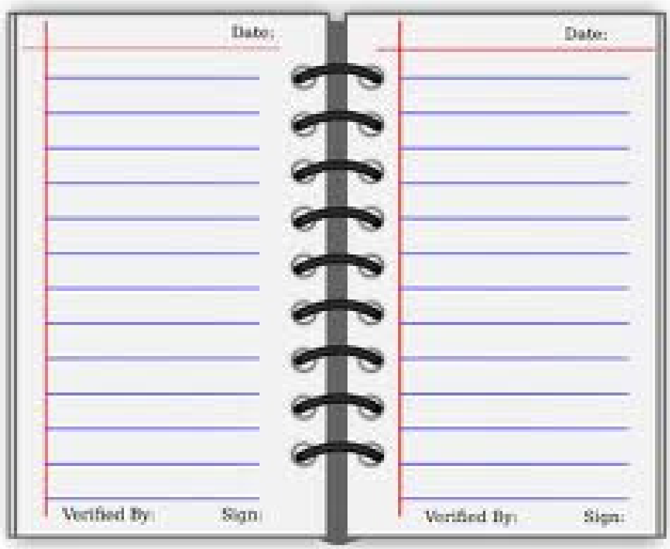
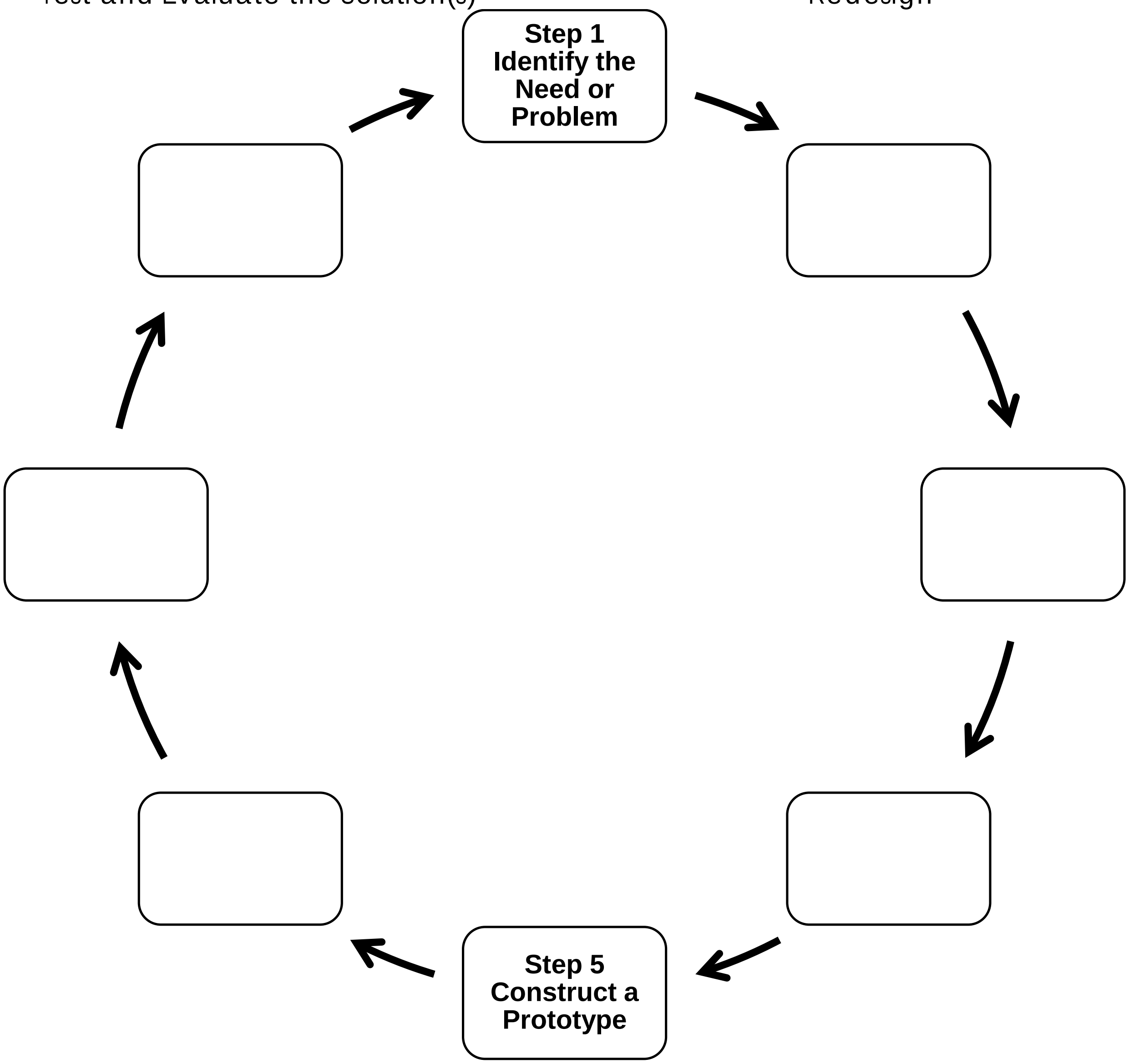
Student Team Challenge Journal



