NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 2 HRS

Dissecting Exploration Vehicles

Students research and compare three deep-sea exploration vehicles to determine how the designs of these vehicles have changed over time.

GRADES

9 - 12+

SUBJECTS

Earth Science, Oceanography, Engineering, Geography

CONTENTS

1 Image, 4 PDFs, 2 Resources, 8 Links

OVERVIEW

Students research and compare three deep-sea exploration vehicles to determine how the designs of these vehicles have changed over time.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/dissecting-exploration-vehicles/

Program

DEEPSEA CHALLENGE

DIRECTIONS

1. Make basic comparisons between two deep-sea exploration vehicles.

Display the provided images of the *Trieste* and the *DEEPSEA CHALLENGER* side-by-side. Explain that these two vehicles are the only vehicles to have carried humans to the deepest known place in the ocean, the Challenger Deep in the Mariana Trench. Ask students to make observations about the similarities and differences between the two vehicles in the images. Ask: *Which do you think is older? Which do you think was able to descend and ascend more quickly? Which do you think weighs more?* Make sure students provide reasoning to support their answers. Distribute the Then and Now: Comparison Table handout and have students look at the table comparing the two vehicles. Review the statistics on the handout while viewing the images. Ask students to identify which vehicle is the *Trieste* and which is the *DEEPSEA CHALLENGER* based on the statistics listed in the table. For each statistic in the table, ask students to point out specifics from the image that indicate or explain the statistic.

2. Briefly explore the history of ocean exploration using the Ocean Exploration GeoStory.

Divide students into pairs and direct them to the provided Ocean Exploration GeoStory. Have students explore the GeoStory to get an overview of some significant events in ocean exploration. After about ten minutes, discuss what students have learned. Ask: *What surprised you about early ocean exploration? What were some limits on early ocean exploration? How have scientists and explorers overcome those limits? What roles have technology and advances in technology played in ocean exploration? How has ocean exploration changed over time?*

3. Have students identify constraints and considerations of deep-sea exploration vehicles.

Introduce the concepts of constraints and considerations to students and give examples of each. Constraints are absolute requirements or limitations in a design or decision-making process. If a choice or solution doesn't meet the constraints, then it must be eliminated. For example, if you are shopping for new bookshelves for your living room, there will be a size constraint. The bookshelves must be small enough to fit in the available space in your living room. Any bookshelves that are too big must be eliminated as a choice, even if they are otherwise perfect. Considerations are desired, but not necessary, elements in a design, solution, or decision. Considerations can be used to rank choices and solutions. For example, if your living room has a lot of dark wood, the tone of the wood for your bookshelves would be a consideration; you may prefer to have dark wood so that it will match the other wood in the room. However, you wouldn't necessarily eliminate a shelf just because it has lighter wood.

Ask students to work with their partners to brainstorm and record constraints and considerations for deep-sea exploration vehicles. For each item they list, have students explain why they categorized it as either a constraint or a consideration. After a few minutes, have pairs share their ideas with the class. Create master lists of constraints and considerations on the board. Discuss whether or not other students agree with the way items have been categorized, and adjust the lists as necessary.

4. Have students research specific deep-sea exploration vehicles.

Explain that students will conduct research to explore how the constraints and considerations they identified are addressed differently in the designs of different vehicles. Divide students into three groups and assign each group one of the following deep-sea exploration vehicles to research: *Trieste*, *Alvin*, or *DEEPSEA CHALLENGER*. Distribute the Vehicle Information worksheet to each student. Have students use the provided websites to do some basic research about their assigned vehicles, working individually or in pairs, and to complete the first two sections of the worksheet. Have students compare notes with others in their group.

5. Have students research individual systems of their assigned vehicles in more detail.

Explain that deep-sea exploration vehicles are complex and include a number of different systems working together in order to fulfill the vehicle's purpose. Within each of the three vehicle groups, assign a system to individuals or pairs for further research. Assign the following systems: the manned chamber, buoyancy control, navigation, research tools (including arms, video, viewports, etc.), communication technology, and power. Explain that students must become the experts within their groups on their assigned systems. Have students continue their research and complete the Vehicle Information worksheet with details about their systems, including their purpose, how they work, and how they connect to the purpose of the vehicle as a whole.

