TeachEngineering

STEM Curriculum for K-12

Designing Prototypes to Save Coral Reefs

What are coral reefs?

Watch: https://www.youtube.com/watch?v=ZiULxLLP32s (0:00 to 1:21)

Brainstorming: Why are coral reefs important?

Watch: https://www.youtube.com/watch?v=ZiULxLLP32s (1:22 – end)

Consider: What do all the negative impacts on coral reefs have in common?

The Answer: **Humans**

Pre-Activity Assessment

Quick Poll: Raise your hand if you think coral reefs are essential.

Why are they essential?

Brainstorming: Now you are going to brainstorm with your table/group the following question . . .

What are all the ways humans impact coral reefs?

Importance of Coral Reefs

Coral reefs are the most biologically diverse ecosystems on our planet. They are located along the coast in shallow, tropical water. Coral reefs are built by different species of hard corals and soft corals, which create the foundation for coral communities to grow on and live in.

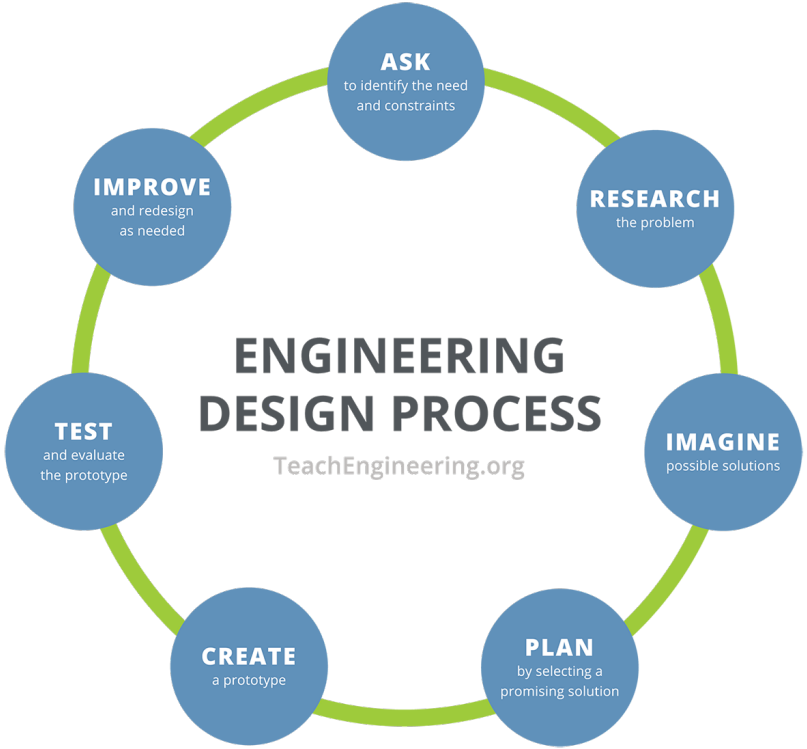
Coral reef located in Fiji.

These ecosystems are a crucial resource for many countries around the world for food, tourism, and coastline protection. Coral reefs are estimated to generate around $375 billion a year in revenue.

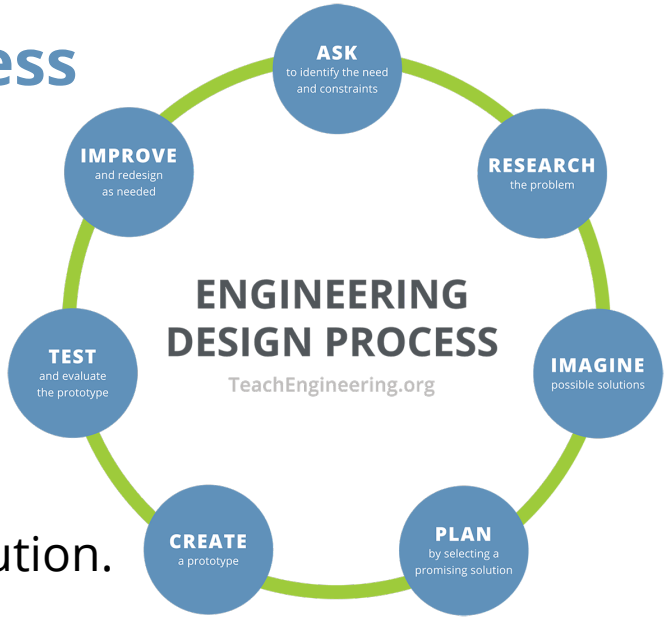
Engineering Design Process

What is engineering design?

- When you have a problem that needs to be solved, you turn to engineering design to develop a solution.
- The process has several steps to help guide you in finding a possible solution.
- It is important to know that mistakes will be made, but just because you make a mistake does NOT mean you have to start over completely!



