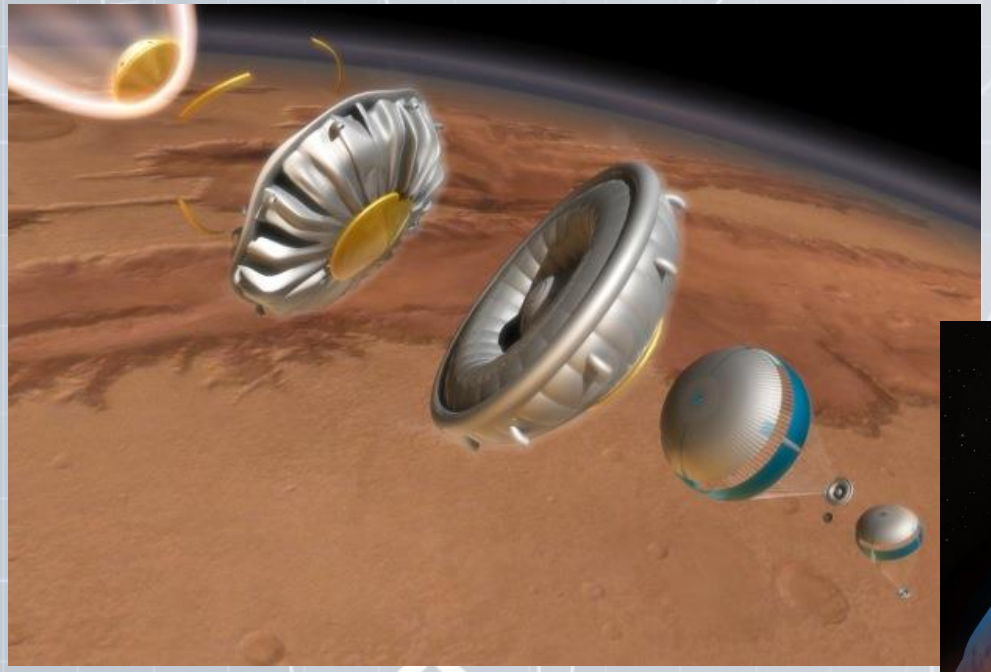
NASA Engineering Design Challenges

Parachuting onto Mars



Parachuting onto Mars

Develop a drag device to slow a spacecraft for entry, descent, and landing.

Geometry

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Introduction Video

Watch the introduction video to the challenge.

[Video Link]

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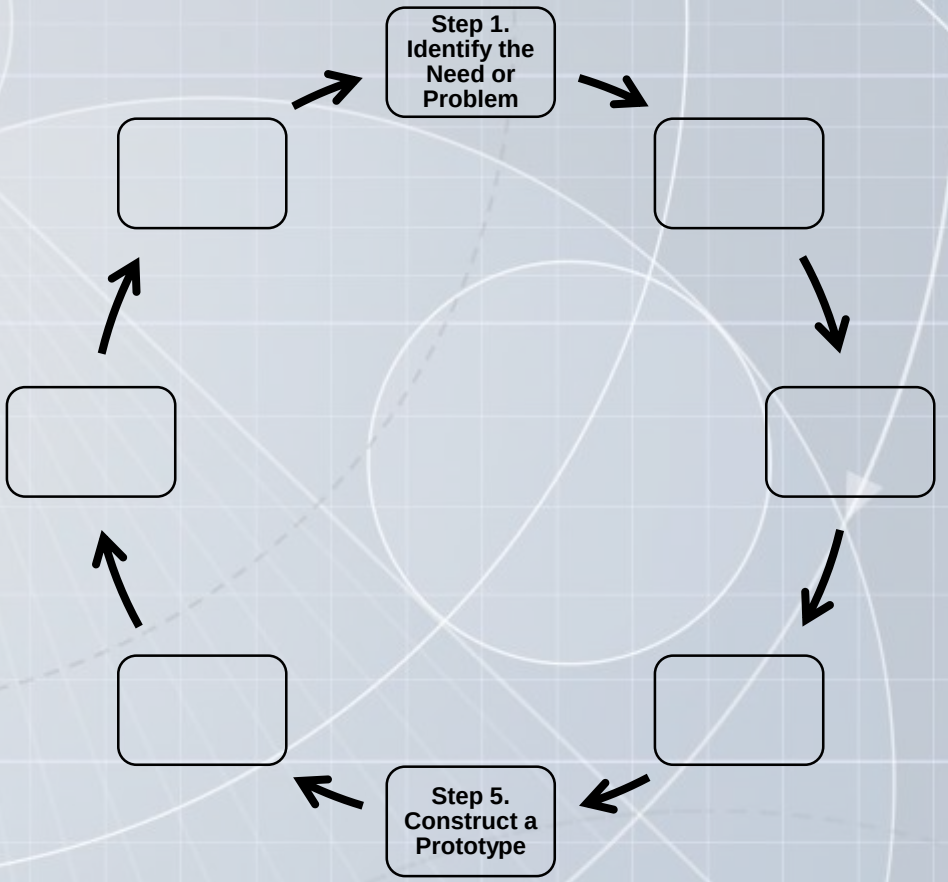
Engineering Design Process (EDP)

<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



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KLEW Chart

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

KNOW	LEARN	EVIDENCE	WONDER
What do I know about landing on Mars?	What did I learn about landing on Mars based on my research?	What evidence do I have that supports what I learned about landing on Mars?	What am I still wondering about landing on Mars?

