Engineering Design Challenge

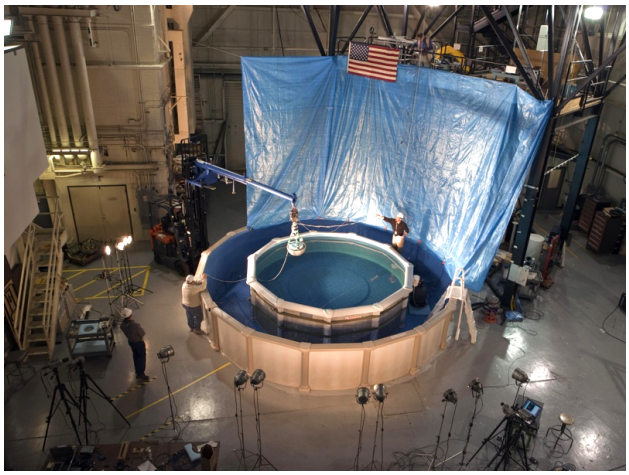
Build a Crew Exploration Vehicle

NASA is building the next generation of Crew Exploration Vehicles. The Orion Multi-Purpose Crew Vehicle, or MPCV, is capable of transporting humans to the Moon, an asteroid or Mars, and is designed to meet the needs of space explorers for decades to come!

The Orion MPCV will launch atop NASA's Space Launch System, or SLS, a new heavy-lift rocket that will be the most powerful rocket ever. Orion has already launched on a Delta-IV Heavy rocket for its initial test flight and will launch again on the SLS' first flight, Exploration Mission-1, before carrying humans on the second SLS flight, Exploration Mission-2.

Before any of that can happen, lots of testing must occur on the ground and in the sky. Because Orion will land in the ocean, many tests are conducted to ensure the safety of astronauts during and after splashdown.

Challenge



Your team must design, build, test and improve a crew exploration vehicle, or CEV, that will safely return toy astronauts to Earth. Your CEV will need to be able to land in water, float and keep water out. Like the engineers building Orion, you will test your small-scale model by dropping it into a water basin.

Criteria for Success

1. The CEV must safely land in water and remain floating for one minute without leaking after being dropped from 61 cm (approximately 2 feet).

2. The CEV must land and remain top-side up.

3. The CEV must securely hold two 2-cm-tall astronaut figures seated inside the CEV.

4. The CEV must have a hatch on top that opens and closes (or can be removed, and is large enough for a 2-cm-tall astronaut figure to pass through.

5. The CEV hatch must remain closed (or attached in place, it if is removable).

6. The CEV interior must have a visible pen mark on the bottom to help identify water leaks.

Design Constraints

1. Teams must use the materials provided.

2. The CEV must weigh less than 100 grams.

Team Name _____

Team Members _____
_____
_____
_____
_____

When designing your crew exploration vehicle, consider the following:

1. Balance and center of mass
2. Total mass
3. Waterproofing techniques
4. Vehicle egress

Challenge Questions

1. What questions do you have about the challenge?

2. How do you plan to keep the CEV upright when it lands in the water?

3. What will you use to protect the inside of the CEV from water?

4. How will you ensure the CEV hatch remains closed during landing?

Design

Sketch Your CEV (use additional sheets of paper for larger drawings if desired)

Top	Bottom
Side	Inside (astronaut compartment)

Test

Perform at least three drop tests of your CEV from a height of approximately 61 cm (2 feet) into a water basin. Make note of what happens as it falls, when it lands, and as it floats. After each drop, identify one element of your design that could be changed to improve the CEV. Do not change more than one element of your design per drop. If you change more than one item, it will be difficult to know which change resulted in a change in performance.

If available, use a mobile device to make a slow-motion video of the CEV dropping and to take pictures of the CEV in the water. You can also use images to document the conditions inside.

Drop Test	Drop Height (cm)	Float time (minutes)	Observations:
1			

Did the hatch door remain closed/attached?
Yes / No

Is there evidence of water in the CEV? (pools of water, warped paper, running ink, etc.)
Yes / No

What unexpected things happened during or at the end of the drop?

_____

Change made to design after test:

_____

Drop Test	Drop Height (cm)	Float time (minutes)	Observations:
2			

Did the hatch door remain closed/attached?
Yes / No

Is there evidence of water in the CEV? (pools of water, warped paper, running ink, etc.)
Yes / No

What unexpected things happened during or at the end of the drop?

_____

Change made to design after test:

_____

Drop Test	Drop Height (cm)	Float time (minutes)	Observations:
3			

Did the hatch door remain closed/attached?
Yes / No

Is there evidence of water in the CEV? (pools of water, warped paper, running ink, etc.)
Yes / No

What unexpected things happened during or at the end of the drop?

_____

Change made to design after test:

_____

After three trials, if your CEV still does not meet the criteria for success, keep trying. If your CEV meets all criteria, attempt a 5-minute float test to model a long-term ocean recovery situation.

Quality Assurance Form

Each team is to review another team's design and model, then answer the following questions.

Name of team reviewed: _____

Total mass of the Crew Exploration Vehicle is: _____ grams

Does the hatch open and close?

Did the astronauts stay in their seats during the drop tests?

List specific strengths of the design:

List specific weaknesses of the design:

How would you improve the design?

Inspected by _____
_____
_____
_____