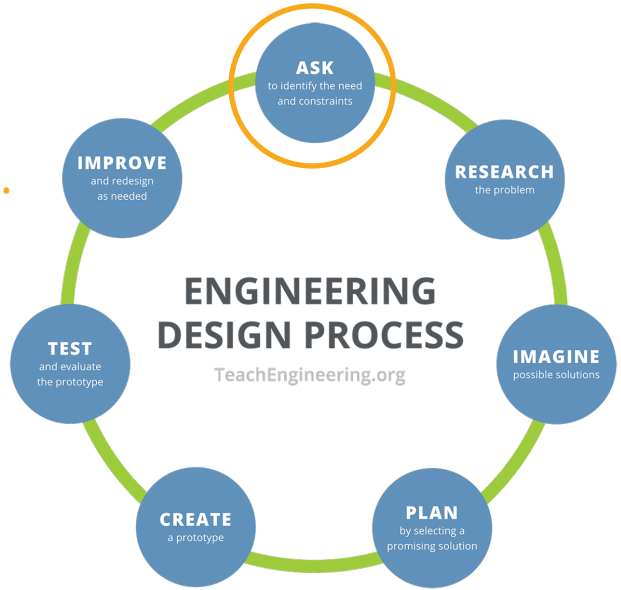
Steps in the Engineering Design Process



1. Ask: Ask questions to identify the need and constraints of the problem.
2. Research: Research the problem, get more information about the issue and current solutions.
3. Imagine: Brainstorm possible solution ideas; no idea is a bad idea in this step!
4. Plan: Create a drawing of your most promising solution.
5. Create: Create your prototype!
6. Test: Conduct various tests to see how your prototype fares.
7. Improve: Go back to your brainstorming when you need to redesign your prototype; this is only as needed.

Engineering Design Process: Example

Problem: We are running out of freshwater resources.



Step #1 Ask: What are possible solutions?

Freshwater Filtration

Limit freshwater usage

Desalination

Look on other planets

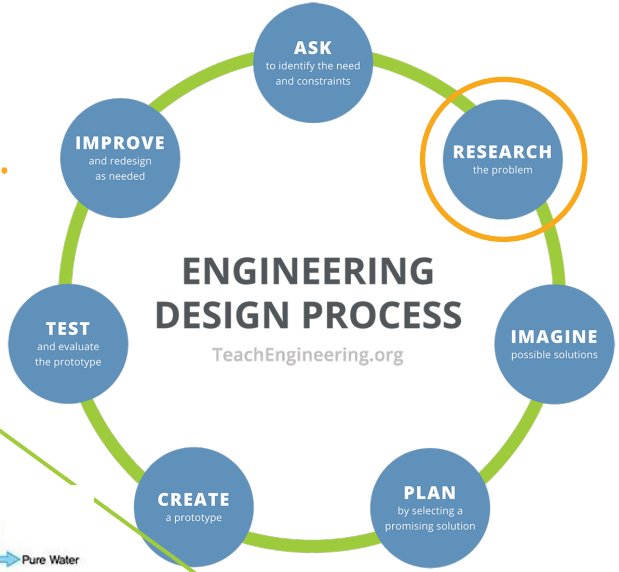
Create freshwater

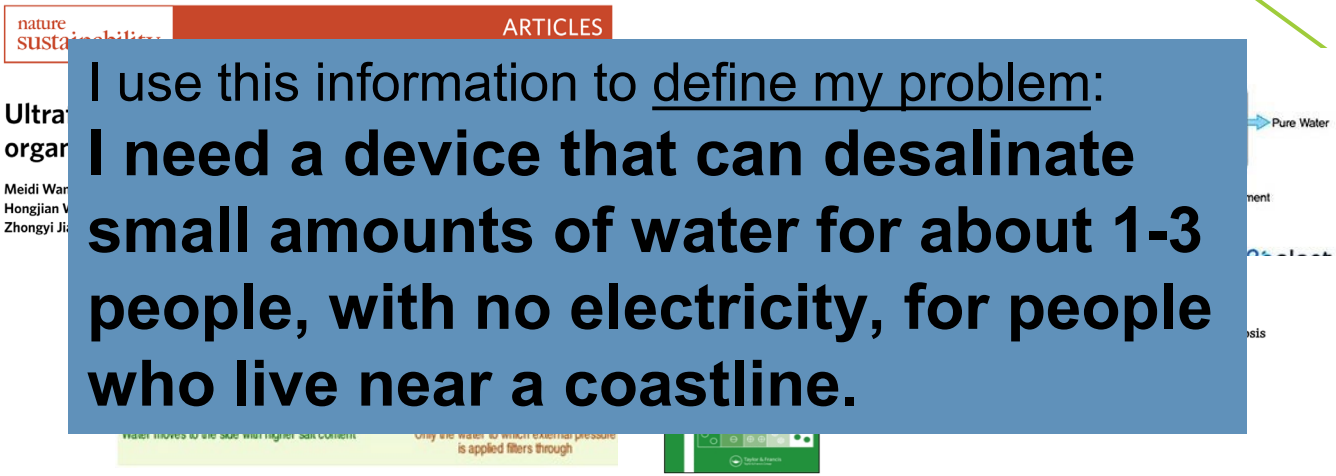
Possible solutions we can design a prototype for!

