ROKENBOK EDUCATION

STEM-Maker CURRICULUM

Aerospace Engineering:

Space Tools

Project Based Integrated STEM

A STEM-Maker Research and Design Project

Context and Rationale

- ✓ *The study of space travel and space habitation.*
- ✓ *Understanding the challenges of planning and working with tools in a zero-gravity environment.*
- ✓ *Researching possible solutions for a variety of tasks to be performed in space, such as tightening bolts and nuts, connecting modular components, retrieving mineral samples, and conducting experiments.*
- ✓ *Designing special tools that can be used with bulky space gloves and space suits.*
- ✓ *Understanding and applying mechanical systems and how they can be used in space.*

Introduction

This STEM-Maker project is appropriate for middle and senior high school levels and is recommended for students working in pairs or small teams up to four students. This project is designed to promote creative thinking, problem solving, innovation, invention, and provides an excellent applied learning experience for all STEM students.

Welcome

Activity Information

This activity will require students to use the process that designers and engineers use to solve problems. Students will walk through each step of the design and engineering process as they develop their own solution to a problem.

Classroom Management

This activity packet should serve as a guide for students as they develop creative solutions to problems. Students can work in groups of up to four to research, design, and engineer their own solution to a thematic problem.

Resources Needed

Rokenbok Advanced Projects Lab

Activity Time

120-180 Minutes

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Design Project

Aerospace Engineering

Design Brief: Scenario

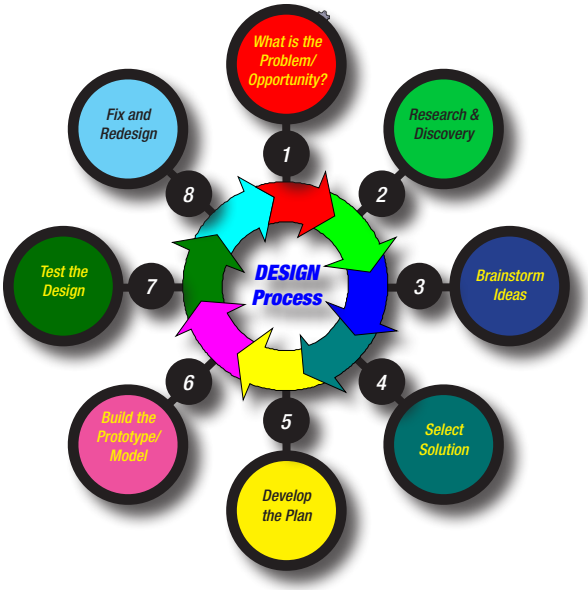
The Rokenbok Exploratory Space Agency (RESA) is in the process of developing plans for a space colony on the planet of Mars over the next ten years.

The building and assembly of a space colony on another planet is a difficult task that requires intense planning and preparation. Specially designed tools and equipment will need to be developed to collect samples for scientific study.

Design Project

Your design team has been contracted by RESA to design and build a set of three special tools to accomplish three specific tasks. These include: a rock gripper capable of gripping martian rocks, a prototype of a mobile, 3D printer system that includes an x,y, and z axis, and a scoop arm capable of digging martian soil and moving it from one location to another.

Time is of the essence and your team must work together to prepare your scale models for presentation. Each team should work through each step of the design process to research, protoype, and develop a high quality design.



Design Project
Aerospace Engineering

Constraints and Specifications

To successfully complete this design and engineering project, the following constraints and specifications must be followed:

- ✓ *Design and build a rock gripper that is capable of grasping and holding various size Martian rock specimens and samples. The gripper arm must be extendable and retractable at least 30cm, and should be easy to operate, even when used by an astronaut with a space glove on his/her hand.*
- ✓ *Design and build a mobile 3D printer system that can be easily set up anywhere on the martian surface. System must showcase functional x, y, and z axis. Work area should be at least 40cm x 40cm.*
- ✓ *Design and build a scoop arm that can be used to scoop up one cup of soil or rock samples in a single scoop. Scoop arm must be easily operated by an astronaut with a space glove on his/her hand. Length should not exceed 60cm.*
- ✓ *All space tools should be designed for minimal storage space. Minimal use of materials should be used to help reduce weight and size.*
- ✓ *Each team should prepare to deliver a presentation demonstrating each space tool developed.*

