Marine Maintenance Challenge

How can we design and innovate a tool that effectively removes biofouling from ships hulls?

Marine Maintenance Challenge

Lesson Length

3-4 class periods

Overview

Imagine having to keep a ship's hull clean from stubborn marine organisms - how would you do it? In this project we will dive into the world of biofouling removal. Biofouling is the accumulation of unwanted sea life on a ship's hull, impacting its performance and fuel efficiency. Using your design and problem-solving skills, you'll develop a practical solution to keep ships in top shape and help reduce repair and maintenance time. Ready to tackle this maritime challenge hull-on?

VDOE CTE/SOL Courses & Standards:

Science
Grade 6 Science
Life Science
Physical Science

CTE
Introduction to Technology and Engineering
Inventions and Innovations
Technological Systems

Computer Science
Grade 6
Grade 7
Grade 8

See page 9 for course standards

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Learning Objectives:

In this challenge students will:

1. Learn about what biofouling is, including the types of organisms involved, and how it affects ship performance, marine environments, and the ship repair process
2. Explore solutions that exist to remove biofouling and work to create a more innovative approach
3. Investigate material properties, regulations, and safety concerns surrounding biofouling removal in current shipyards

Materials/Supplies:

*Materials can be modified as needed

- Robots or parts to construct a robot (VEX robotics kits, LEGO robotic kits, Sphero Robots, Ozobot Robots, etc)
- Cardboard
- Popsicle Sticks
- Paperclips
- Tape
- Scissors
- Hot glue *teacher discretion
- Exacto Knife *teacher discretion
- 3D printer, CNC Machine, or Laser Engraver and supplies

Did you know it takes over 200,000 gallons of paint to paint an aircraft carrier?

Key Vocabulary

- Hull: the main body of a ship or boat, excluding the mast, rigging, and other equipment
- Biofouling: the accumulation of aquatic organisms, such as algae, barnacles, and mussels, on submerged surfaces like ship hulls
- Corrosion: the gradual deterioration of materials, especially metals, due to chemical reactions with their environment, such as rusting
- Efficiency: how well a tool or system performs its intended function with minimal waste of resources, such as time, energy, or materials
- Sustainability: practices that ensure resources are used in a way that does not deplete them or harm the environment
- Regulation: rules or guidelines that must be followed, especially those related to safety and environmental standards

Background Information & Resources

Biofouling from the AMPP Standard perspective (this it the organization that creates the standards for coating and blasting ships)
https://blogs.ampp.org/protectperform/advanced-coatings-make-biofouling-removal-easier#:~:text=If%20the%20substrate%20is%20covered,been%20controlled%20with%20antifouling%20coatings.

https://www.youtube.com/watch?v=X78V4BG78CA

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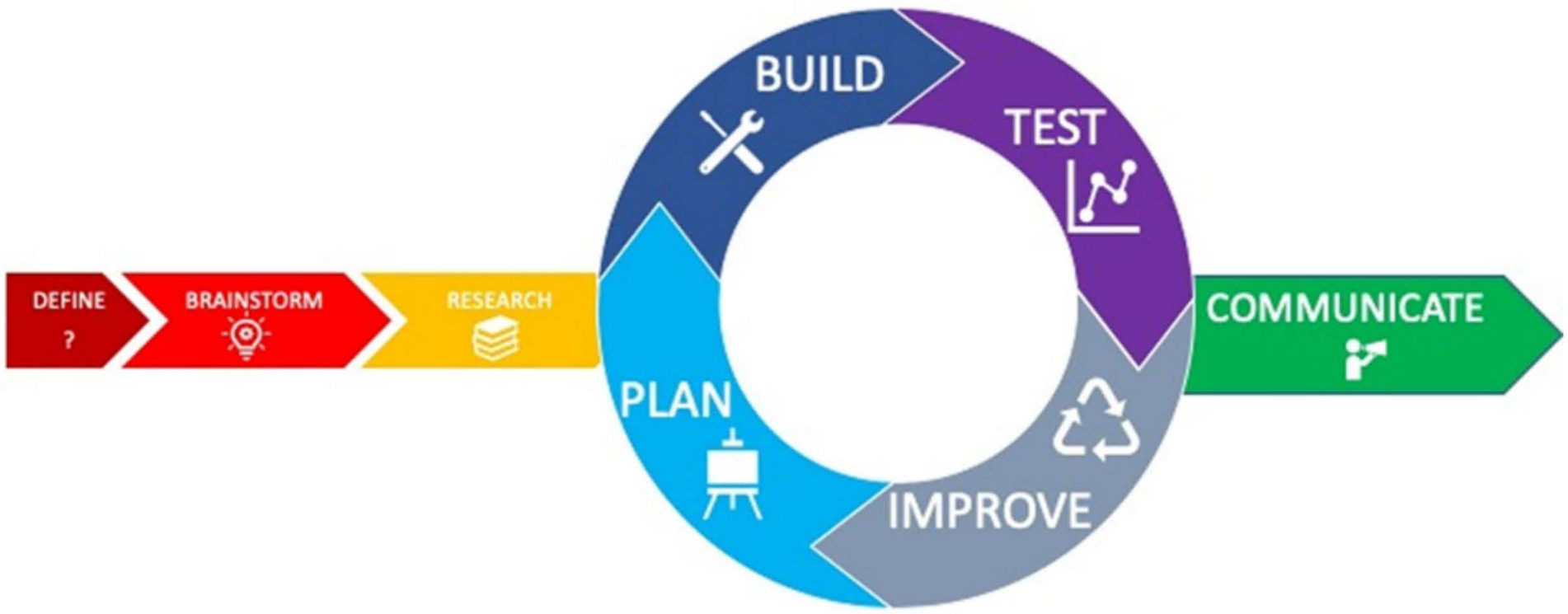
Marine Maintenance Challenge
Teacher Prep