Engineering Design Process: Example

Problem: We are running out of freshwater resources.

Step #2 Research: What is desalination? What ways is it already used? What products are already out there? What do I want to design?





I use this information to define my problem:

I need a device that can desalinate small amounts of water for about 1-3 people, with no electricity, for people who live near a coastline.

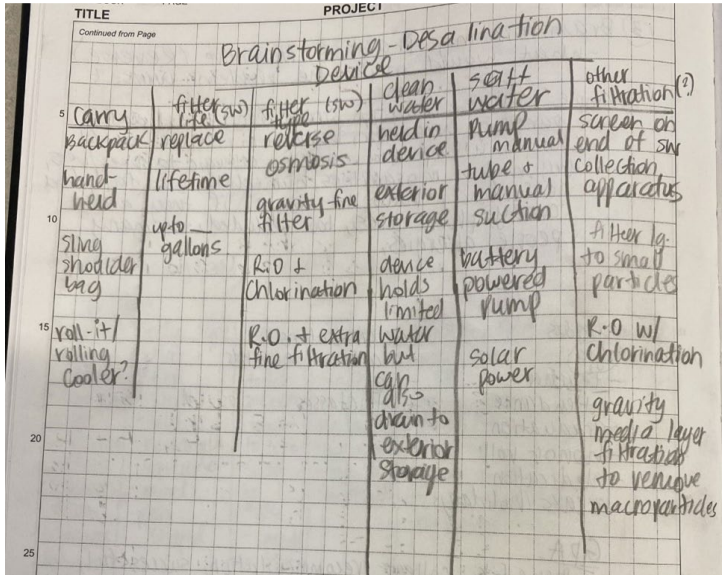
I am asking questions to help further define the parameters of my prototype.

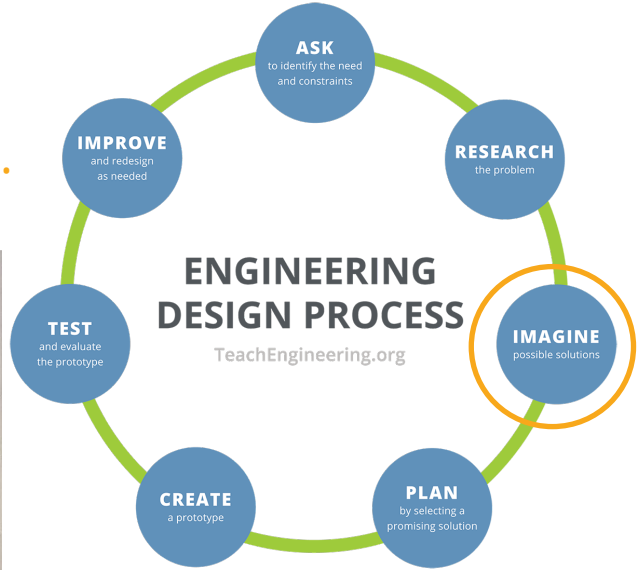
Engineering Design Process: Example

Problem: We are running out of freshwater resources.

Step #3 Imagine:

What are all the possible parts I would need? What criteria do I need to meet my goal? What will I use? **= Brainstorming time!**



