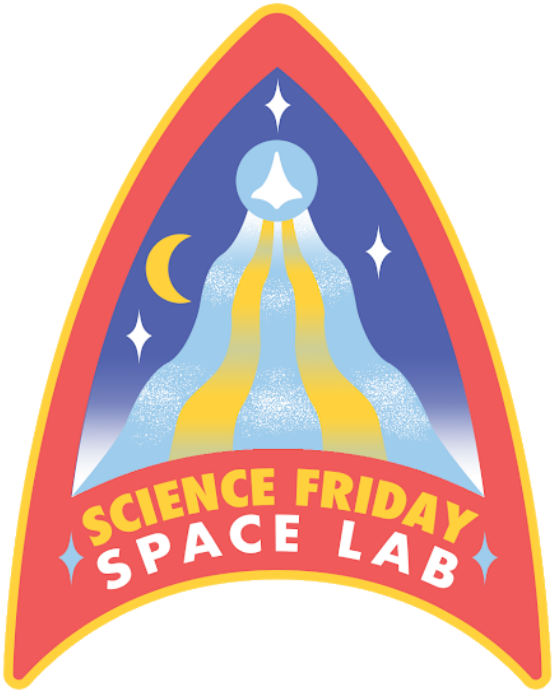


Mission Engineer Workbook

WWW.SCIENCEFRIDAY.COM

Created by Science Friday Educator Collaborator Jennifer Powers

MISSION BRIEF

Welcome to the Science Friday Space Lab!

Our mission is to design and develop tools that will help us further our space exploration goals. As a member of our engineering team, you will be designing new equipment for astronauts heading to planets and moons in our solar system.

Specifically, you have been tasked with designing new astronaut gloves. Gloves are important tools for astronauts when exploring a new planet or moon because they protect hands and are also integral for collecting surface samples.

We have identified six target locations as top priorities for space travel and exploration:

- Venus
- Europa
- Io
- Titan
- Mercury
- Mars

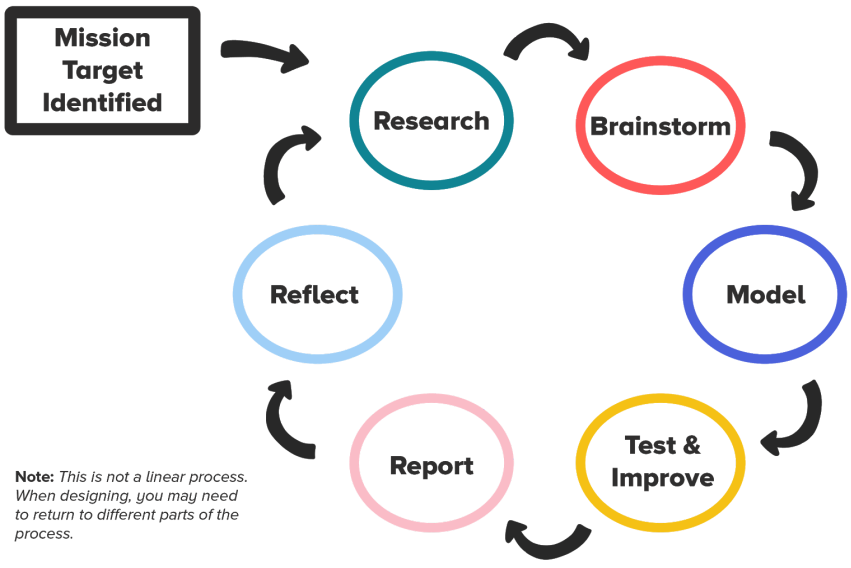
If you have a Mission Commander (instructor), they will give further details on your **Target Destination** (the planet or moon) to inform your glove design. (If you are working without a commander, then select a destination by looking at the Challenge Cards.)

YOUR MISSION

Design a glove that will allow astronauts to safely complete their mission to collect surface samples (rock, ice, or sand) from their target destination.

Design Protocol

As engineers in the Science Friday Space Lab, you will use an engineering and design protocol to develop your glove designs. Specific question prompts for each stage of design are included on the following page to help orient you to your task.



Note: *This is not a linear process. When designing, you may need to return to different parts of the process.*

Created by Science Friday Educator Collaborator Jennifer Powers

Glove Design Specific Design Protocol

Be sure to review mission information and your challenge card information before you begin designing.

Research

Collect information about your destination that will help you design your glove.

- *What surface conditions are you designing for?*
- *What would we collect or possibly discover about your destination?*
- *What are ideas from nature that might help your design?*

Brainstorm

Use your research and mission directive to generate some possible glove designs.

