Title	Design Challenge: Save Fred
Program Type	Design Challenge: a walk-up engineering activity involving a story, a mission or challenge, and designated supplies; facilitated by a staff member and steered by visitors' interests, ideas, and abilities.
Location	Level 1: Workshop.
Story	Fred is a water-loving worm who can't swim; when his boat capsizes in the middle of a sudden storm, it's up to participants to save him. There's a catch: he wasn't wearing his life vest, and he's also terribly allergic to human contact.
Target Audience	Visitors 6 years of age and up working in family or peer groups of 2-4.
Goal(s)	To increase STEM equity by equipping participants with feelings of self-efficacy and personal relevance as they complete each design challenge; to encourage innovation, collaboration, and creative problem solving; to empower girls and visitors with a broad range of science capital to seek engineering-related careers and see the Engineering Design Process as "for me."
Duration	5-10 minutes.
STEM Career Highlight	First Responders

Objective(s)	

What is the objective?	How will you measure it?
All participants will use the Engineering Design Process to complete the challenge. They will **ask** questions to understand the challenge, **imagine** possible solutions, **plan** how they will use their materials, **create/implement** their solution and test it out, and **improve** their work based off what they learned. **What is the Engineering Design Process?:** This process is a series of steps (included above) that engineering teams use to solve problems. It is an iterative process, meaning it can be repeated as many times as necessary with improvements made along the way ("Teach Engineering"). This process can be used by **anyone** to problem solve in their everyday life.	100% of participants will go through the Engineering Design Process at least once as they successfully save Fred; 65% of participants will go through the process at least twice by taking what they learned the first time they saved Fred and using that information to save him in a faster, more efficient way.

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Materials	

- Rubber bands
- Paper clips
- Straws
- Plastic cups
- Gummy worms
- Lifesaver gummy "vests"
- Engineering Design Challenge graphic

Safety

Some materials may present a choking hazard to younger participants. Make sure participants are not using any materials (such as rubber bands or paperclips) to harm themselves or other participants.

Set Up

Each group will need one plastic cup, one gummy worm, one Lifesaver gummy, two paper clips, two straws, and one rubber band. Participants may work together in groups of 2-4 people; prepare for multiple groups to work at once.

Introduce/Invite

- Smile and greet visitors as they approach the Workshop
- Introduce yourself and the name of the activity
- Ask visitors if they would like to participate, and invite them to find a place at a table in the Workshop if so

Example: "Hello! My name is _____ and welcome to Design Challenge: Save Fred. Would you like to join me for an activity today?"

Tell The Story

Storytelling humanizes and personalizes the challenge, sparking creativity and altruism while highlighting the relevance of the engineering design process. It allows us to connect hearts and minds while participants learn the engineering design process. Write the story down on the whiteboard so visitors can refer to it while they work.

Example:

"Before we get started, let me introduce you to Fred." Hold the gummy worm up for everyone to see. "Fred is a worm who loves to go sailing. Earlier today, he hopped in his sailboat," (hold up the plastic cup)

"for a delightful trip across the lake." Hold up the Lifesaver gummy. "Like any responsible seaworm, Fred remembered his life vest. Unfortunately, he didn't put it on.

"Well, Fred was sailing along. It was a beautiful day – the sun was shining, the sky was blue, the clouds were nice and puffy. All of a sudden, a terrible storm came up. Fred's sailboat capsized," (flip over the plastic cup) "and Fred barely managed to climb on top of it." Put the cup on the table upside down with the life vest underneath and Fred on top. "It's our job to save Fred and send him sailing away to safety."

"Now, we have two problems here: first, Fred can't swim. And even though he brought his life vest, it's trapped underneath his sailboat. Secondly, Fred is horribly allergic to human contact. If we touch him, his boat, or his life vest, he's going to break out in an awful rash." Give participants two straws, two paper clips, and one rubber band. "Instead, we're going to save Fred using only these materials. We need to put him in his life vest and turn his boat right side up so that he can sail away."

Encourage visitors to work together in small groups of two to four.

Interact

Before visitors begin working, discuss the Engineering Design Process. Structure the activity around these five steps so that all participants have time to ask, imagine, and plan before they begin to create. It may be helpful to ask participants to leave materials in the middle of the table until they are ready to build.

Example:

"We're going to use the Engineering Design Process to help us save Fred. The Engineering Design Process is a series of steps people use to help them solve problems and create new designs and solutions. When we use the Engineering Design Process, we ask questions about our problem so that we can understand it better. Then we imagine some possible solutions we could try. Next, we bring our plan to life and test it out. If it didn't work or if we want to make our plan better, we improve our plan and go through the process again." Point to the Engineering Design Process graphic so that participants can refer to it while they work.

Steps:

Ask questions about the problem. What are we trying to accomplish? What materials can we use? Are there any additional challenges we might face as we work? Encourage participants to use **empathy** as they think about the problem (e.g., "If I were in this situation, how would I feel? What challenges would I face? How could my friends help?")

Imagine possible solutions. Take a few moments to brainstorm, either by yourself or as a group.

Plan your design. Which solution will you test out first? What materials do you need?

Create. For Save Fred, this step might involve designing a tool to use to save Fred, or might be the stage where participants implement an idea they had (for example, using the rubber band to flip the cup over) and test it to see how it works. This is the building and testing step. Was your idea successful? Do you think it could be improved? If one of their ideas didn't work, encourage them to continue working until they find one that does.

Improve your design. **Ask** questions about how it could be more effective, and **imagine** ways you could improve it. **Plan** your new design and **create** it to test it out. This process can be repeated as many times as desired! Encourage participants to share their ideas and solutions with you.

After participants have successfully put Fred in his life vest and into his boat, encourage them to try the activity a second time.

Facilitation Strategies

- Encourage creativity and thinking outside the box
- Help participants brainstorm new solutions and strategies if they feel stuck
- Build confidence by praising participants for their persistence and ingenuity, instead of focusing on the "right" strategy
- Give ownership by allowing participants to solve the challenge independently without being told what to do; facilitate instead of instruct
- Relate the activity to participants' personal lives and interests
- Ask questions to help participants think through their designs
- Pay attention to body language: is the participant nervous or unsure? Are they looking to you for encouragement? Are they excluding other participants?
- Encourage visitors to tackle the challenge one step at a time by asking, "What's our next step?"
- Encourage participants to walk through the activity twice, using what they learned the first time to help them the second time.

Apply

Ask questions that encourage participants to think.
- Why did we ask, imagine, and plan before we started to work?
- What are other problems we can solve using the engineering design process?
- What did you do when your first solution didn't work?
- How can you apply what you learned to something in your life? (Focus on transferable skills and critical thinking)
- Have you ever used the Engineering Design Process to solve a problem before, even if you didn't know what the process was called?
- What are some of the challenges we faced while we were engineering our solutions?
- Why do you think it's helpful to work as a team?

Clean Up

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Encourage participants to reorganize the materials they used into the cup on their table. Discuss how these items will be reused for future programs and Design Challenges.

Close

Thank visitors for coming to the program and invite them to explore new exhibits/see other programs. Example:
"Thank you so much for saving Fred! Because of you, he can live to sail another day. As you leave, don't forget to check out our other programs happening today."

Sources:

OMSI Designing Our World: Engineering Activities and Resources

National Association for Interpretation: Mission, Vision, and Core Values

NISE Net Explore Science: Let's Do Chemistry Kit

Teach Engineering: STEM Curriculum for K-12. "Engineering Design Process."