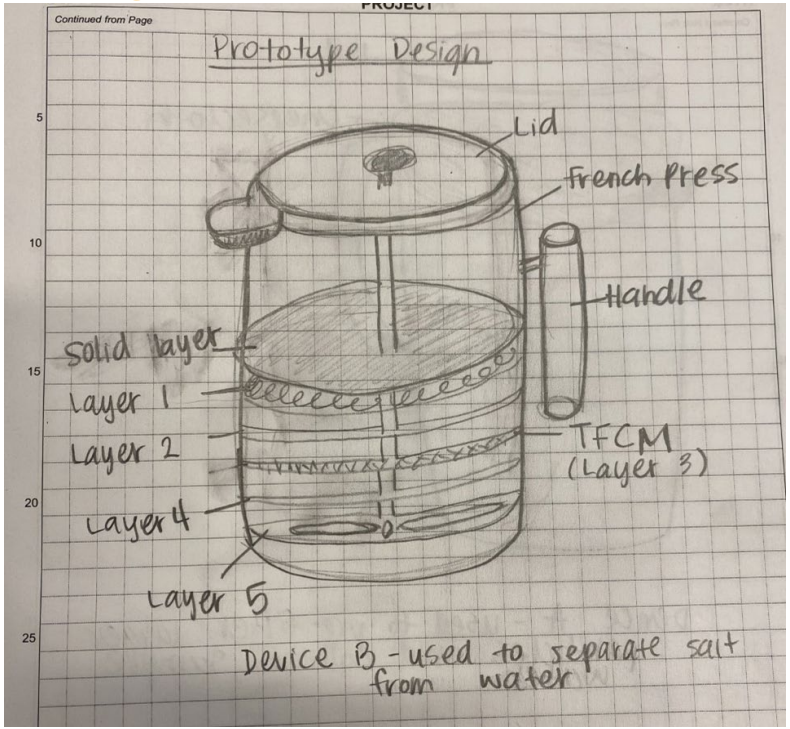


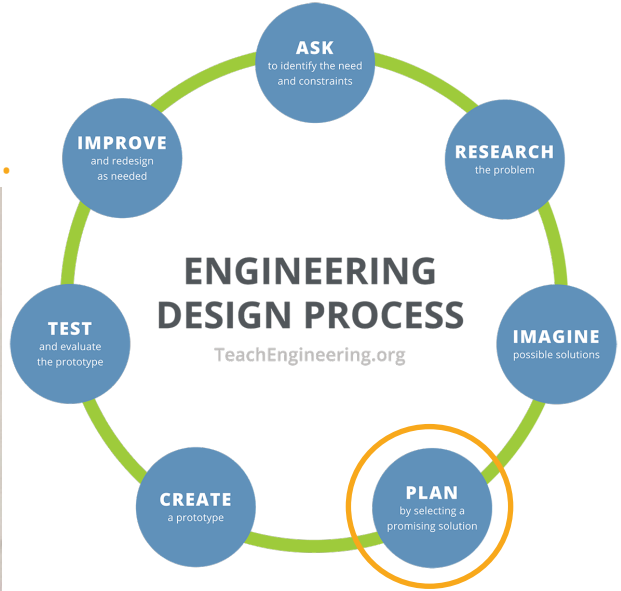
Engineering Design Process: Example

Problem: We are running out of freshwater resources.

Step #4 Plan:

Choose the best conditions for the prototype and sketch a design!

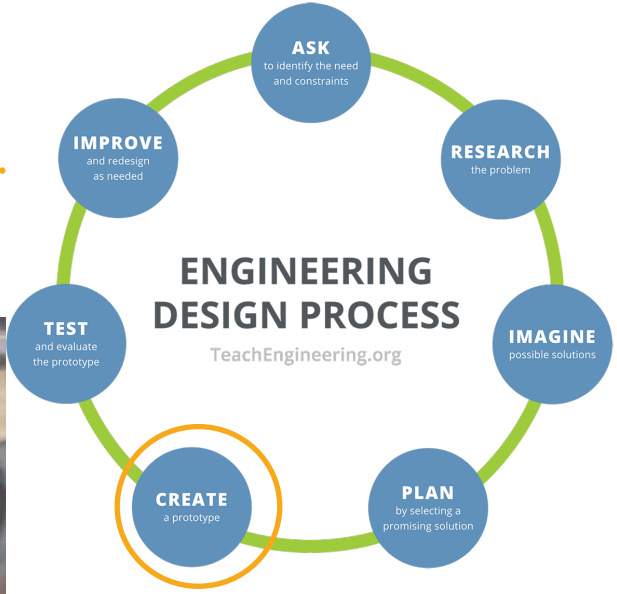




Engineering Design Process: Example

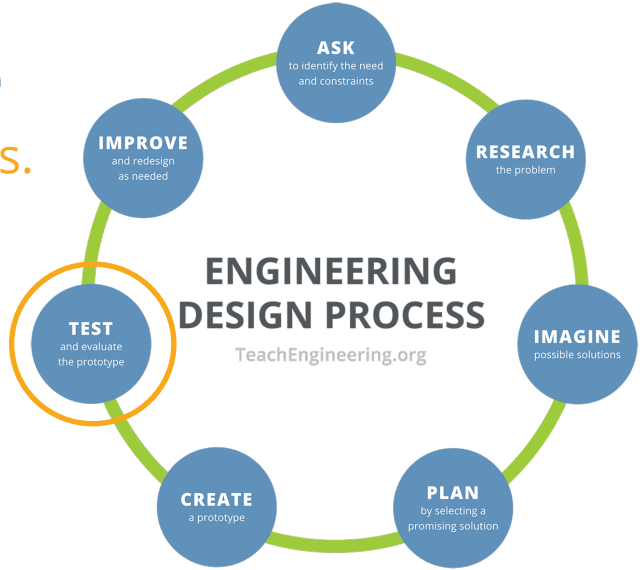
Problem: We are running out of freshwater resources.

Step #5 Create: Build your prototype!



Engineering Design Process: Example

Problem: We are running out of freshwater resources.

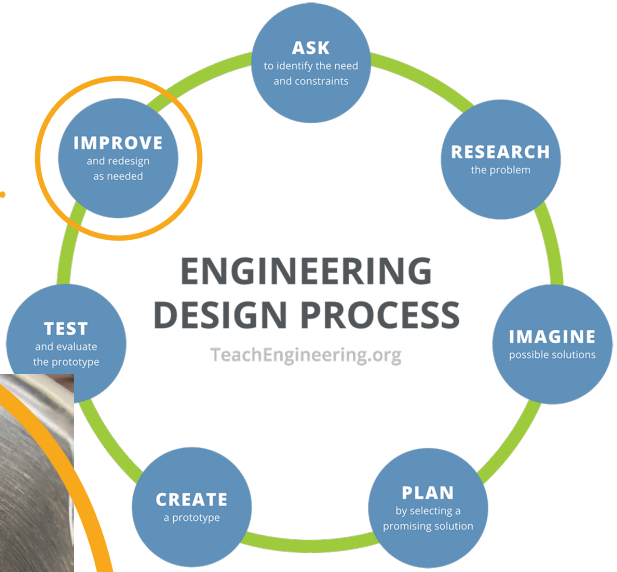


Step #6 Test: Test your prototype!

