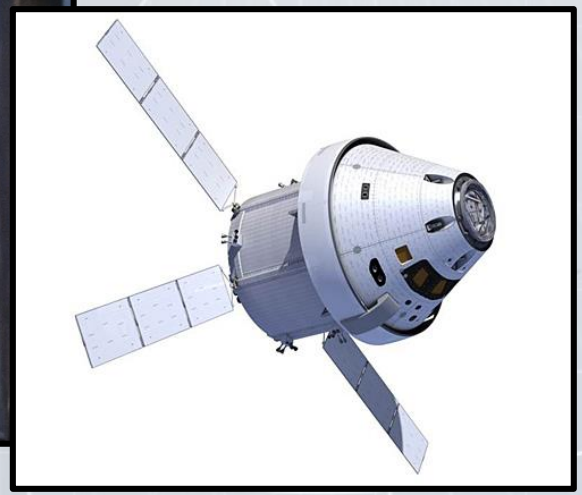
NASA Engineering Design Challenges

Design A Crew Exploration Vehicle



Design a Crew Exploration Vehicle (CEV)

Design a CEV, to serve multiple functions and operate in a variety of environments.

Measuring and Volume

NASA Engineering Design Challenges

Design A Crew Exploration Vehicle

Introduction Video

Watch the introduction video to the challenge.

Select the link below

https://www.y4y.ed.gov/stemchallenge/nasa/challenge-6

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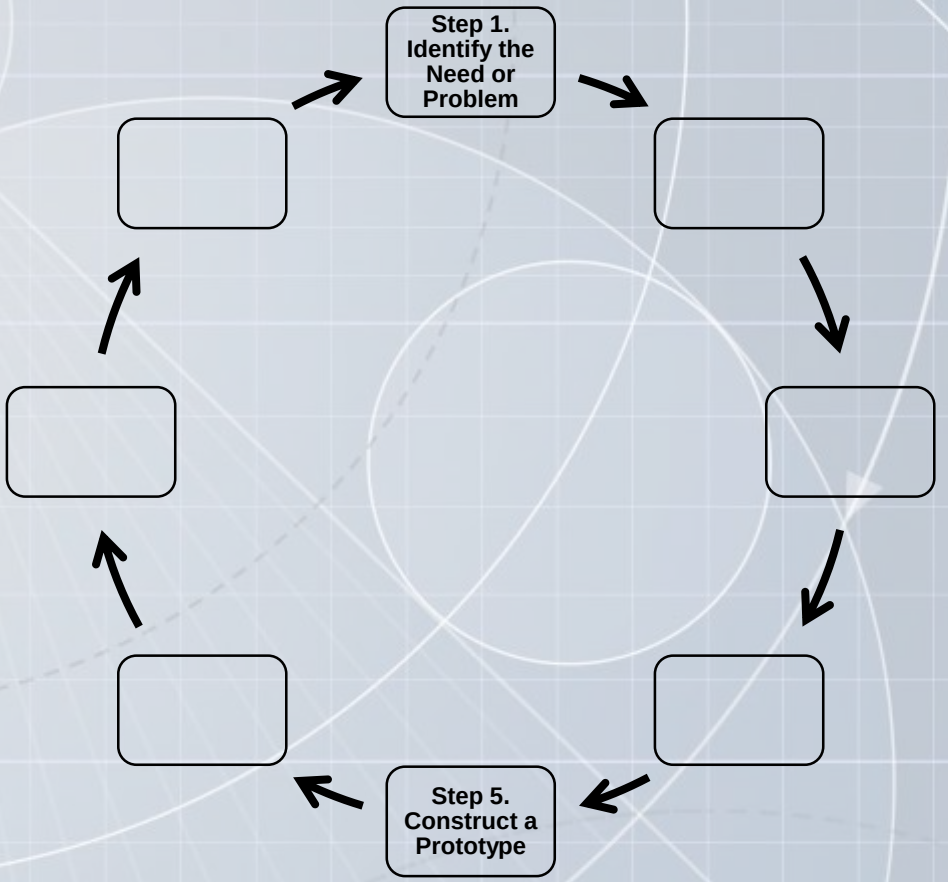
Engineering Design Process (EDP)