Before beginning the activity, students/teachers can collect recycable materials to use. Make sure that they have been cleaned out.

For this project, students can use manufacturing equipment. This includes 3D Printers, CNC Machines, and/or Laser Engravers. Teachers should prepare students with the software they need to use for these pieces of equipment. Teachers will also need to make sure they have supplies for these pieces of equipment on hand for this project.

For the testing component of this project, the teacher will need to prepare a ship hull with biofouling on it. The can be as simple as clay on a desktop or can be as advanced as a 3D printed ship hull with removable material representing biofouling.

Marine Maintenance Challenge Directions



- Define the problem and determine the parameters
- Brainstorm potential solutions
- Research the problem (this can be done before the brainstorm session)
- Plan: pick one solution, plan a prototype, and determine what data to collect to determine its effectiveness
- Build the prototype
- Test the prototype
- Improve the prototype and test it again
- Communicate the results

Challenge: Design and build a tool or system that can effectively remove biofouling organisms from the hulls of ships. The tool or system should attach to a robotic device to allow for programmable control.

1. Present the challenge to the students
2. Individually research biofouling, what it is, its effects on ships, and current methods used to remove biofouling from ships. Discuss their findings.
3. In teams of 2-3, have students brainstorm ideas for their biofouling removal device.
   a. Brainstorming can look like sketches on paper, word clouds, or images pulled from their research. You decide how you want this to look.

Marine Maintenance Challenge Directions

4. Have students decide on their design and plan how they are going to make their prototype.
    a. This includes deciding if they are going to use 3D printers, CNC Machines, or the Laser Engraver.
    b. Students should practice programming their robot once a base robot design has been constructed or decided on
    c. Use this time to decide if you need to implement a size constraint based on your testing hull or the size of the robots.
5. Prototype construction
6. Test each prototype
    a. Up to the teacher is there will be testing allowed throughout the construction process or if students have to wait until all prototypes have been completed
7. If time permits, students can redesign and retest their prototypes. If there is not time for that, students should complete a "report" that documents the positives and negatives of their prototype and how they would improve it.
    a. The report can look different depending on the teacher
8. Students should do a small informal presentation on what they learned, their design, and what they would do different. Teacher's can add additional talking points.

Marine Maintenance Challenge
Take It Further!

- Have students research and do experiments on corrosion and its effects on ship hulls
- Focus on using environmentally friendly ways to remove biofouling from the hull, how would this change environmental impacts?
- Contact a local shipyard to hear about biofouling removal from industry.
- Perform more in depth testing, adjusting the surfaces, making the device autonomous, or adding in a change of environment (wind conditions, temperature, etc.)

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Marine Maintenance Challenge

VDOE CTE/SOL Courses & Standards:

Science

Grade 6 Science

- 6.1: The student will demonstrate an understanding of scientific and engineering practices by:
  - a) asking questions and defining problems
  - b) planning and carrying out investigations
  - c) interpreting, analyzing, and evaluating data
  - d) constructing and critiquing conclusions and explanations
  - e) developing and using models
  - f) obtaining, evaluating, and communicating information
- 6.6: The student will investigate and understand that water has unique physical properties and has a role in the natural and human-made environment
- 6.9: The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment

Life Science

- LS.1: The student will demonstrate an understanding of scientific and engineering practices by:
  - a) asking questions and defining problems
  - b) planning and carrying out investigations
  - c) interpreting, analyzing, and evaluating data
  - d) constructing and critiquing conclusions and explanations
  - e) developing and using models
  - f) obtaining, evaluating, and communicating information
- LS.9: The student will investigate and understand the relationships that exist between ecosystem dynamics and human activity

Physical Science

- PS.1: The student will demonstrate an understanding of scientific and engineering practices by:
  - a) asking questions and defining problems
  - b) planning and carrying out investigations
  - c) interpreting, analyzing, and evaluating data
  - d) constructing and critiquing conclusions and explanations
  - e) developing and using models
  - f) obtaining, evaluating, and communicating information
- PS.3: The student will investigate and understand that matter has properties and is conserved in chemical and physical processes.

Computer Science

Grade 6 Computer Science

- 6.1: The student will construct programs to accomplish a task as a means of creative expression or scientific exploration using block based or text based programming language, both independently and collaboratively.
- 6.3: The student will seek and incorporate feedback from team members and users to refine a program that meets user needs.

