Activities—Designing Spacesuits for Mars

Technology Education, Science, and Mathematics

Introduction:

The steps spacesuit engineers and technicians followed in achieving a goal of creating reliable spacesuit systems for exploration of the surface of the Moon and for construction and maintenance work in Earth orbit were the same as those used in nearly every technological endeavor:

Challenge
Design and construct a protective garment that will permit humans to venture safely into outer space and perform work.

Research
Investigate the environment in which the garment will be worn and determine what protective measures must be employed.

Management
Organize the effort into teams that design suit subsystems and investigate and select appropriate materials and technologies.

Fabricate Prototypes
Construct and assemble suit subsystems into the completed garment.

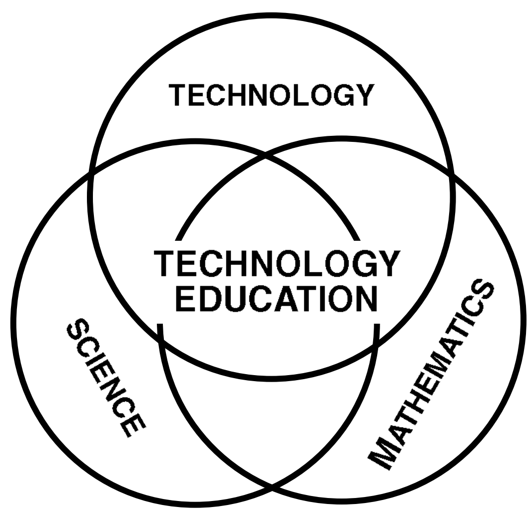
Evaluate
Test the garment in a simulated space environment and make modifications where needed.

Manufacture
Construct operational spacesuits.

Ongoing Evaluation
Continue refining spacesuit subsystems to improve efficiency, reliability, versatility, and safety while lowering costs.

The pages that follow outline a multifaceted technology education activity on spacesuits. This activity, designed for an entire class to work on as a team, combines skills and content from science, mathematics, and technology. The challenge is to design and build a full-scale wearable model spacesuit to be used to explore the surface of Mars. Since no human expeditions to Mars are planned for many years, actual Martian spacesuits have not yet been built and there are no "right" answers. Consequently, this activity permits students to participate in "leading edge" research.

The overview of the activity is contained in a Design Brief format. It begins with a title and a context statement (introduction) and is followed by a challenge to create a Martian spacesuit. This is followed by information on materials, equipment, procedures, and evaluation. The success of the activity depends upon how well the students organize their work and communicate with each other. A computer with project software can be used to monitor the progress of the project or a flow chart can be constructed on a chalk or bulletin board. As an added aid to communication, Interface Control Documents (ICD) are created as systems are designed.(Reproducible master on page 49. Sample



Technology Education is a multi-disciplinary subject combining mathematics, science, and technology.

document on page 50.) These documents are completed by the teams. Critical details about systems, such as size, shape, and function, are recorded on the form. The form has a grid where diagrams can be made. ICD forms are then placed in a notebook and made available to all teams as a coordination tool. An ICD master is provided.

If desired, the project can be divided among several classes (or even several schools) which will each have to work together. This is the way major NASA projects are divided between contractors and subcontractors located across the country.

To support the activity, a collection of Teacher Tech Briefs (TTB) are included. These briefs provide suggestions for your use when guiding students in accomplishing their tasks. For example, if student teams conclude that high-speed particles (micrometeoroids) are a problem in the Martian environment, plans are provided for a device that measures impact damage to materials. TTBs are not intended as "blue prints" for students to use. Rather, they provide information on one of many ways in which the task can be accomplished. Students will build an impact test stand of their own design. TTBs aid you in facilitating the students' ideas. Following the TTBs is a section on spacesuit testing apparatus used at the NASA Johnson Space Center. The apparatus are "one of a kind" devices created by following the same design process students will use.

Exploration Briefs (EBs) are suggestions for activities that can be used to help students understand the nature of the environment for which they are designing a spacesuit. They provide background information and instructions for simple demonstrations and experiments that may be tried. A "bank" of additional ideas follow the EBs.

The guide concludes with appendices that list resources, such as NASA publications and Internet web sites, where students can obtain more information to help them in their research and development work.

Design Brief

Context:

Spacesuits are one of the important enabling technologies that have permitted humans to explore outer space. To survive the hostile environment, humans had to be covered with a protective shell as they exited their spacecraft. This shell contained a part of Earth's surface environment while remaining flexible and impervious to the unique hazards, such as high-speed particle impacts, encountered there. These requirements meant that engineers and technicians had to spend long hours investigating and selecting appropriate materials, finding ways of fabricating and joining suit parts together, and providing operating pressure, power, and communications while assembling a garment that was tough but flexible. The task was achieved with such great success that astronauts and cosmonauts have safely conducted thousands of hours of extravehicular activity.