<u>Directions for the Students:</u> 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~~
- Select the Best Possible Solution(s)
- ~~Construct a Prototype~~
- Communicate the Solution(s)
- Research the Need or Problem
- Develop Possible Solution(s)
- Test and Evaluate the Solution(s)
- Redesign



Design A Crew Exploration Vehicle

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KLEW Chart

- **KNOW**
- **LEARN**
- **EVIDENCE**
- **WONDER**

KNOW	LEARN	EVIDENCE	WONDER
What do I know about a CEV and space travel?	What did I learn about a CEV and traveling into space after watching the video?	What facts do I know about a CEV and space travel?	What am I still wondering about a CEV and space travel?

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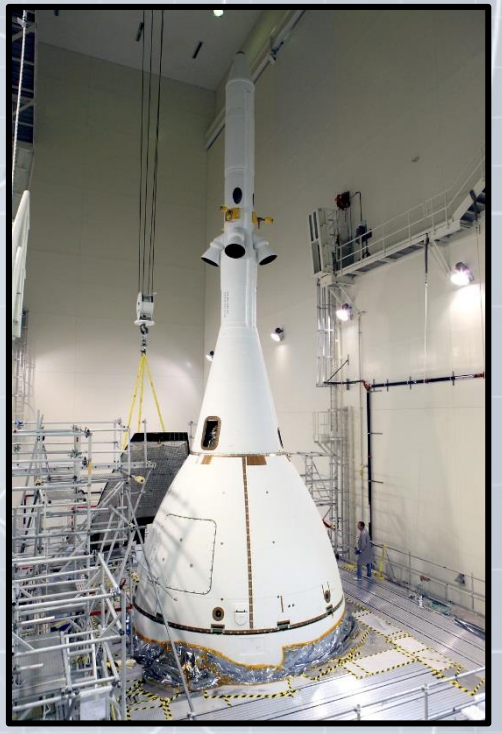
The Challenge

NASA needs a new vehicle to take astronauts to the Moon because the Space Shuttle was never designed to leave the Earth's orbit. NASA and its' industry partners are working on a space vehicle that will take astronauts to the Moon, Mars, and beyond. This spacecraft is called the Multi Purpose Crew Vehicle (MPCV). The MPCV is a vehicle to transport human crews beyond low-Earth orbit and back again. The MPCV must be designed to serve multiple functions and operate in a variety of environments.

Each team using the Engineering Design Process must design and build a Crew Exploration Vehicle.

Help us get to the Moon, Asteroids, and Mars!



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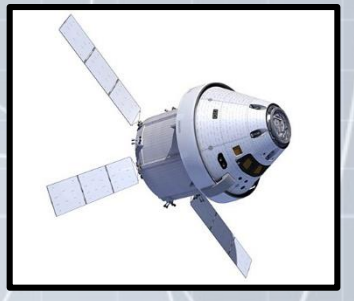
Materials



- General building supplies
- Digital scale, or a balance scale
- Mailing tube, oatmeal canister, or small coffee can (used as size constraint)
- 2 - 2 cm plastic people (i.e. Lego®)
- Grid Paper

Pre-Activity Set-Up

Select a size constraint (for example, a mailing tube, oatmeal canister or coffee can).

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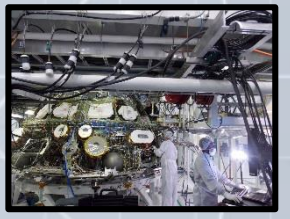
STEP 1: Identify the Need or Problem

Each team must design and build a Crew Exploration Vehicle with the following constraints:

The CEV must safely carry two astronauts. Each astronaut must be 2 centimeters in length. You must design and build a secure seat for these astronauts, without gluing or taping them in place. The astronauts should stay in their seats during each drop test.

The CEV must fit within the _____ (fill in the given constraint in unit form). This item serves simply as a size constraint. The CEV is not to be stored in this or launched from this item.

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.)



The total mass cannot exceed 100 grams. Use a scale or balance to measure the mass of your design components.

The CEV must have one hatch that opens and closes and is a size that your astronauts can easily enter/exit from. The hatch should remain shut during all drop tests.

