ROKENBOK EDUCATION

STEM-Maker CURRICULUM

Aerospace Engineering:

Space Colony

Project Based Integrated STEM

A STEM-Maker Research and Design

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

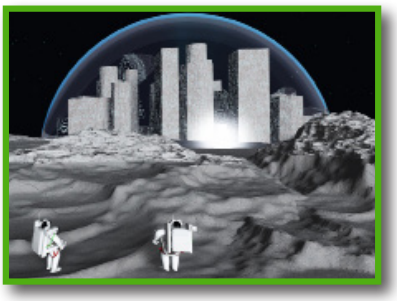
Aerospace Engineering

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.

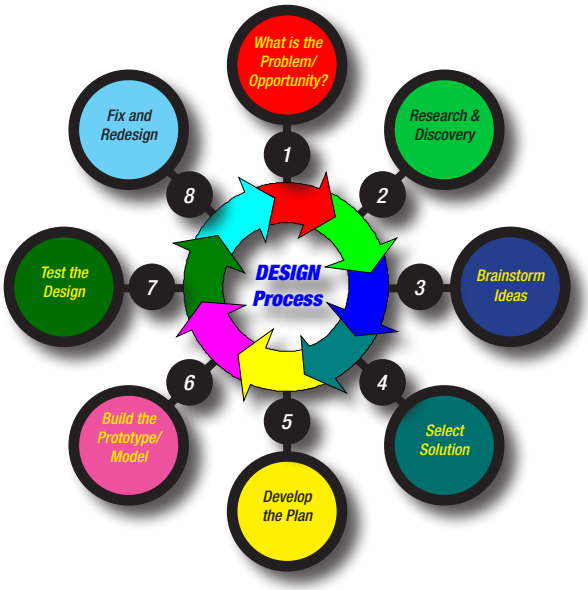
Plans are to transport pre-fabricated components and structures to Mars to support a team of aerospace scientists as they explore the feasibility of sustaining life on Mars. One concept that will be tested is the idea of using existing martian surface dust as a filler material for large-scale 3D printing systems that will be used to construct living and working structures right on Mars.

Design Project



Your design team has been contracted by RESA to design and build a working prototype of a possible space colony concept. Launching capacity into space is limited, so the new space colony should be built in multiple, smaller modules that can be launched into space and then later assembled on Mars. These necessary life support systems must 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.

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.



Design Project
Aerospace Engineering

Constraints

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

- ✓ *The space colony must be designed to support up to twelve aerospace scientists, engineers, and astronauts.*
- ✓ *The space colony 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 colony 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 on Mars.*
- ✓ *Your team should prepare to deliver a multimedia presentation to the RESA about the merits of your space colony model and design.*

Evaluation

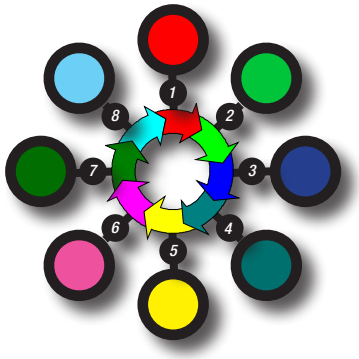
Students will be evaluated on the following criteria:

- *Creativity and design*
- *Functionality of designed unit*
- *Time management and teamwork*
- *Successful completion of the challenge*
- *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?***
A space colony needs to be designed and engineered.

Step 2: ***Research and Discovery***
Check out availability of materials and how to build a space colony 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 colony.

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.

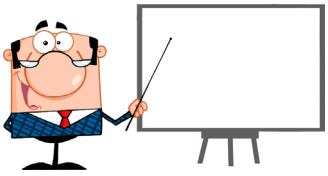
Design Project
Aerospace Engineering

Writing Your Story

After you have completed the design of the space colony, 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 colony 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

AEROSPACE ENGINEERING: SPACE COLONY

Science

Students will use and reinforce these science concepts:

- *Developing descriptions, explanations, predictions, and models using evidence*
- *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*