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The Challenge:

When NASA sends spacecraft to land on the surface of Mars, they travel at extreme speeds and need to slow down using some sort of drag device that slows the space capsule to prevent the machinery from crashing into the planet and damaging or destroying it. As missions increase in complexity and capability, the landers and rovers are getting heavier; and therefore, require even more effective drag devices.

You will work in a team to design, build, and test a drag device. You may only use materials provided, and must connect to a team-built cargo bay that is assembled using the template provided. The overall mass cannot exceed 50 grams. The drag device must have at least five separate angled edges (rounded edges are allowed, but one big circle is not allowed). It should protect the weighted cargo bay when it is dropped from a height of at least 2 meters. Surviving higher drops is preferred.

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Materials

The following is a suggested list of materials needed to complete this challenge. The quantity will depend on the number of students participating. Alternatives can be used if necessary.

- Digital scale or balance (1)
- Stopwatch (1)
- Measuring tape (1)
- Rulers (1 per team)
- Thin string like embroidery thread or fishing line
- Small sealable plastic storage bag to hold payload inside capsule (1 per team)
- Washers, marbles, or pennies to serve as mass
- Hole reinforcements or stickers with a hole punch
- Template for capsule (see page 39) – one for each team
- General building supplies

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STEP 1: Identify the Need or Problem

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

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.

What general scientific concepts do you and your team need to consider to 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 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 drag device in the space below. Label each part of your drawing. Consider the following questions when brainstorming your ideas.

What shape do you think the drag device should be?

What features would your drag design have?

What materials could you use to design your drag device and capsule?

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.

Design # Designer Name	Does this design meet all criteria and constraints of the problem?	What are the strong elements of this design?	What elements need to be improved?
1.			
2			
3			
4			

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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)

Record the mass and calculate the surface area of the drag device below. Show your calculations.

Total Mass _____
Surface Area of Drag Device _____
Record the drop height _____

Drop drag device attached to capsule while timing descent. After each drop, note any damage to the drag device or capsule. Each device should be dropped three times and results averaged together. For advanced students, calculate the speed. Record results in table.

Drop #	Time (sec)	Speed (cm/sec)	Note any damage after each drop.
1			
2			
3			
Mean Average			

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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?

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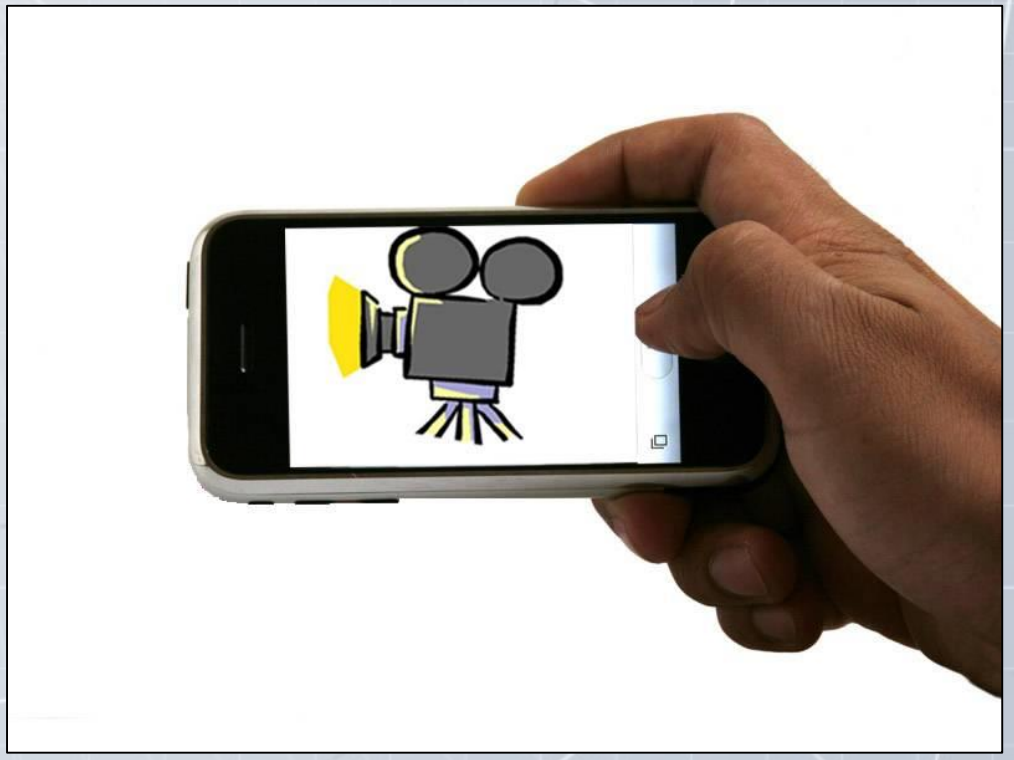
Conclusion

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