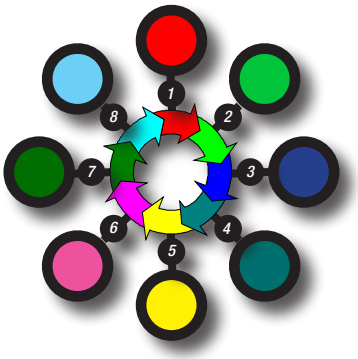
Evaluation

Students will be evaluated on the following criteria:

- *Creativity and design*
- *Functionality of designed unit*
- *Time management and teamwork*
- *Successful completion of the project*
- *Adherence to constraints/criteria*

Use the Rokenbok Universal Performance Rubric for evaluation. Available for download at RokenbokEducation.org

Design Project
Aerospace Engineering



Using the Design and Engineering Process

Use the steps in the design and engineering process to develop a high quality design.

Step 1: ***What is the Problem/Opportunity?***
Space tools need to be developed to conduct research on Mars.

Step 2: ***Research and Discovery***
Check out availability of materials and how to build highly functionable space tools.

Step 3: ***Brainstorm Ideas***
List all the ideas that you have found, then look at the pros and cons for each idea, considering each one carefully before making a final decision.

Step 4: ***Select a Solution***
Identify the best solution and move forward with your designs.

Step 5: ***Develop a Plan***
Once you have made a decision on which solutions you think are best, then put together a good plan for designing and building your custom space tools.

Step 6: ***Build a Prototype/Model***
Build working models of your designs.

Step 7: ***Test the Design***
Once you build your prototypes or models, test your designs to make sure that they meet all constraints and specifications.

Step 8: ***Fix and Redesign***
If you have identified any problems or design issues, then go back through the design process to make any needed changes or redesigns.

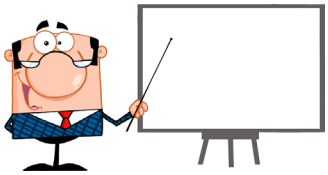
Design Project
Aerospace Engineering

Writing Your Story

After you have completed the design of the space tools, it is important to tell others what you have learned and experienced. One good way to share is to write your story down on paper or on the computer. Some things you might include are:

1. *What were the ideas your team brainstormed?*
2. *Why did you choose the designs that were built?*
3. *What was the most difficult part of your designs?*
4. *What did you enjoy the most about this project? The least?*
5. *What did you learn about design and engineering by completing this project?*

Telling Your Story



An important part to design and engineering is the ability to communicate the design to someone else. Prepare a short presentation to explain the space tools that were built and the process of building them. Make sure you speak loudly and clearly so everyone can hear and understand you. Be enthusiastic and ready to answer any questions that might be asked.

Presenting the Design

When your team has completed the project, it should be presented to your teacher and classmates for evaluation.

Your grade will be determined by how well you do on all grading criteria. These include:

Specifications	*Were all design constraints met?*
Design Quality	*Are the space tools built well? Are they highly functionable?*
Time Management	*Did you get your project done on time? Did you use your time wisely?*
Aesthetics	*Do the tools look good?*
Story	*Were you able to clearly communicate the design by writing a story?*
Presentation	*Did you make a good presentation? Were you interesting and engaging?*

STEM Concepts

AEROSPACE ENGINEERING: SPACE TOOLS

Science

Students will use and reinforce these science concepts:

- *Simple machines including levers and pulleys*
- *Mechanical advantage of simple machines*
- *Structural analysis*
- *Mechanical systems*
- *Astrophysics*

Technology and Engineering

Students will use and reinforce these technology and engineering concepts:

- *Prototyping and modeling*
- *Invention and innovation*
- *Structural integrity/strength*
- *Brainstorming and problem solving*
- *Trial and error engineering concepts*

Math

Students will use and reinforce these math concepts:

- *Calculating size and space*
- *3D conceptualization, X, Y, and Z axes*
- *Linear measurement and scaling techniques*
- *Measuring area, volume, and distance*
- *Measuring mass and weight*

Standards

This design project is based on the following national standards:

- *The Next Generation Science standards*
- *Common Core standards*
- *Standards for Technological Literacy*
- *Endorsed by the International STEM Education Association*