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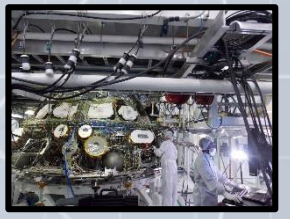
STEP 2: Research the Need or Problem

Conduct research to answer the following questions related to the challenge problem. Cite where you found your information on the line labeled “Source(s):”.

Who is currently working on this or a similar problem today? What solutions have they created or are working on currently? Source(s):

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

Who in our society will benefit from this problem being solved? How could this relate to everyday uses in society? Source(s):



What are some innovative options for using the materials that are available to solve this challenge? Source(s):

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STEP 3: Develop Possible Solutions

Sketch your Crew Exploration Vehicle (CEV) in the space below. Label each part of your drawing. Consider the following questions when brainstorming your ideas.

What shape do you think the CEV should be?
What features would your design have?
What materials could you use to design your CEV?
Are all the criteria and constraints being met by these ideas?

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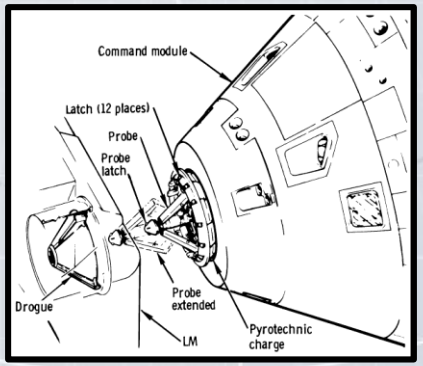
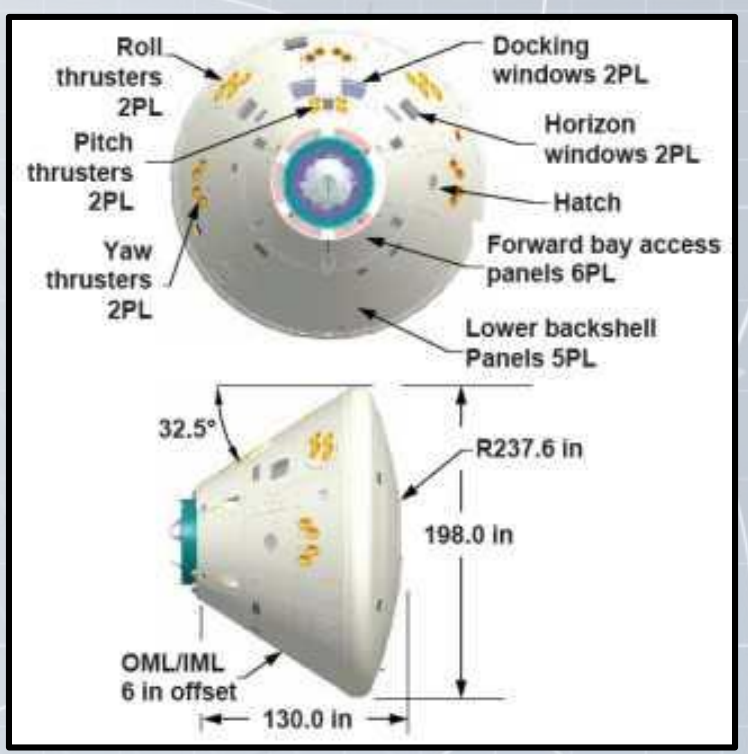
STEP 4: Select the Best Possible Solution(s)

Work with your team to analyze each person's final drawing using the table below. Based on the team's discussions, determine which design will be used to solve the problem, and what features will be included to create team's prototype.





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STEP 5: Construct a Prototype

Make a final drawing of your prototype. Have it approved by your facilitator.

Approved by: _____

What are the resources that will need to be gathered?

Who in the group is doing what?

Team Member				
Responsibilities in the building process?				

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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
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 _____	To test size constraints	Volume: _____ cm^3

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STEP 7: Communicate the Solution(s)

It is not enough to simply produce raw data. Scientists and engineers need to interpret the data so that they can convince others that their results are meaningful. This step will help you summarize how your design changed through multiple iterations of the engineering design process. Start by filling out the table about your initial prototype.