6. Have all the experts on each system discuss their system together.

Have students form new groups, one for each system. Each system group should be composed of three members—the experts on that system for each of the three vehicles. Have students share information with their new group about how the system worked on their assigned vehicle. Have groups identify similarities and differences in their assigned system among the three vehicles. Also have students identify the constraints and considerations of deep-sea exploration that their system addresses and discuss how the system addresses each one. Ask students to take into consideration when each of the vehicles was built and how the designs of deep-sea exploration vehicles have changed over time. Have each system group briefly present their findings to the class.

7. Have students compare the three vehicles in their original vehicle groups.

Have students return to their original vehicle groups from step 4. Distribute the Three-Circle Venn Diagram to students and have them label each circle with the name of one of the vehicles the class researched. If necessary, briefly review how to fill out a Venn diagram. Have students work collaboratively to complete the Venn diagram using each other's expertise on the various systems within the vehicles in their comparisons.

8. Discuss the activity's guiding questions.

Ask students: *How do individual systems within a deep-sea exploration vehicle work together to fulfill the purpose of the vehicle? How have the individual systems changed over time?* Encourage students to provide specific examples from the vehicles they researched to support their ideas.

Tip

For step 7, check to be sure that students understand how to use a Venn diagram. If not, briefly model how Venn diagrams work before students complete this step.

Modification

In steps 5 and 6, pair students who need more support with more advanced students and have them research a system as a team.

Informal Assessment

Use the provided Three-Circle Venn Diagram Answer Key to assess students' Venn diagrams.

Extending the Learning

Have students perform a similar “dissection” on a simple piece of equipment in the classroom, such as a pencil sharpener or a drawer. Ask students to identify the purpose of the equipment, identify any systems within the equipment, and explain how the design of the equipment reflects its purpose.

Have students create a model of one of the deep-sea exploration vehicles they studied. Provide students with materials such as cardboard, poster board, duct tape, foam board, and wire to complete their models.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Oceanography

- Engineering

Geography

Learning Objectives

Students will:

- determine the constraints and considerations for deep-sea exploration vehicles
- research the design of a deep-sea exploration vehicle
- compare three deep-sea exploration vehicles
- analyze how deep-sea exploration vehicles have changed over time

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Cooperative learning

- Discussions
- Jigsaw
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard E-1:**
Abilities of technological design
• **(9-12) Standard G-3:**
Historical perspectives

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 7a:**
The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
• **Principle 7d:**
New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

ISTE STANDARDS FOR STUDENTS (ISTE STANDARDS*S)

• **Standard 2**:
Communication and Collaboration

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per learner, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom
- Computer lab

GROUPING

- Large-group instruction

BACKGROUND & VOCABULARY

Background Information

On March 26, 2012, James Cameron made the first-ever solo dive to the bottom of the Mariana Trench. Cameron's deep-sea exploration vehicle, *DEEPSEA CHALLENGER*, was only the second manned vehicle to reach the deepest-known point in the ocean, the Challenger Deep in the Mariana Trench, nearly 11 kilometers (7 miles) down. The first vehicle to reach the Challenger Deep was the *Trieste*, which carried two people to the ocean floor in 1960. Much changed in the years between the two manned dives. Advances in technology and materials led to innovations in design, which allowed the *DEEPSEA CHALLENGER* to explore the ocean for six hours—18 times longer than the *Trieste's* 20 minutes on the ocean floor. The *DEEPSEA CHALLENGER*'s lighter weight and vertical design allowed for a faster descent and ascent, allowing more time for exploration at the bottom of the ocean. Advances in communication technology also made it possible for the *DEEPSEA CHALLENGER* to film the voyage, something the *Trieste* was unable to do. *Alvin* is another deep-sea exploration vehicle—one that has spanned the years of deep-sea exploration between the *Trieste* and *DEEPSEA CHALLENGER*. Built in 1964, *Alvi*n has been updated over the years and is still in use today. Though *Alvin* has not reached the deepest-known point in the ocean, it is capable of exploring depths up to 4,500 meters (about 3 miles). Like *Trieste* and *DEEPSEA CHALLENGER*, *Alvin* has made history, including the exploration of the first known hydrothermal vent site.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
buoyancy	*noun*	the power to float or rise in a fluid.
consideration	*noun*	a matter weighed or taken into account when formulating an opinion or plan.
constraint	*noun*	limitation or obstacle.
submarine	*noun*	vehicle that can travel underwater.

FUNDER

Alfred P. Sloan Foundation

National Geographic