Engineering Design Process: Example

Problem: We are running out of freshwater resources.

Step #7 Improve: Improve your prototype!



In this case the original ended up being the best one!

Consider the following . . .

As a group, discuss the following questions:

1. Can we help coral reefs?
2. Why should we help coral reefs?

Coral reef located in Fiji.

Designing Prototypes to Save Coral Reefs

You and your group will be building a device that will help coral reefs survive based on your specific issue:

Coral Bleaching
Marine Debris
Pollution
Tourism

Your prototype will be tested to ensure that it can be functional in water, it is designed to help lessen the effect of your human impact, and it is made using everyday items.

Engineering Design Process: Step #1 ASK

Brainstorm . . .

What are possible constraints of your project?

Engineering Design Process: Step #2 RESEARCH

Each group will receive ‘Research Materials’ based on your specific issue. You will have _____ minutes or ____ class periods to conduct your research and define your problem (Define the Problem and Brainstorming Worksheet).

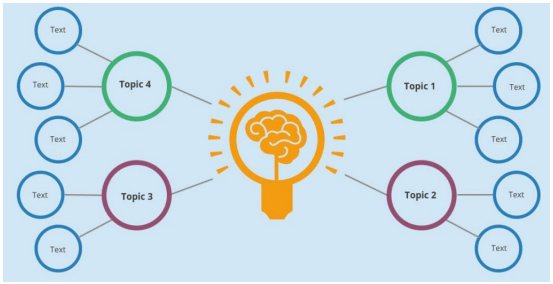
Engineering Design Process: Step #3 IMAGINE

Individually on your 'Define the Problem and Brainstorm' worksheet, you will choose a brainstorming strategy and brainstorm ideas for your prototype.

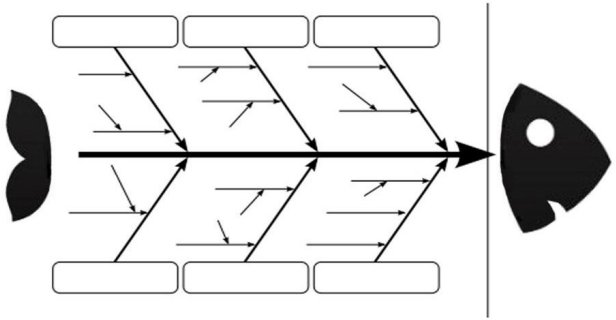
Rules: There are no bad ideas, we don't judge other's ideas, write everything down!

Brainstorming Strategies Include:

Mind Mapping



Fish Skeleton



Morphological Chart

Category #1	Category #2	Category #3	Category #4
Idea #1	Idea #1	Idea #1	Idea #1
Idea #2	Idea #2	Idea #2	Idea #2
Idea #3	Idea #3	Idea #3	Idea #3
Idea # . . .	Idea # . . .	Idea # . . .	Idea # . . .

Engineering Design Process: Step #3 IMAGINE- Practice!

