NAVSEA
SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS

#SeaworthySTEM

Navigating the High Seas

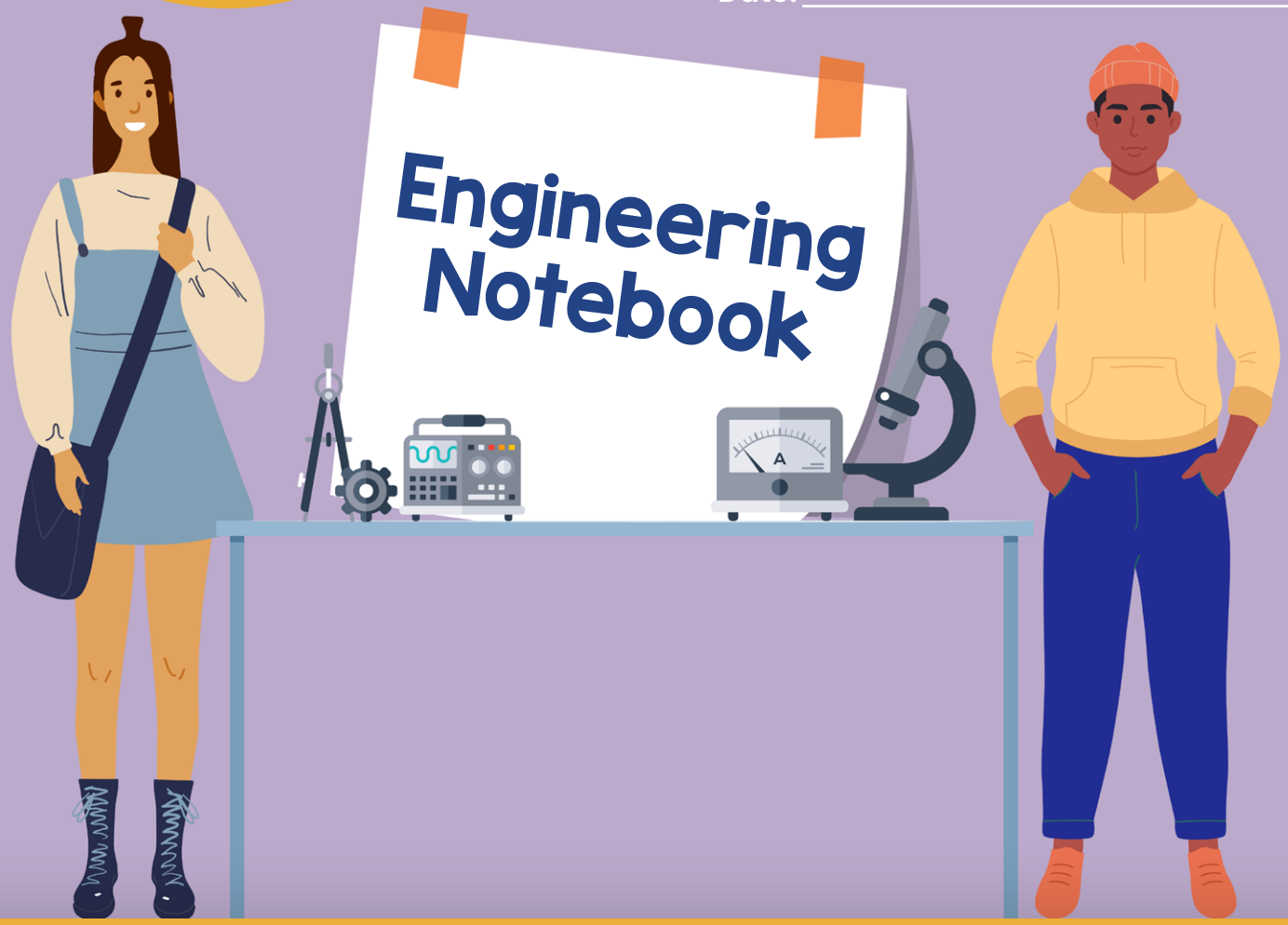
A Sailor's Tool Design Adventure

Grades 9-12

Student Activity Workbook

Name: _____

Date: _____



Seaworthy STEM™ in a Box Series

NAVSEA
SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS

NAVAL STEM
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Office of Naval Research
ONR
Science & Technology

Part I: Let's Research!

