)
- 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. (NCTM Measurement)
- Understand relationships among units and convert from one unit to another within the same system. (NCTM Measurement)

Purpose of Unit

This unit introduces students to the engineering challenges involved in supporting a sustained, human presence on the lunar surface.

Unit Objectives

Lesson 1: Identifying Criteria and Constraints

Students will:

- Explain how invention and innovation relate to the development of new products, processes and systems.
- Identify criteria and constraints related to the design and development of a lunar plant growth chamber on the lunar surface.
- Explain that requirements for a design are made up of criteria and constraints.

- Explain why there is no perfect design.
- Explain that an organism uses oxygen to burn food to release energy and that the energy was originally from sunlight.
- Identify the four main goals in the Vision for Space Exploration.
- Determine the approximate ratio of two areas.

Lesson 2: Let's Design

Students will learn to:

- Explain that design is a creative planning process that leads to useful products and systems.
- Identify criteria and constraints related to the design and development of a plant growth chamber on the lunar surface.
- Apply the engineering design process to solve a problem.
- Identify and describe the major steps in the engineering design process.
- Explain that brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
- Use criteria and constraints related to the design and development of a plant growth chamber to brainstorm possible design solutions.
- Analyze possible solutions to the design challenge.
- Select an approach to the design challenge.

Lesson 3: Turning Designs into Reality

Students will learn to:

- Develop a design proposal for a lunar plant growth chamber.
- Develop a production plan for a prototype lunar plant growth chamber.
- Explain that management is the process of planning organizing and controlling work.
- Describe how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions.
- Make two-dimensional and three-dimensional representations of the designed solution.
- Apply the engineering design process to solve a problem.
- Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints and refine as needed.
- Make, analyze and refine a prototype of a lunar plant growth chamber and document the solution.

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