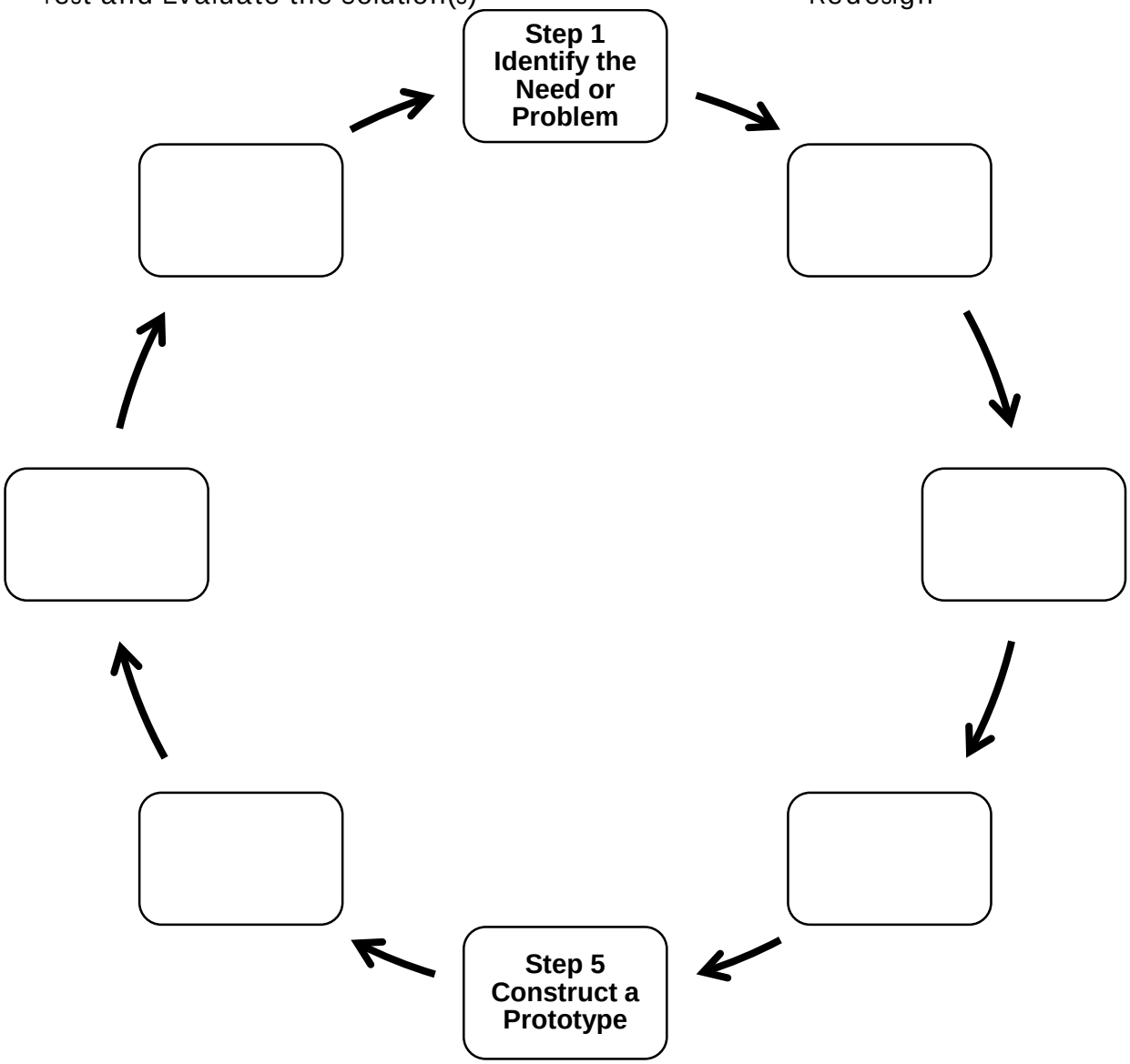
Student Team Challenge Journal

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

NASA and its industry partners are currently working on a space vehicle called the Crew Exploration Vehicle (CEV) that will take astronauts to the Moon, Mars, and other destinations. The CEV will be able to transport astronauts beyond low-Earth orbit and back again. Because the CEV may travel to the Moon, Mars, and other space objects, it must be designed to serve multiple functions and operate in a variety of environments.

