Undersea Adventure

Outcomes:

1. Describe examples of how scientific knowledge has improved over time.(110-8)
2. Provide examples of technologies that have enabled scientific research. (111-3)
3. Explain how society's needs can lead to developments in science and technology. (112-3)

Erosion

It took the sea a thousand years,
A thousand years to trace,
The granite features of this cliff,
In crag and scarp and base.

It took the sea an hour one night,
An hour of storm to place
The sculpture of these granite seams
Upon a woman's face.

E.J. Pratt, June 1931

Introduction

E. J. Prattt's poem provides an example of our close connection with the ocean. The poem illustrates how the ocean has affected both our landscape and our people. Traditionally, our ancestors have braved the waters of the North Atlantic in search of codfish. These voyages were driven by both our hunger for food and our thirst or money. Recently we have discovered that the continental shelf that surrounds our province contains millions of barrels of oil. Finding and extracting this natural resource is the new challenge for the current generation of Newfoundlanders and Labradorians who are risking their lives on the ocean.

Solving Underwater Mysteries

For thousands of years the underwater world has been an unknown and unexplored region of our planet. Even today, the deep ocean remains the last great frontier of exploration. Tales of sea monsters put fear in the heart of many a sailor. The Kraken of Portugal Cove was a giant squid that attacked two fishermen and a boy in a small boat in 1873.

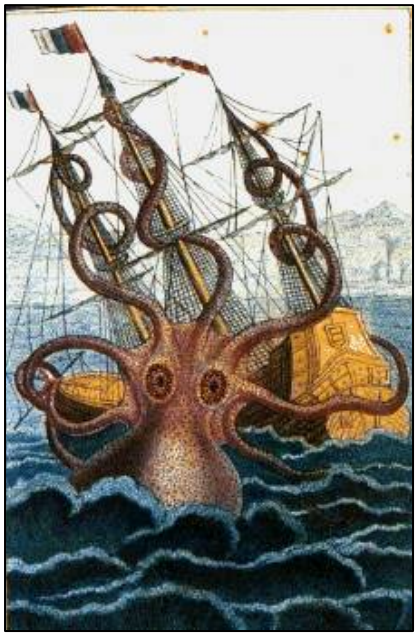

Illustration of a giant squid attacking a ship, by Pierre Denys de Montfort in 1801 from descriptions of French sailors who reported being attacked by such a creature.

During the struggle, the boy managed to chop off one tentacle that measure 19 feet long, before the creature finally escaped.

A Cadborosaurus, a creature similar to the fabled Loch Ness Monster, was believed to be sighted in Trinity Bay. Are these creatures real or just a fantasy? Recent changes in technology have allowed people to go where no one has explored before. However some mysteries remain unsolved.

Did you know? If Mount Everest, the tallest mountain in the world (8,848 m above sea level), were laid in the Marianas Trench there would still be 2 kilometres of water above it…and no sunlight would reach it.

In 1985, Dr. Robert Ballard discovered the wreck of the Titanic. The remains of this huge ocean liner were in water almost 4 kilometres deep. Dr. Ballard and his team were able to find this ship wreck y use the deep sea submersible, *Alvin.* The *Avin* has space for 2 scientists and a pilot and can dive to depths of 4500 metres and remain under water for up to nine hours.

Figure 1: The submersible Alvin was named in honor of Allyn Vine, a scientist at Woods Hole and the key person responsible for getting the vessel built. Photo courtesy of Woods Hole Oceanographic Institute (photo retrieved from http://www.whoi.edu/page.do?pid=10737).

Using Remotely Operated Vehicles, called ROV's, we are now able to explore areas underwater that were impossible to view in the past. Controls, like those used to operate video games, are used to move these vehicles at great depths underwater. Originally, ROV's were used by the American military for deep sea rescue and recovery missions. Now, as we explore in deeper and deeper water, divers are gradually being replaced by ROV's.

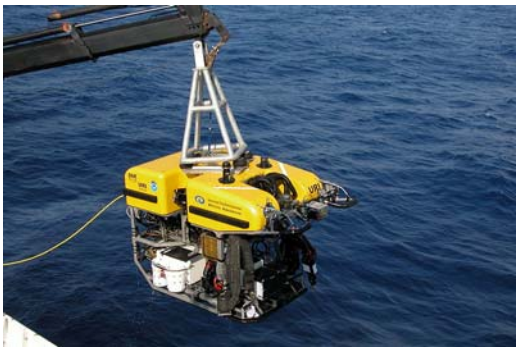

Figure 2: The ROV "Hercules" being launched from a research vessel. Photo courtesy of Wikipedia.