Engineering Design Process

Directions for the Students: Can you determine the sequence that engineers take to make a completed design? On your own, try to label the steps of the Engineering Design Process. Put the rest of the steps below in order based on the two that have already been filled in for you.

~~Identify the Need or Problem~~
~~Construct a Prototype~~
Research the Need or Problem
Test and Evaluate the Solution(s)
Select the Best Possible Solution(s)
Communicate the Solution(s)
Develop Possible Solution(s)
Redesign



Step 1: Identify the Need or Problem

Background

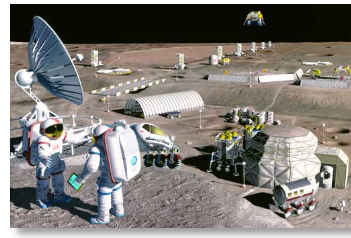


Figure 10.—Artist's concept of a potential lunar outpost. (NASA)

Future astronaut crews will need to learn how to grow safe, edible, and nutritious plants while living and working in space during long-duration missions. The lunar environment is so extreme that astronauts or plants are not able to live on the lunar surface without a protective habitat. Because of the extreme environment, the lunar habitat must provide the plants with light, water, and atmosphere. All the essential supplies and materials needed to survive on the Moon will be stowed on a rocket, shipped to the Moon, and deployed on the surface. There is a limited amount of space available on the rocket for the large amount of needed lunar cargo. The mass and the volume of the stowed cargo must be closely monitored for fuel efficiency and the limited storage on the rocket.

The Challenge

You and your team will have the task of engineering a tabletop model of a plant growth chamber that can be folded, stowed, and shipped on a rocket destined for the Moon. When the shipment arrives, the future lunar astronauts will then be able to expand the plant growth chamber and deploy it on the lunar surface. Because this project is in the development stage, the team will only need to design, build, and present a tabletop model of the plant growth chamber rather than a full-sized, lunar structure that is designed to grow enough food for the entire lunar crew.

Criteria and Constraints

The plant growth chamber must meet the following criteria and constraints:

1. On the rocket, the plant growth chamber model must **not exceed** a mass of 50 grams and a stowed volume of 1000 cm^3.
2. The deployed plant growth chamber can be any shape, however, the volume cannot exceed 1,000,000 cm^3.
3. The deployed plant growth chamber may or may not be connected to the lunar habitat, but it must have a way for the astronauts to have access to the chamber.
4. The model plant growth chamber must use a system of expansion from its stowed shipment package on the rocket to its final deployed structure on the Moon.

Based on this information and the challenge introductory video, answer the following questions.

1. Using your own words, restate the problem in the form of "How can I design a __________ that will ___________?" Be sure to include all expected criteria and constraints.