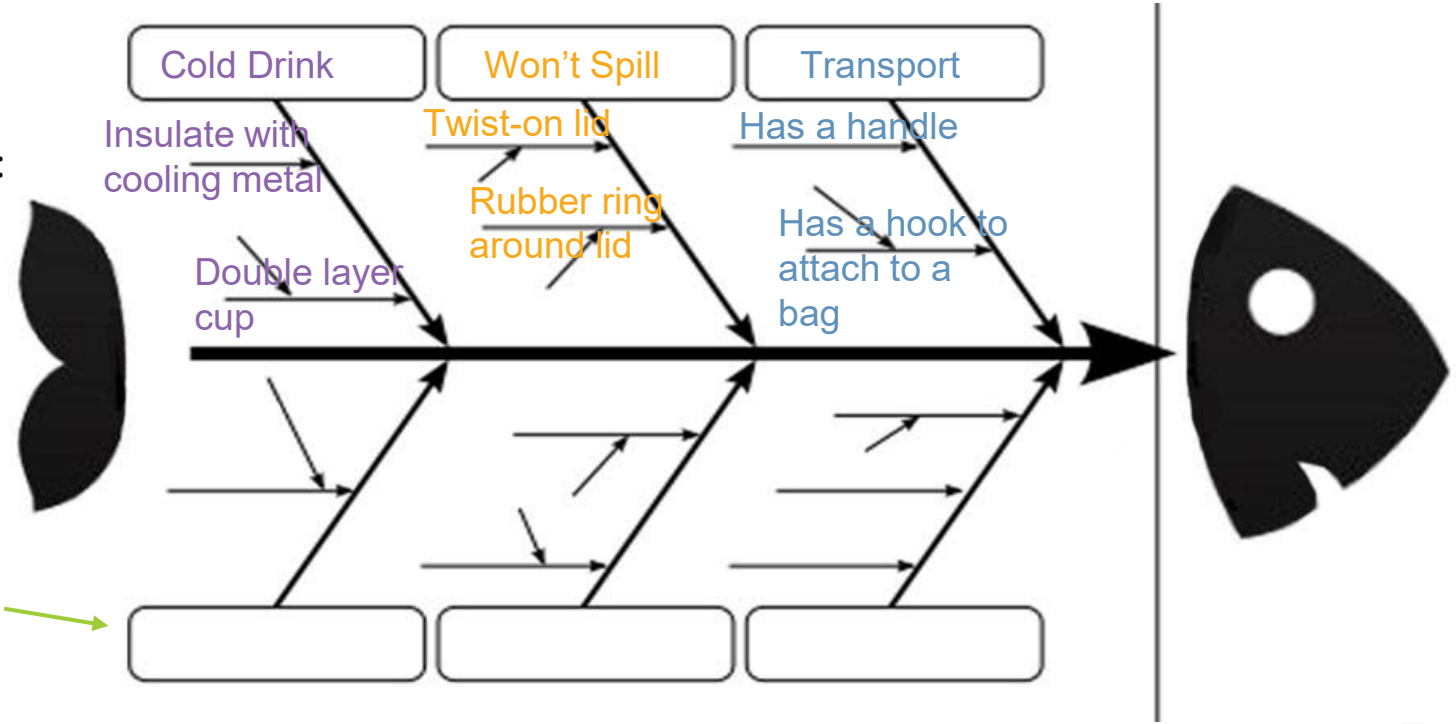
Use any of the brainstorming methods from before to produce a possible solution for the following problem.

Problem: Mark loves to take cold drinks with him wherever he goes. He wants a cup that is easily transportable, keeps his drinks cold, is easy to carry, won't spill, and has a straw that can be removed.

Engineering Design Process: Step #3 IMAGINE- Practice!

Problem: Mark loves to take cold drinks with him wherever he goes. He wants a cup that is easily transportable, keeps his drinks cold, is easy to carry, won't spill, and has a straw that can be removed.

Example Brainstorm: Fish Skeleton



What other categories can we produce?

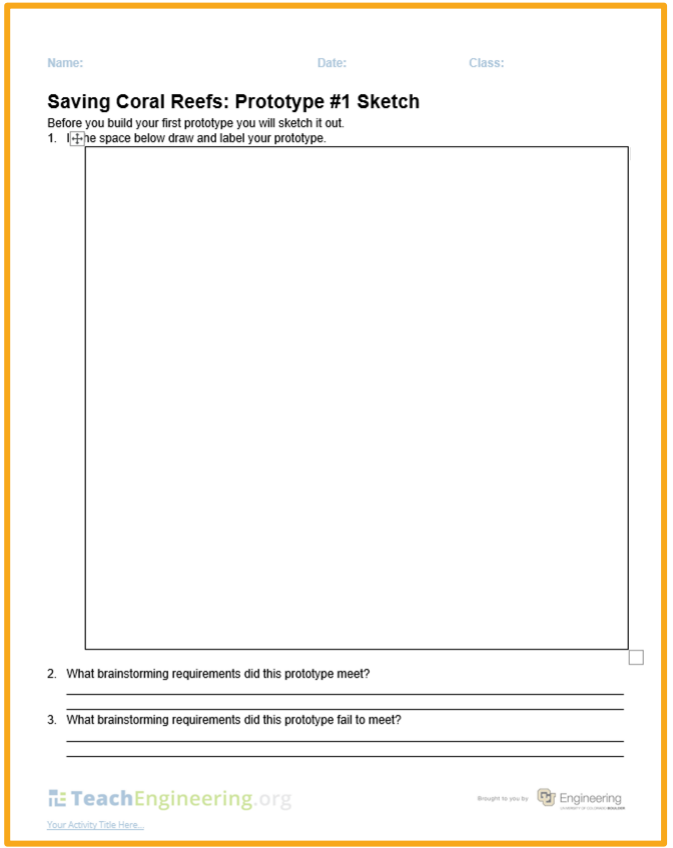
Defining Prototype Requirements:

- Has to be easily used and maneuverable by people
- Has to fit into a 29-gallon tank
- Has to be able to be in the water without falling apart for a minimum of 5 minutes
- Has to be able to sink/float/anchor according to your own expectations
- Has to meet any additional requirements that you set for your prototype
- Can only use the materials provided for you by your teacher, or any that you want to bring for yourself

Engineering Design Process: Step #4 PLAN

Once your group has consolidated ideas and chosen the best for your goal, you will now draw your prototype #1.

Complete the Prototype #1 Sketch worksheet with your group.