Grade 7 Computer Science

- 7.1: The student will construct programs to accomplish a task as a means of creative expression or scientific expression using block based or text based programming language, both independently and collaboratively.

Grade 8 Computer Science

- 8.1: The student will construct programs to accomplish a task as a means of creative expression or scientific expression using block based or text based programming language, both independently and collaboratively.

CTE

All Workplace Readiness Skills Competencies can be addressed throughout the project.

Introduction to Technology and Engineering

- Designing Solutions
  - Describe the VDOE engineering design process
  - Demonstrate the use of an engineering design process
- Using the Engineering Design Process
  - Define the goal of a challenge
  - Design a device using criteria and constraints
  - Evaluate viable solutions
  - Select a solution
  - Plan the model or prototype
  - Produce a model or prototype
  - Assess the design
  - Describe how the solution could be improved
  - Communicate the results
  - Use the engineering design process as part of a team

Inventions and Innovations

- Exploring Tools for Invention and Innovation
  - Demonstrate safe use of a minumum of five tools and/or equipment
  - Demonstrate various types of measuring
  - Create sketches and drawings
- Explore Design and Creativity
  - Evaluate a product's design with the goal of innovation
  - Describe the VDOE engineering design process
- Applying the Engineering Design Process
  - Plan a solution to an engineering design problem
  - Build a model or prototype of the propose solution
  - Communicate the process and results of the proposed solution

Technological Systems

- Exploring Technological Systems
  - Analyze existing products or solutions
  - Describe the steps of the VDOE engineering design process
- Creating Systems
  - Plan a solution to an engineering design problem, as part of a team
  - Demonstrate the safe use of a minimum of seven tools and/or pieces of equipment
  - Construct a model or prototype of the proposed solution, as part of a team
  - Communicate the processes and results of the solution, as part of a team
- Evaluating Technological Systems
  - Assess the effect of technological systems on individuals, resources, society, and the environment.

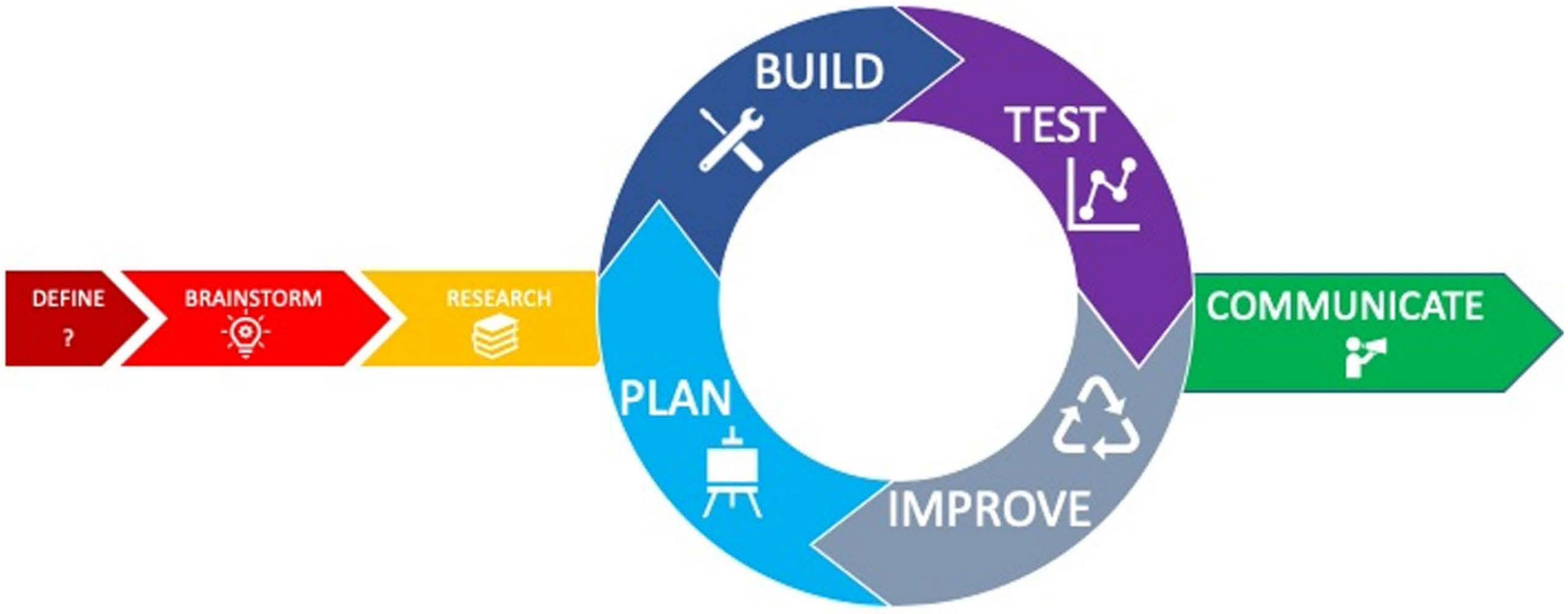
Project Management Plan

Team Member Roles

Team Goals & Timelines

Team Member Tasking

Research Planning



Sketches & Design Planning