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2. What general scientific concepts do you and your team need to consider before you begin solving this need or problem?

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Step 2: Research the Need or Problem

Conduct research to answer the following questions related to the challenge problem. Cite where you found your information on the Source(s) lines below.

1. Who is currently working on this or a similar problem today? What solutions have they created? What solutions are they working on currently?

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Source(s): ____

2. What questions would you ask an expert who is currently trying to solve problems like this one?

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3. Who in our society will benefit from this problem being solved? How could this relate to everyday use?

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Source(s): ____

KLEW Chart for Students

Student Name:___________________________ **Team Name:** _________________________

This Challenge is _________________________

Know	Learn	Evidence	Wonder
What do I know about plants and plant growth chambers?	What did I learn about plants and plant growth chambers based on my research?	What evidence do I have that supports what I learned about plants and plant growth chambers?	What am I still wondering about plants and plant growth chambers?

Step 3: Develop Possible Solutions

Sketch your idea in the space below and label each part of your drawing. If you need more space, use a blank sheet of paper.

Step 4: Select the Best Possible Solution(s)

Collaborate with your team to analyze each team member's final drawing using the table below. Based on the team discussions, determine which parts of each design will be used to solve the problem and which features will be included in the final team drawing.

Design number Designer name	Does this design meet all problem criteria and constraints?	What are the strongest elements of this design?	What needs to be improved?
1			
2			
3			
4			

Step 5: Construct a Prototype

Make a team drawing of your final prototype and have it approved by your educator. Include labels and a key.

Approved by:____________________________

Packing Up for the Moon

1. Are each of the criteria represented in the final design?

Criteria	Addressed in final design?	
1.	Yes	No
2.	Yes	No
3.	Yes	No
4.	Yes	No

2. List what materials the team needs to build the prototype.

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3. Determine who in the group is doing what.

Team member	Responsibility

Budget Planning Worksheet

Team Name:___________________________

Directions: As a team, complete the cost sheet below. Be sure to include all of the materials, quantity, unit cost (determined by your educator), and the total cost to complete your design. Try to keep the cost of your design low while still producing a quality project.

Line item number	Material	Unit cost	Quantity	Item total
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

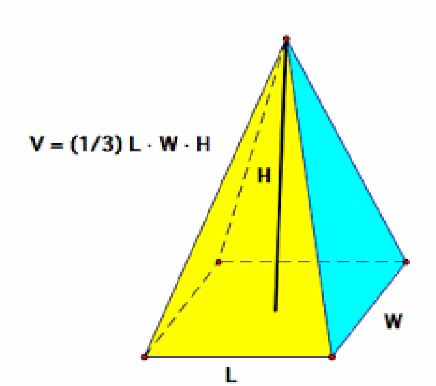
Total cost ______________

Step 6: Test and Evaluate the Solution(s)

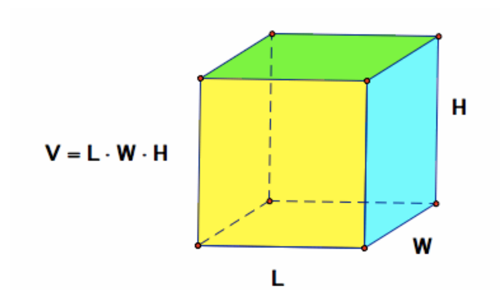
Now that you have built your model, you will need to calculate the volume of your model in both the stowed and deployed positions to be sure it meets the challenge criteria. For each iteration, record the data in the chart below.

Iteration	Model shape	Stowed volume	Deployed volume	Mass
1.				
2.				
3.				
4.				

To calculate the volume, multiply the length, width, and height for both the stowed and deployed model. All of your answers must be labeled as cubic centimeters (cm^3).



Pyramid



Cube

When your model was deployed, were there any issues with the deployment? If so, what were they?