Name: Date: Class:

Saving Coral Reefs: Prototype #1 Sketch

Before you build your first prototype you will sketch it out.

1. In the space below draw and label your prototype.

2. What brainstorming requirements did this prototype meet?

3. What brainstorming requirements did this prototype fail to meet?

TeachEngineering.org

Brought to you by Engineering

Your Activity Title Here...

Engineering Design Process: Step #5 CREATE

You will now BUILD your prototype with your group using the materials available to you that you selected!

Engineering Design Process: Step #6 TEST

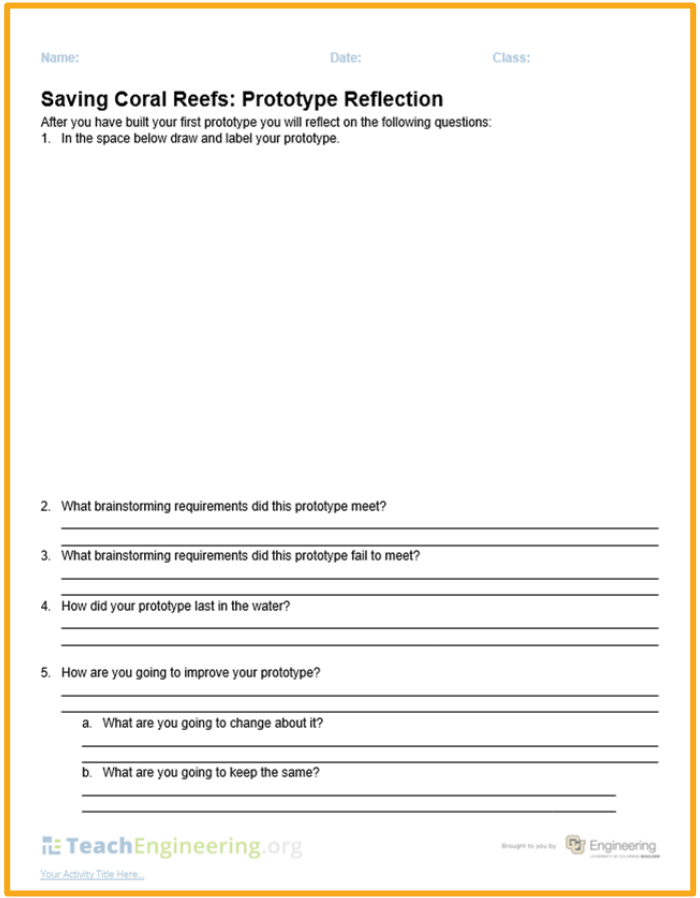
Next, you will test your prototype.
We will place all prototypes in the designated saltwater containers overnight and reflect in the morning on how well they ‘survived’ in the water.

Engineering Design Process: Step #7 IMPROVE

Complete the following:

1. Pull your prototype out of the water.
2. Collect a 'Prototype Reflection' worksheet for your group.
3. Complete the worksheet.

Once your teacher has checked your worksheet, continue to make any modifications to your prototype.



Name: Date: Class:

Saving Coral Reefs: Prototype Reflection

After you have built your first prototype you will reflect on the following questions:

1. In the space below draw and label your prototype.

2. What brainstorming requirements did this prototype meet?

3. What brainstorming requirements did this prototype fail to meet?

4. How did your prototype last in the water?

5. How are you going to improve your prototype?

   a. What are you going to change about it?

   b. What are you going to keep the same?

TeachEngineering.org

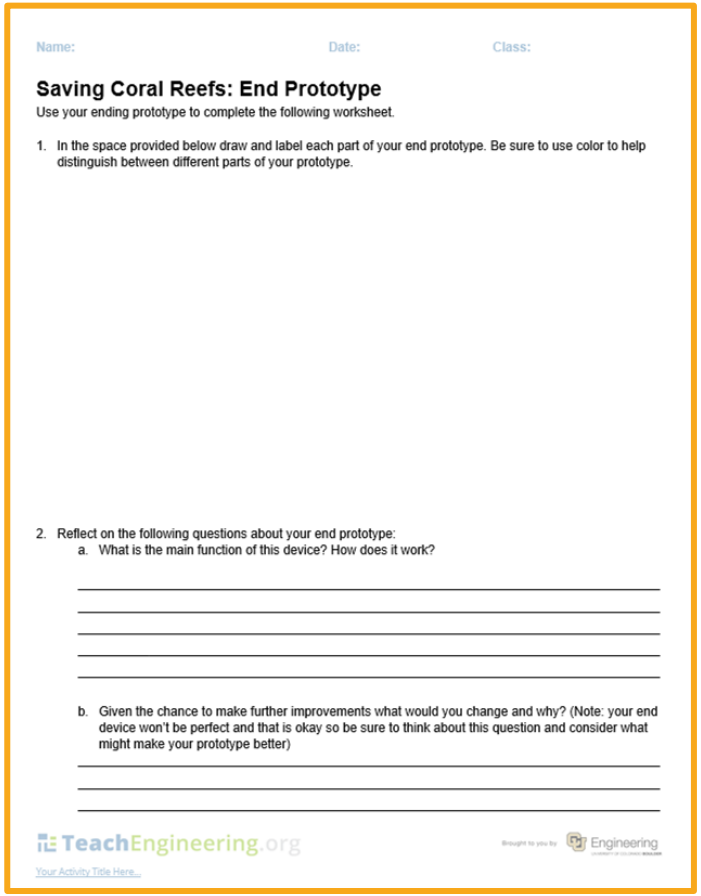
Your Activity Title Here...

