

Aerospace Engineering:

Space Station

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 space exploration, including zero-gravity, time and distance, and lack of essential life support systems.*
- ✓ *Researching possible solutions for sustaining life on other planets, moons, or other celestial elements.*
- ✓ *Designing space transportation systems, space communications, and space habitats that support human life.*
- ✓ *Understanding and applying laws of motion, fluid mechanics, and conservation.*



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

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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.



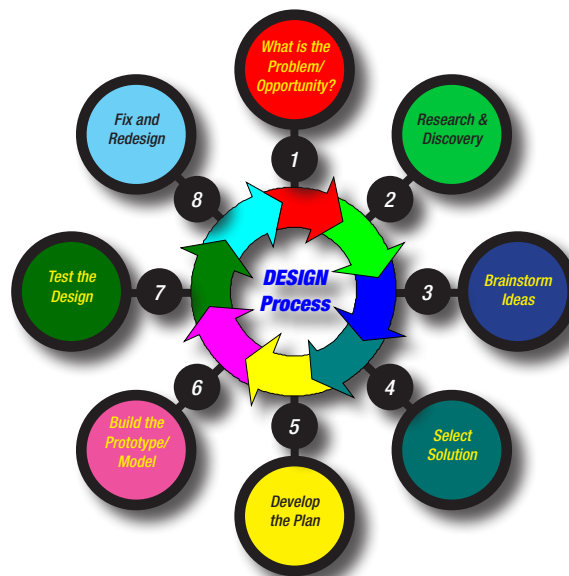
To facilitate the transportation and structural systems that need to be taken into space, RESA has determined that an orbiting space station would be needed in earth's orbit to support this ambitious effort. Components for a future space colony would be stored in space and transported to Mars at a later date.

Design Project

Your design team has been contracted by RESA to design and build a working prototype of a possible space station concept. Launching capacity into space is limited, so the new space station should be built in multiple, smaller modules that can be launched into space and then assembled to create the needed spaces. These include living areas, work areas, personal hygiene and exercise areas, energy production systems, water and air generation management systems, and docking and transfer areas.



Time is of the essence and your team must work together to prepare your scale model for presentation to RESA at their next planning meeting.



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Constraints and Specifications

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

- ✓ *The space station must be designed to support a three-person crew with accommodations for up to twelve additional astronauts at any given time.*
- ✓ *The space station should be designed as individual modular components that can be transported into space by RESA launch vehicles. The maximum size of any module is 30cm wide x 30cm tall x 40cm long.*
- ✓ *The space station should include living areas, work areas, personal hygiene and exercise areas, energy production systems, water and air generation and management systems, and docking and transfer areas.*
- ✓ *The individual components should be designed to connect easily when they arrive in space. There is no limit on the completed size of the space station.*
- ✓ *The space station should have the capacity to store additional modular components that will be used for the RESA martian space colony to be built in the future.*
- ✓ *Your team should prepare to deliver a multimedia presentation to RESA about the merits of your space station model and design.*

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

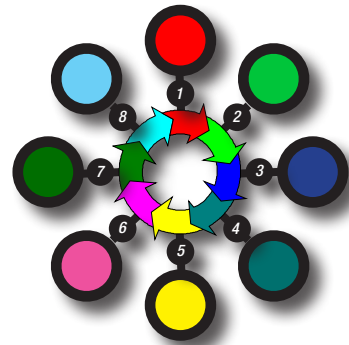


Use the Rokenbok Universal Performance Rubric for evaluation. Available for download at RokenbokEducation.org

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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?

A space station needs to be designed and engineered.



Step 2:

Research and Discovery

Check out availability of materials and how to build a high quality space station that meets certain specifications.



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 design.



Step 5:

Develop a Plan

Once you have made a decision on which solution you think is best, then put together a good plan for designing and building a custom space station.



Step 6:

Build a Prototype/Model

Build a model of your design.



Step 7:

Test the Design

Once you build your prototype or model, test your design to make sure it meets 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.

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Writing Your Story

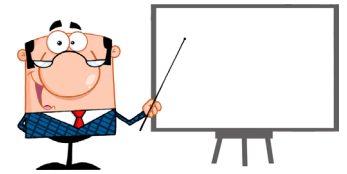
After you have completed the design of the space station, it is important to tell others what you have learned and experienced. One good way to share is to write your story down on paper or on the computer. Some things you might include are:



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 design?
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 station that was built and the process of building it. 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	Is the design built well? Is it highly functionable?
Time Management	Did you get your project done on time? Did you use your time wisely?
Aesthetics	Does the design look good? Is it well balanced?
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

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Science

Students will use and reinforce these science concepts:

- Applications of simple machines including wheels and axles, levers, and pulleys
- Materials science
- Concepts of zero-gravity
- Space astronomy
- 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
- Measuring temperature
- 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