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How did you expand the plant growth chamber from the stowed configuration to the deployed area on the lunar surface?

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Packing Up for the Moon

Make a drawing of the expansion system you designed to expand your model from the stowed position on the rocket to the deployed position on the lunar surface. Be sure to label all of the parts. Use a separate sheet of paper if needed.

You and your team will need to make a map of the lunar surface to show where you are going to place your plant growth chamber in relation to the lunar habitat. How will the astronauts have access to the plant growth chamber? Use a separate sheet of paper if needed.

Step 7: Communicate the Solution(s)

It is not enough to just collect data during testing. Scientists and engineers need to interpret the data so that they can convince others that their results are meaningful. This step will help your team keep a log of the design changes through each design and build cycle. Fill out the table below using information from your initial drawing. Record all changes, no matter how big or small.

Iteration number	What are the key components to your initial prototype?	What do you think caused the design to succeed or fail during testing and why do you think that?
1		

All modifications to your design, both major overhauls and minor tweaks, should be recorded below to track the changes you made. After every test phase, complete the table below by describing changes and summarizing what the test results showed.

Iteration number	What was added, removed, or changed in this iteration of your design?	What do you think caused the design to succeed or fail during testing and why do you think that?
2		
3		
4		
5		

Step 8: Redesign

This step is designed for your team to summarize each iteration and the modifications that you made to the design. Make sure to use the data collected to explain why your team made the changes.

Design cycle	What was added, removed, or changed in this iteration of your design?	What do you think caused the design to succeed or fail during testing and why do you think that?
1		
2		
3		

Did your design meet all of the constraints of the original problem during testing? If not, describe what problems your team discovered.

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What will you do to try to improve your design based on this data?

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How do you predict that these changes will improve the design you just tested?

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Student Reflection Questions

1. Describe any three steps of the engineering design process (EDP).

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2. What design change was the most successful from original drawing to final prototype and why did that make a difference?

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3. How did the EDP help with your design?

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4. What was the most difficult problem your team had to solve and how was it solved?

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5. What are the problems that must be considered in order to grow food on the Moon?

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6. What were the special concerns you had to include in your plant growth chamber design?

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7. Would you like to be an astronaut responsible for growing plants in your chamber on the Moon? Why or why not?

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Team Progress Chart

Student Name:_________________________ **Team Name:** _________________________

How did your team move through the engineering design process steps?

Document each step your team worked through by writing a short description of the work completed by your team. This will help your team stop, discuss, and decide what to do next in the process. After you finalize your design, use this chart to help explain the steps you took to reach your solution and create the script for your video.

Step number	Step name	What did you do and why?	Documentation for the video

Student Presentation Organizer

Organize notes and review the evidence to present in the video your team will be creating below.

Welcome	Introduce your team, provide the title of your video, and explain what challenge your team worked on.	
Engineering Design Process Steps	**Ideas for what should be included in each step of the video**	**Take notes on what your team wants to show and say in the video.**
Step 1: Identify the Need or Problem	Talk about the problem and the constraints. Discuss what constraints will need to be met to solve the problem.	
Step 2: Research the Need or Problem	Discuss what your team discovered during the research and the connections with a NASA subject matter expert. Who did you speak with? What did you learn? Where did you find answers to your questions?	
Step 3: Develop Possible Solutions	Briefly discuss each team member's original designs and how it contributed to the final design.	

Step 4: Select the Best Possible Solution(s)	Show what each team member contributed to the original team drawing.	
Step 5: Construct a Prototype	Show materials used and how you built the prototype.	
Step 6: Test and Evaluate the Solution(s)	Talk about how your team tested the design including results. Discuss strengths and weaknesses of your team's prototype.	

Step 7: Communicate the Solution	Talk about your data. Was your team able to solve the problem? Talk about the most difficult issue your team had to solve and how you solved it.	
Step 8: Redesign	What design changes did your team make after testing? Discuss any further actions your team will take on this problem.	