Engineering Design Process: Step #6 & 7 TEST AND IMPROVE

Continue to test and improve your prototypes as necessary.

Engineering Design Process: Reflection

For your final prototype, you will complete the ‘End Prototype’ worksheet with your group. Be sure to be thorough in your reflection answers about your prototype.



Name: Date: Class:

Saving Coral Reefs: End Prototype

Use your ending prototype to complete the following worksheet.

1. In the space provided below draw and label each part of your end prototype. Be sure to use color to help distinguish between different parts of your prototype.

2. Reflect on the following questions about your end prototype:
   a. What is the main function of this device? How does it work?

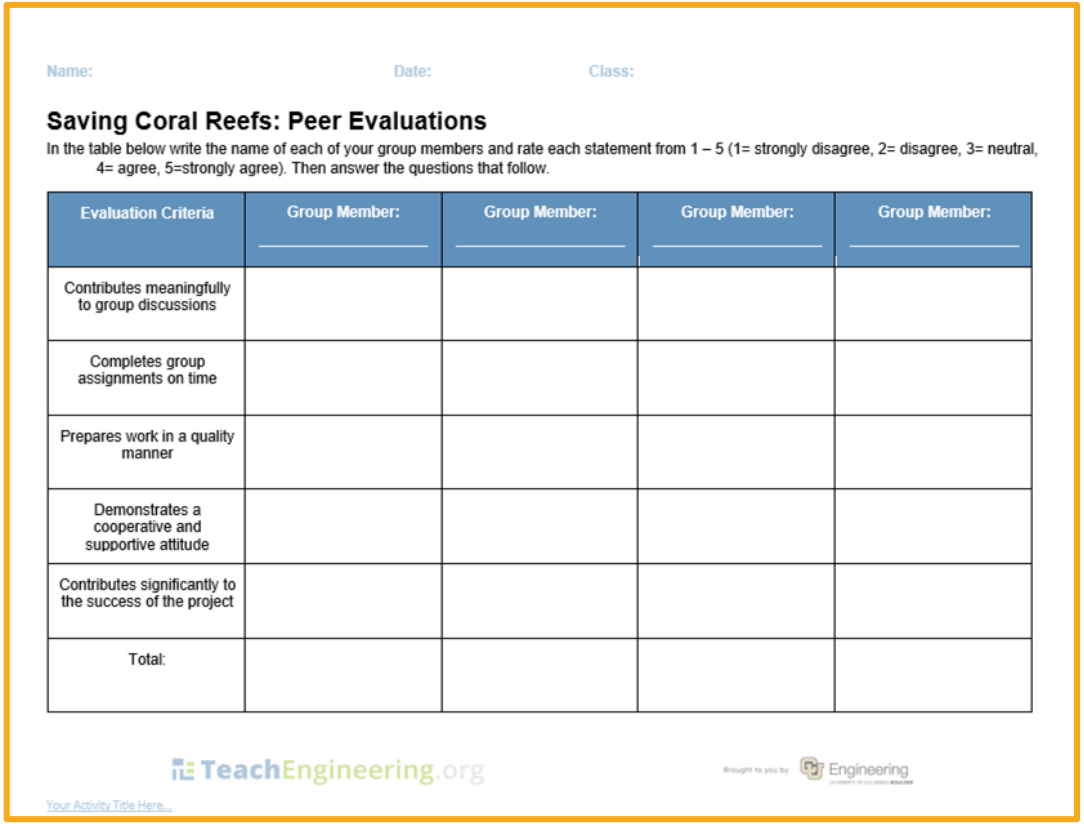
   b. Given the chance to make further improvements what would you change and why? (Note: your end device won't be perfect and that is okay so be sure to think about this question and consider what might make your prototype better)

TeachEngineering.org

Your Activity Title Here...

Peer Evaluations

Complete the peer evaluation for each of your group members.



Name: Date: Class:

Saving Coral Reefs: Peer Evaluations

In the table below write the name of each of your group members and rate each statement from 1 – 5 (1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5=strongly agree). Then answer the questions that follow.

Evaluation Criteria	Group Member:	Group Member:	Group Member:	Group Member:
Contributes meaningfully to group discussions				
Completes group assignments on time				
Prepares work in a quality manner				
Demonstrates a cooperative and supportive attitude				
Contributes significantly to the success of the project				
Total:				

TeachEngineering.org

Brought to you by Engineering

Your Activity Title Here...