- *What are the design constraints based on your research?*
- *What are some initial ideas for features of your glove?*
- *What materials will work best in your design?*
- *Create a labelled design sketch.*

Model

Construct a model of your glove design using your selected building materials.

- *What challenges did you encounter while constructing your model?*
- *Did you use any materials as a "stand-in?" If so, describe the material you are representing.*

Note: If your design doesn't work in fabrication, head back to the brainstorming section.

Test & Improve

Design a test and then test your glove model based on your mission objective and conditions at your target destination.

- *Where should the tests take place? What conditions do you want to simulate?*
- *How did the glove perform on your test?*

Based on your gloves performance, go back and revise your design.

Report

Document the details of your model to prepare for prototyping.

- *What will the final product look like?*
- *How does the design work? Where in nature can we look for inspiration?*
- *What are the materials and their function in the design?*
- *Describe how it will be used by astronauts to pick up samples.*

Reflect

Consider these questions as you reflect on your design:

- *What worked well? What would you change?*
- *If you could use unlimited materials, what would you change about your design?*
- *Where else might you look for inspiration for your design?*

Created by Science Friday Educator Collaborator Jennifer Powers

Research

Use this guide to research your target destination, Earth test site, and nature inspiration.

Target Destination	

Suggested Resources:

- NASA Planets Overview
- NASA Moons Overview
- NASA Mission Information
- The Biomimicry Institute

Topic	Research Notes
Surface Conditions	*What surface conditions are you designing for?*
Astronaut Considerations	*What type of surface samples would the mission collect?*
	What might harm astronauts? (Be sure to account for ideal and extreme conditions that the human body can withstand on Earth when answering.)
	How will your glove protect astronauts?
Earth Test Site	*Where on Earth will you test your glove? Why is it a good fit?*
Nature Inspiration	*Describe 1-2 ideas from nature that might influence your design.*

Brainstorm

1. Identify design constraints.

Target Destination	*Name:*
	What surface conditions are important to consider? *What dangers to humans does your target destination pose?*
Mission Fulfillment	*What type of surface samples will the astronauts collect?*
Earth Test Site	*Where will you test your glove?* *What conditions make it helpful as a test site?*

2. Jot down initial design ideas.

Created by Science Friday Educator Collaborator Jennifer Powers

Brainstorm

3. Conduct a materials analysis and plan your budget.

NOTE: *You may only use FOUR materials in your design in addition to your tools (glove, tape, scissors).*

Material	Ideas about function.
1.	
2.	
3.	
4.	

4. Create a design sketch.

- *Use the space below to create or attach your design sketch.*
- *Remember to label your sketch with materials and notes to provide a clear idea of your design.*

Mission Commander Approval: _____

Model

As you build your model, document your process and challenges.

- *What challenges did you encounter while constructing your model?*
- *Did you make any substitutions?*
- *Did you use any materials as a "stand-in?" If so, describe the material you are representing.*

Process	Challenges

Created by Science Friday Educator Collaborator Jennifer Powers

Test & Improve

Testing your design during the building process can reveal flaws and areas for improvement. Remember, future astronauts using your glove will need to collect surface samples!

1. Design your test.

Use your research to help you design a test that will help you determine how your glove will perform when picking up a surface sample.

Surface Conditions	*What samples will the astronauts collect from your planet or moon?*
Surface Simulation	*Describe how you are going to simulate the sample collection.*
Test Threshold	*How will testers know your design has been successful?*

2. Conduct your test.

How did the glove perform on your test? Could it pick up a sample similar to the surface substrate of your target planet or moon? What other observations of your design do you have?

Test & Improve

3. Brainstorm improvements.

- *If you are unable to collect a simulated surface sample, consider how your design must change to become successful.*
- *Even if sample collection is successful, are there ways you could improve the efficiency of your design? The comfort? The cost of production?*

4. Sketch a revised design.

Don't forget to label your designs.

Design Fabrication Report

In order to create a prototype of your gloves, you must document every aspect of your model so you and others can make additional, identical copies in the future.

Final Sketch

Don't forget to add labels to your sketch to identify materials and

Design Overview

Summarize your design and how it works. How did nature inspire your design?

Design Fabrication Report

Detailed Design Description

Describe each material and its intended function. Use pictures to illustrate.

Material & Picture	Function

Design Use

Describe how astronauts will use your design on their target planet or moon to collect a surface sample.

Created by Science Friday Educator Collaborator Jennifer Powers

Reflect

Consider these questions as you reflect on your design experience.

What about your design worked well?	
What would you change if you could redesign your glove?	
Would testing your model glove in the field produce useful results? Why?	
How would your design change if you could use unlimited materials?	
Where else do space engineers look for design inspiration, besides nature?	