Exploring Primary Sources & Research Techniques

Journal Entry:

"Think about...":

Artifact 1:

Smock, W. (1979) Old Machete-Like Tool. , 1979. October. [Photograph]
Retrieved from the Library of Congress, https://www.loc.gov/item/ncr001920/

1. Check out the image above, what do you notice, wonder, or predict about its functionality?

2. What about this device gives it a unique purpose?

3. What **STRUCTURES** on the device are used for specific **FUNCTIONS**? Explain and label a diagram with at least three ideas.

4. What could you add to this device that would change its function? Specify the function you're trying to achieve?

Artifact 2:

Wilson, W. A. (1978) Tools, Horseshoeing. , 1978. May. [Photograph]
Retrieved from the Library of Congress, https://www.loc.gov/item/ncr001063/

1. Check out the image above, what do you notice, wonder, or predict about its functionality?

2. What about this device gives it a unique purpose?

3. What **STRUCTURES** on the device are used for specific **FUNCTIONS**? Explain and label a diagram with at least three ideas.

4. What could you add to this device that would change its function? Specify the function you're trying to achieve?

Artifact 3:

Eiler, L. S. (1996) Connard Wolfe's sculpting tools. Kanawha County Gallagher West Virginia, 1996. [Photograph] Retrieved from the Library of Congress, https://www.loc.gov/item/cmns000585/

1. Check out the image above, what do you notice, wonder, or predict about its functionality?

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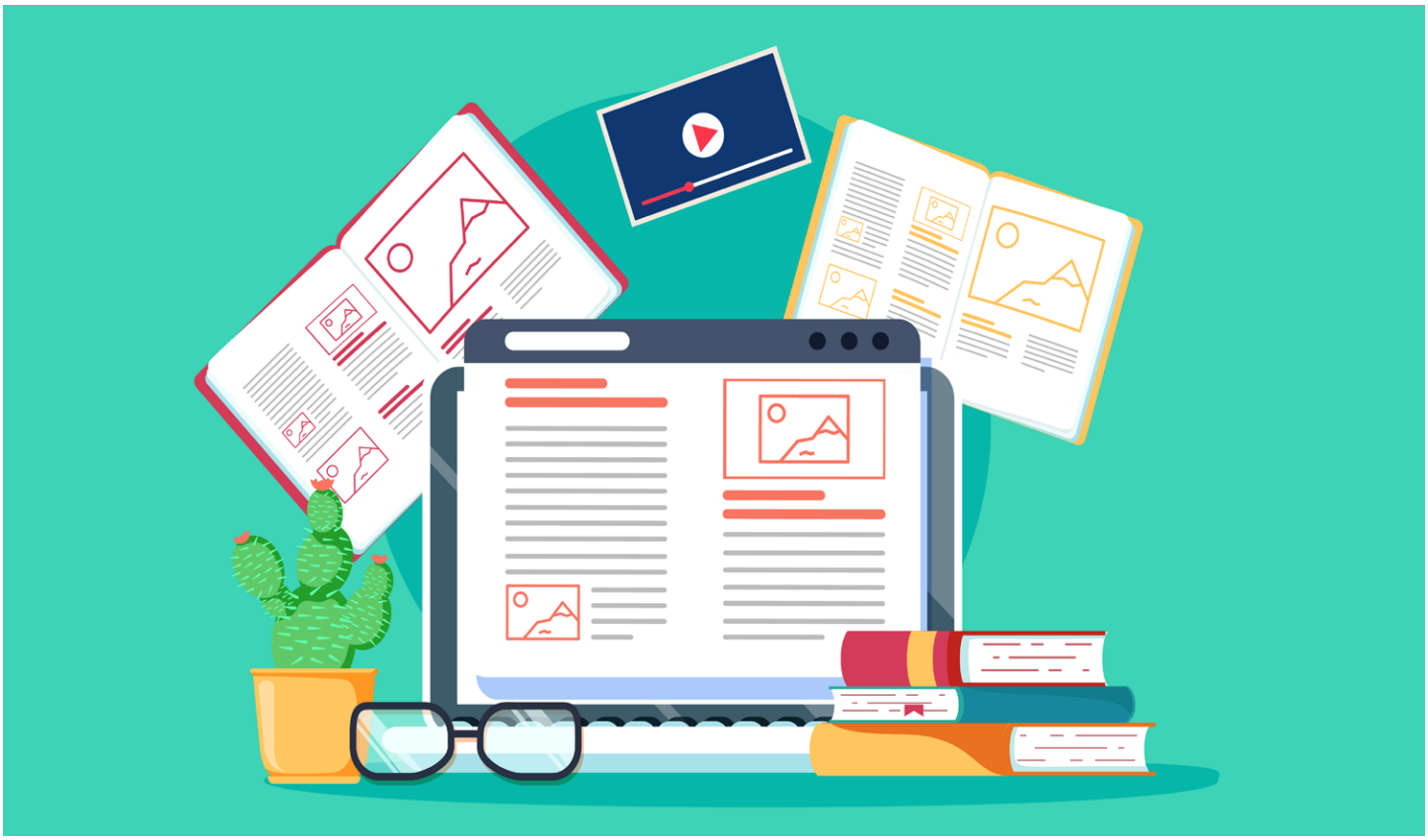
Part 2: Let's Explore!