Challenge:

Design and build a protective garment that will permit future space travelers to explore the surface of Mars. The garment must protect the person inside from the hazards of the Martian environment while remaining comfortable to wear. Excursions on the surface will nominally last 8 hours, but the garment will have to function as long as 10 hours in emergency situations. The garment must be flexible enough to enable the wearer to walk up to 10 kilometers, collect geologic samples, and operate a variety of tools and experimental apparatus. Furthermore, the garment's design must be rugged enough to permit repeated use and be able to be serviced simply and quickly. Along with the garment, design a collection of geologic sampling tools, such as rock hammers, and a general set of tools for assembly and repair activities. These tools should be easy to use while wearing the protective garment, be safe and rugged, and interface with a general purpose tool carrier that must also be designed.

Procedures:

Select subcontractor teams to design and construct each of the garment's components, such as the helmet or gloves. Teams will coordinate their work with each other as materials for and sizes of the components are selected.

Materials:

Use whatever materials you find to construct the garment's components. Test these materials to ensure they will survive the Martian environment. Existing tools can be modified for use on Mars.

Evaluation:

Conduct periodic team evaluations of the progress of the garment and tool design process. When all components are completed, integrate them for a full test in a simulated Martian environment. Evaluate the garment and tools on the basis of the criteria presented in the context section.

Interface Control Document

Page ________ Of ________

System Name: ____________________

Team Members

Project No. ____________________

____

Date: ____________ Rev. No. ____________

____

Briefly explain how this system functions.

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Interface Control Document

Page 1 Of 1

System Name: Space Helmet

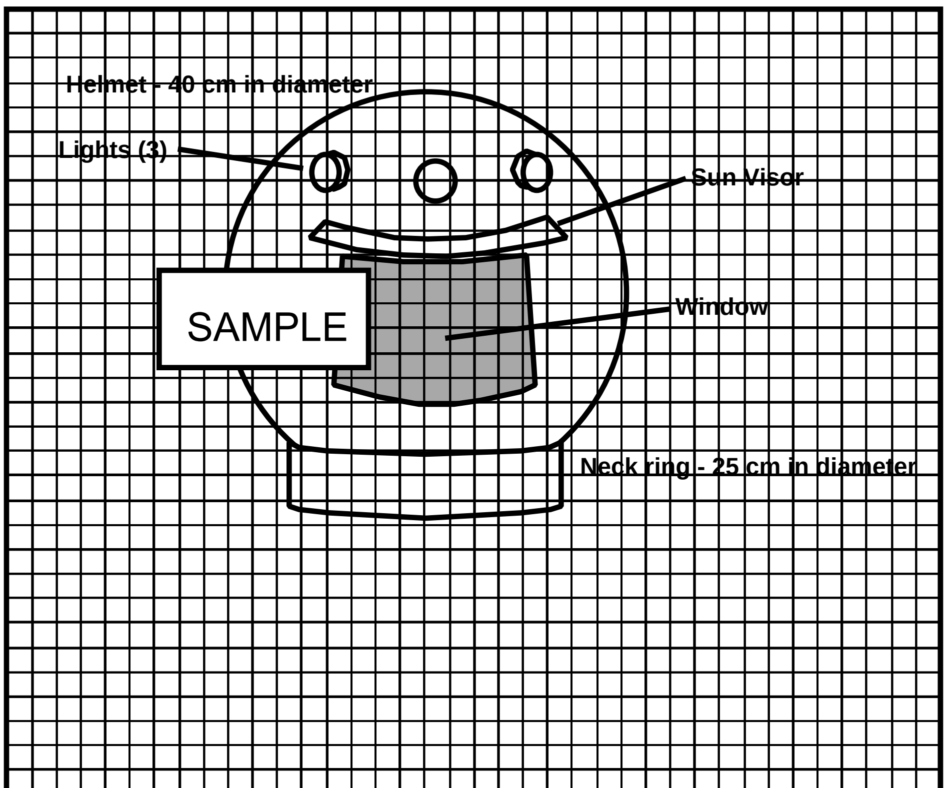
Team Members

Project No. 8

Peter

Date: Nov. 22, 1997 Rev. No. 4

Kiesha



SCALE: 1:5	MASS: 5 kg	POWER REQUIREMENTS: 6 volts

Briefly explain how this system functions.

The helmet seals off the top of the suit. It has a window for looking out and a sun visor. The neck ring connects to the shoulders of the suit.

Interface Control Documents are a communication tool that helps the various Martian Surface Exploration Suit design teams to coordinate with each other. This sample shows a design for a space helmet. The team working on the upper torso will learn from this document how large the connection with the helmet has to be.