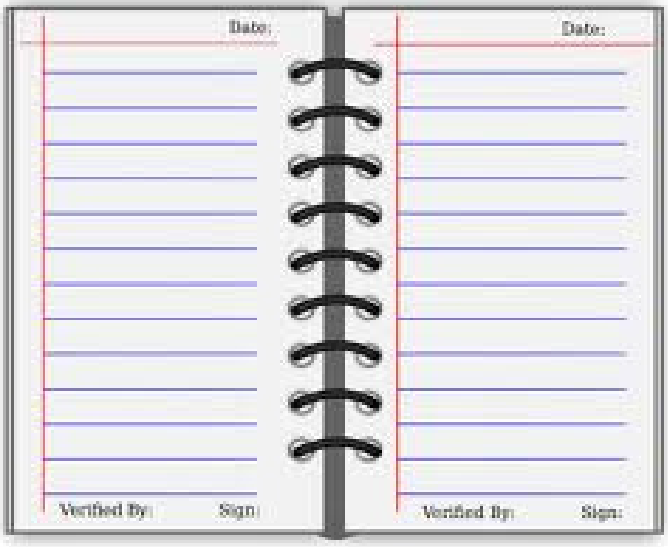
# Student Team Challenge Journal

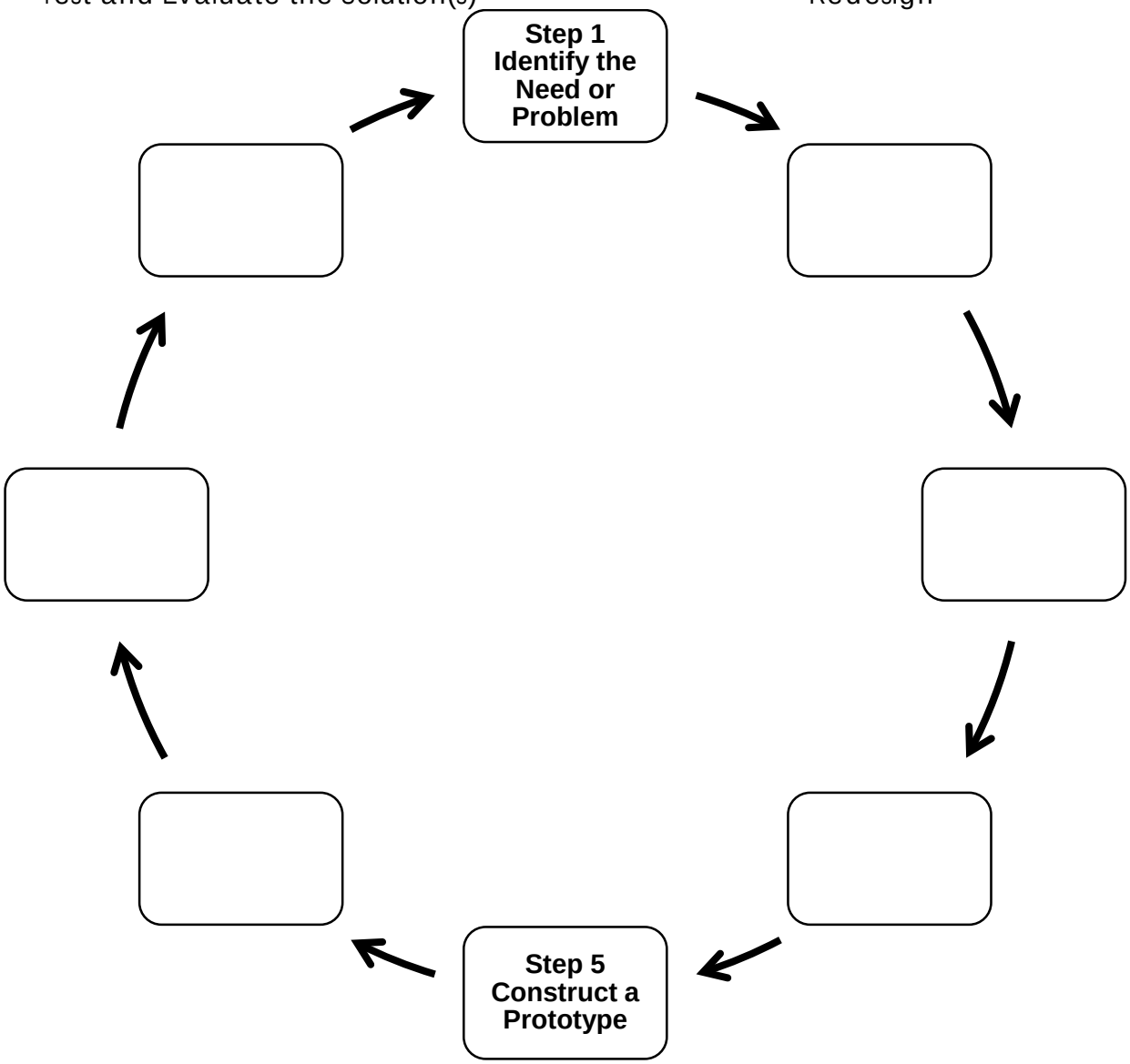


# Engineering Design Process

**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 works tirelessly to ensure the safety of its pilots and astronauts. As research continues, the pressure suits that provide many layers of protection against the harsh environments of the upper-atmosphere and space also improve. Pressure suits are necessary for space exploration. Because pilots and astronauts must complete their work in a near-vacuum or absolute vacuum environment, the protective suits must exert pressure on the body to simulate Earth's environment to keep the pilots and astronauts safe at all times.

*Figure 9.—Peggy Whitson, the first female commander of the International Space Station, participates in a 7 hour, 10 minute spacewalk, Jan. 30, 2008. (NASA)*

**The Challenge**

Your team will design and build a pressure suit that will protect pilots and astronauts from the dangers of low-pressure environments. All materials used for spacesuits must be tested in a vacuum to make sure they are safe in low-pressure environments. Your team can use a marshmallow or a balloon to represent the pilot or astronaut.

**Criteria and Constraints**

1. The pressure suit must completely surround the marshmallow or balloon astronaut.
2. Prevents your astronaut from expanding and constricting while in the vacuum.
3. The protective suit must be constructed of materials that are not affected by near-vacuum or absolute-vacuum environments.
4. The astronaut must fit completely within the vacuum chamber and have a total mass of less than 50 grams.

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 pressure suits?** | **What did I learn about pressure suits based on my research?** | **What evidence do I have that supports what I learned about pressure suits?** | **What am I still wondering about pressure suits?** |
| | | | |

# 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<br>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:**_____

# Why Pressure Suits?

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.

_____

_____

_____

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)

**Using the materials provided, build and test your model.**

1. Record the total mass _____
2. Insert your pilot or astronaut into the suit and then into the vacuum chamber. Draw a vacuum and carefully observe and record any changes to the suit and the astronaut.
3. For each change, record the pressure of the vacuum system at the time when that change occurred using appropriate units such as pounds per square inch, number of draws of the syringe, or time into the test if the vacuum being pulled is constant.

| Iteration | Test time in seconds | Mass in grams | Suit observations | Pilot or astronaut observations |
|---|---|---|---|---|
| | | | | |
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| | | | | |

# 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. Which suit design worked best in this challenge to protect your astronaut?

6. Which materials worked best in this challenge to protect your astronaut?

7. What caused the marshmallow or balloon to swell and contract?

# 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 |
|---|---|---|---|
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# 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.<br><br>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.<br><br>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.<br><br>Discuss strengths and weaknesses of your team's prototype. | |