1 **Activity:**

Research at least three of the tools listed below (your teacher may add more options):

Suggested tools:

- Hammer
- Ruler
- Thermometer
- Scale
- Paintbrush

Complete the charts in the following pages for each selection.

Measurement Tool Research Sheet

Tool Type and Diagram: _____

What was the purpose of the tool?

Are there any **STRUCTURES** on the tool used for specific **FUNCTIONS**? Explain.

What other functions could this tool have that may not be its initial purpose?

How can you improve this tool to make it better?

Measurement Tool Research Sheet

Tool Type and Diagram: _____

What was the purpose of the tool?

Are there any **STRUCTURES** on the tool used for specific **FUNCTIONS**? Explain.

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Are there any **STRUCTURES** on the tool used for specific **FUNCTIONS**? Explain.

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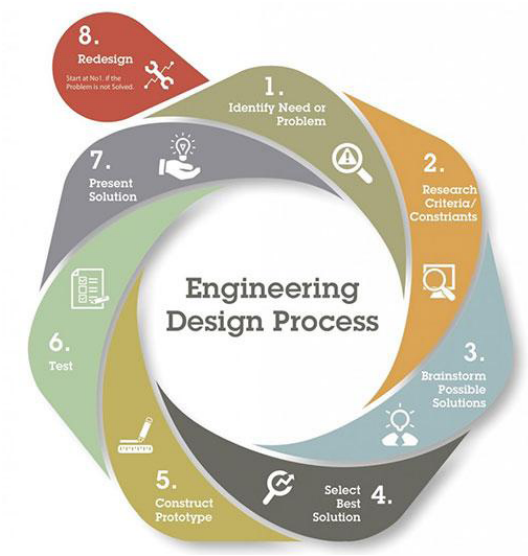
Part 3: Design Engineering Challenge

Over the course of this next section, you are going to utilize the engineering design process (EDP). The EDP is utilized by people everyday when they are attempting to find a solution to a problem. The goal of the cycle is not to develop a perfect product, but rather it is to develop prototypes (systems or machines) that can improve the current way of doing things.



1. Your teacher will identify the problem for you to solve (the engineering design challenge) and will also assign you to a design team of 2-4 students. At this point you will work together to complete the "Team Code of Cooperation" which will lay the foundation for how your team will function. Once complete, please sign then have your teacher initial at the bottom of the page.

2. Fortunately, you have already completed much of the necessary research when you completed the Research Sheets. Explore choices from the list contained within the challenge description and find one that seems able to accomplish the challenge provided by your teacher. Now your team will complete "Preparing Goals for an Engineering Design Challenge." The sheet will help your team note the constraints (Time limitations, types/ quantities of materials, etc) of the project that are provided by your teacher. With those constraints in mind, your team will then discuss and then list design objectives for the prototype that your team will develop.

3. Individual Design: Now that you have developed a list of common design objectives with your team, it is your turn to independently create a blueprint of your prototype. You will draw your idea as well as note the exact materials that you are using in your design. Do not forget to include things like measurements, how the individual components are connected as well as any other comments that you would like to share with your team.

4. Team Design: Once all of your team members have completed their individual designs, it is now time to share with the rest of the group. Each person should follow the agreed upon rules in the "Team Code of Conduct" as you work together to develop your team design. Once your prototype is drawn below, please have your teacher initialize the provided space.

5. Now it is time to build your prototype!

6. Test your prototype (redesign and retest your prototype if necessary and time permits).

7. Work as a team to complete the "Prototype Analysis and Reflection" sheet. Then share your solution (or attempted solution) with the class. Be sure to include both your successes as well as your failures so that the various teams can learn from each other's designs.

8. Complete the "Peer Evaluation of Teamwork," so your teacher can have a better idea of how the people in your team functioned as a group.