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

Iteration #	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		

Iteration #	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		

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STEP 8: Redesign
Did this iteration of your design meet all of the constraints of the original problem? _____

What problem(s) did you discover while testing this iteration?

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

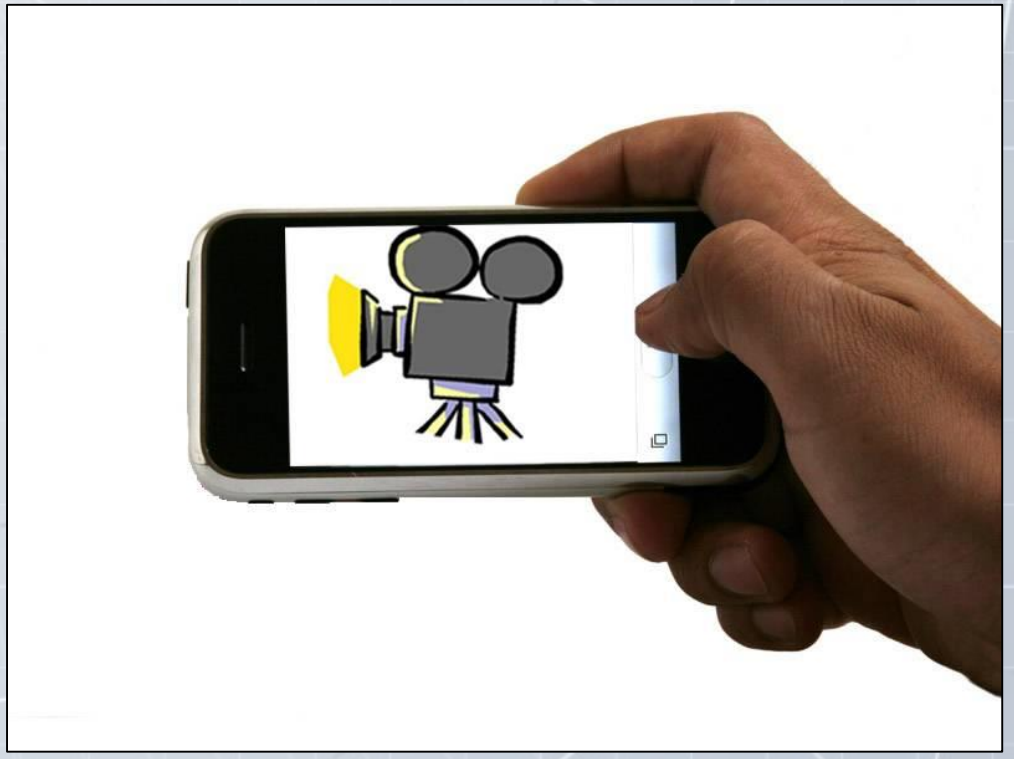
How do you predict that these changes will improve over the iteration you just tested?

Design A Crew Exploration Vehicle

Conclusion

Students, you will have completed

- Creating a video documenting what the team has done during the Engineering Design Process and Challenge.
- Determine the video meets the criteria for submission
- Submit the video for review
- Add to the LEARN section of the KLEW chart
- Revisit the Engineering Design Process and fill in the steps of the EDP comparing it to the chart they did at the beginning of the challenge



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Submitting your final video…

Visit the website at http://y4y.ed.gov/stemchallenge/nasa for instructions on submitting your final video

Advance to the next page for tips on video production

Telling Your Story with Video

NASA Engineering Design Challenges

Trial By Fire Video

Watch the Orion Spacecraft go through the Engineering Design Process!

As the flight test of NASA's Orion spacecraft nears, the agency released a video -- called "Trial By Fire" -- detailing the spacecraft's test and the critical systems engineers will evaluate during the Dec test flight.

Orion is in the final stages of preparation for the uncrewed flight test that will take it 3,600 miles above Earth on a 4.5-hour mission to test many of the systems necessary for future human missions into deep space. After two orbits, Orion will reenter Earth's atmosphere at almost 20,000 miles per hour, and reach temperatures near 4,000 degrees Fahrenheit before its parachute system deploys to slow the spacecraft for a splashdown in the Pacific Ocean.

We wish you Good Luck with your Challenge

https://www.youtube.com/watch?v=KyZqSWWKmHQ