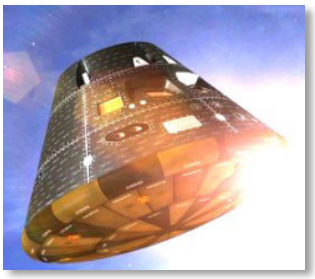


Figure 11.—Illustration of the CEV command module. (NASA)

The Challenge

You and your team will design and build a CEV model that can safely transport two astronauts on a mission to the Moon, Mars, or other space object such as an asteroid. A drop test will be used to determine how well the CEV will protect the astronauts during landing. During the drop test, the CEV will be deployed (dropped) from one, two and three meters to simulate landing. The astronauts must stay securely in their seats during the drop test. Your CEV must have an internal tank for fuel.

Criteria and Constraints

The CEV must meet the following criteria and constraints:

1. The CEV must carry two astronauts safely. Each astronaut is 3- to 7-cm long. You must design and build secure seats for both astronauts. The astronauts should stay in their seats during each drop test without being glued or taped in place.
2. The CEV must have one hatch that opens and closes, and is sized so that your astronauts can enter or exit easily. The hatch should be closed during all drop tests.
3. The CEV must fit within the _____ (fill in the constraint based on the Preactivity Setup in the Materials section). This item serves simply as a size constraint. The CEV should not be stored in or launched from this item.
4. The CEV must include a model of an internal holding tank for fuel with a volume of 30 cm^3 (Note: Your tanks will not actually be filled with a liquid.)
5. The total mass cannot exceed 100 grams. Use a scale or balance to measure the mass of your design components.

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.

_____

_____

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

_____

_____

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?

_____

_____

_____

_____

_____

_____

Source(s):

_____

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

_____

_____

_____

_____

_____

_____

_____

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

_____

_____

_____

_____

_____

_____

Source(s):

_____

KLEW Chart for Students

Student Name:_____ **Team Name:** _____

This Challenge is _____

Know	Learn	Evidence	Wonder
What do I know about CEVs and space travel?	What did I learn about CEVs and space travel in my research?	What evidence do I have that supports what I learned about CEVs and space travel?	What am I still wondering about CEVs and space travel?

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:_____

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
5.	Yes No

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

_____

_____

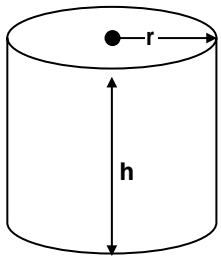
_____

3. Determine who in the group is doing what.

Team member	Responsibility

How to calculate the volume of the internal fuel tank. The volume cannot exceed 30 cm³.

$V = \pi r^2 h$



1. Find the radius of the circle at the top and bottom of the cylinder. The radius (r) is half of the measurement of the diameter of the circle.
2. Square the radius value and multiply it by pi (π)(π = 3.14).
3. Find the height (h) of the cylinder and multiply it by the value calculated in Step 2.

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)

Work with your team to complete the table below. Be sure to record the data from each of your trials.

Vehicle components	Use	Measurement or calculation
Astronauts	Crew	Mass: _____grams each _____ grams total
Crew Exploration Vehicle (CEV)	Carries crew to Moon	Mass: _____ grams
Hatch	Allows entry and exit	Dimensions: _____cm (long) by _____cm (wide)
Internal tank	Stores liquid fuel	Mass: _____grams Volume: _____cm^3
Size constraint _____	Tests size constraints	Volume: _____cm^3

Drop your Crew Exploration Vehicle (CEV) model from 1, 2, and 3 meters and record the dependent variable.

The drop height is the independent variable of this experiment. A dependent variable is determined by the independent variable. The number of astronauts that stayed in their seats during a drop is an example of a dependent variable.

CEV Drop Test Table

Independent variable drop height	Dependent variables
1 meter	
2 meters	
3 meters	

Did the hatch stay closed when the CEV was dropped and what materials did your team use to meet this criteria?

_____

_____

_____

Did your team include internal fuel tanks on the CEV? What was used to represent the tanks?

_____

_____

_____

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.

_____

_____

_____

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

_____

_____

_____

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

_____

_____

_____

Student Reflection Questions

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

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

3. How did the EDP help with your design?

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

5. Why is it important for the hatch to stay closed during the drop tests?

6. Why is it important for fuel tanks on the Crew Exploration Vehicle (CEV) to be internal?

7. What obstacles would astronauts in an actual CEV encounter? How would this influence the seat design?

8. Would you like to be a passenger in a CEV? Why or why not?

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.	