9. Submit all of the papers to your teacher.

Team Dynamics

A. Decide on a team name: _____

B. List all members of the team for this project: _____

_____

C. Create a one-sentence mission statement for your team: _____

_____

_____

List anticipated goals. All team members agree to:

A.

B.

C.

D.

E.

When a team member lets their team down by ignoring the anticipated goals listed above, the following actions will be taken based on number of offenses:

Step 1:

Step 2:

Step 3:

✓ Teacher Approved: _____
(Teacher's initials)

By signing this document on one of the lines below, you are stating that you agree to meet the anticipated goals and understand the consequences if you fail to do so.
Team Signatures:

_____ _____

_____ _____

_____ _____

Procedure

1 What is the Problem?

What is the challenge you are trying to solve? Brainstorm and write out the problem you are trying to solve in question format:

2 What are the Criteria and Constraints?

What is the challenge you are trying to solve? Brainstorm and write out the problem you are trying to solve in question format:

Criteria Brainstorm	Constraints Brainstorm

List final criteria and constraints below:

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

Budget Allocations:

Item	Quality Needed	Cost per Item	Total
		Total Cost:	

As a team, develop at least five design objectives (attributes that your team would like your prototype to have, based on your background research):

A. _____

B. _____

C. _____

D. _____

E. _____

✓ Teacher Approved: _____

(Teacher's initials)

3 How can we Brainstorm and construct the Prototype?

Design 1

Does it meet the criteria? _____

_____

_____

Does it meet the constraints? _____

_____

_____

Is it within the allocated budget? _____

_____

_____

Justification: _____

_____

_____

Design 2

Does it meet the criteria? _____

_____

_____

Does it meet the constraints? _____

_____

_____

Is it within the allocated budget? _____

_____

_____

Justification: _____

_____

_____

Design 3

Does it meet the criteria? _____

_____

_____

Does it meet the constraints? _____

_____

_____

Is it within the allocated budget? _____

_____

_____

Justification: _____

_____

_____

4 **How can we Test and Data Collection?** Create a data table or use the one below.

Trial	Variable 1 _____	Variable 2 _____	Variable 3 _____	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Variable Averages				
Total Averages				

5 What are our Findings? Data Analysis and Reflection (20 minutes):

Your team will create a quick visual representation of findings. The teacher will indicate the appropriate methods of data visualization. Complete the following:

A. Discuss and reflect with your team on the following: what worked and what did not in their design.

- What worked overall? Explain.
- What did not work overall? Explain.
- Does my prototype meet the requirements of the design challenge?
- Can I improve the design from its original specifications?
- How can I reduce the cost of my final prototype without sacrificing quality?

B. Include the following information in your data visualization:

- Data Chart
- Graph of information
- Answers to all the reflection questions from part A

6 Let's Improve it! Class Discussion, Team Redesign Conclusion

Team Redesign:

Based on the results of your testing, identify two areas of success in your team's prototype design. Why were these areas successful? Explain.

A.

B.

Based on the results of your testing, identify two areas of failure in your prototype design. What caused the failure? Explain.

A.

B.

As a group, determine at least four suggestions for further meeting or exceeding the constraints in the future.

A.

B.

C.

D.

Individual Reflection:

Discuss the most successful designs and strategies:

A.

B.

C.

D.

Relate the activity to real-world applications in naval engineering or beyond:

A.

B.

C.

D.

7 Peer Evaluation of Teamwork

Evaluator's Name: _____

This form will help you evaluate your team and team members. Please list all of your team members in the space provided below. Then on a scale of 1-5 (1 being the lowest; 5 being the highest), rank your peers (and yourself) on how well you think that each did in a particular area. *Do not forget to include yourself on the list.

Here is the scale:

1= Did not perform in this manner at all
2= Low performance in this area
3= Did okay in this area, but could have contributed more to the group
4= Contributed enough to be considered an active part of the group
5= Performed as an integral, vital part of the group in this area

Team Member Name	Cooperation	Dependability	Participation	Quality of Work	Motivation	Overall Contribution

I would also like to get an overall idea of how members of your group performed. In the space below, divide the 100% total points amongst the members of your group. For example, if you think each member of the group (including yourself) contributed equally, then assign each member the same number of points. If you think that you had "slackers" or "high achievers" in your group, then assign them less or more points. Again, please include yourself in the scoring. Don't forget that the total should add up to 100 points.

Team Member Name	Number of Points Assigned
Total	100

Notes

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