Constructing an ROV

What materials and equipment would you need to put together an underwater vehicle? That depends on how and where you are going to use it. One of the vehicles that Dr. Ballard used to explore the Titanic was a manned device and, therefore, it required all the necessities to sustain life (Space for people, air tanks, interior heating, interior lighting, viewports, communication equipment, a power source and the ability to have all these things inside it and withstand pressure at great depths). Unmanned ROV's can be much smaller. Most of these devices are tethered, meaning attached to an above water partner ship by a cable. This cable connects the operator to the device and allows electrical signals to be sent back and forth. The ROV needs light because the deeper you go into the ocean the darker it gets.

Did you know? At sea level, the particles that make up air push down on you with a force of about 1 kg per square cm of your body. The pressure at around 4000 m below the sea, at which the Titanic was discovered, is equivalent to 378 times the pressure our body feels at sea level. This would be like having 3 large people standing on the top of a nail pressing on our skin.

A video camera is mounted on the ROV and provides a "window" to the undersea world and allows the operator to see in order to maneuver the vehicle. Thrusters, usually a propeller in an enclosed cylinder, are required for moving the vehicle. The rest of the equipment really depends on what specific job needs to be done. Vehicles designed for searching for things may use sonar and magnetometers.

Did you know? Did you know a magnetometer is a device for finding metal objects. Its name describes its function; magnet, for magnetism of an object and; meter, for measuring device.
SONAR is another measuring device, but it uses sound and how it bounces back from an object to find it. The word SONAR is an acronym, for SOund, NAvigation and Ranging.

Other have options for manipulating objects, digging, cutting and taking a variety of samples. Designing vehicles for use underwater has been compared to designing vehicles for use in outer space.

A Whole New World

Did you know that more people have been to the Moon, over 380 000 km away, than have been to the deepest part of our oceans? Scuba diving, or diving with a "Self Contained Underwater Breathing Apparatus," becomes more difficult as the water depth increases. Any dive deeper than 40 metres is considered a technical dive.

Figure 3: SCUBA diving opens up a whole new world for exploration! Photo courtesy of Wikipedia.

The dives are called such because they require special breathing mixtures that increase the risk. Submersibles (Such as the *Alvin* mentioned above) have been designed to reach depths of over 4000 metres. As we continue to explore deeper into the ocean in search of sunken treasure, new and unusual organisms are being discovered. The Jago submersible has been used to successfully film the habitat of Coelacanth (a prehistoric species of fish that can grow up to 2 metres in length and weight up to 80kg). First discovered in 1938, this link to the Dinosaur age has been found living in underwater caves at a depth of 150-200 m off Grand Comoro Island in the Indian Ocean.

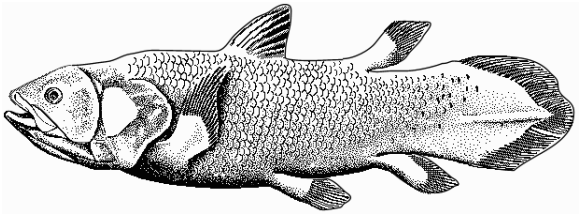

Figure 4: Diagram of Coelacanth based on former FishBase artist Robbie Cada. Courtesy of Wikipedia.

In 1968, the deep sea submersible *Alvin* sank 5000 m to the sea floor when the cable that supported it snapped. Fortunately, it was unmanned at the time. When it was retrieved 10 months later, the sandwiches that the crew had packed were so well preserved in the water at that depth that they were soggy but still edible. The near-freezing temperatures and lack of oxygen helped to preserve the lunches.

Did you know that sea water, due to the salt in it, does not actually freeze at 0^{o} C, but rather around - 1^{o} C . Below a certain depth, ocean temperature gets close to 0^{o} C. At great depths and pressures ocean water can actually go below this number and not freeze.

Recently, underwater explorations have verified the existence of squid that are up to 20 m long (National Geographic, 2005),

which would also confirm the story from Portugal Cove in the 1800's.

Figure 5: Giant squid. Could this be the Kraken of old? Photo courtesy of NASA.

Conclusion

Seven tenths of our planet is covered with water. Of that seven tenths, over half is more than 3000 m deep.

Oil has been recovered in relatively shallow continental shelf regions of the oceans. Exploration has revealed additional reserves of oil in deeper water.

Limitations to the depth at which a diver can comfortably and safely work will mean the majority of the underwater work required in these deeper regions will have to be done using ROV's. Operation and construction of these new vehicles will be an ongoing challenge. Each design must keep in mind safety for both the individuals involved and the undersea environment.

As we continue to explore this last frontier on Earth, who knows what strange creatures and other treasures are yet to be discovered.

Questions

1. Why would we need to use ROV's in deep water?

2. How would an underwater ROV's be similar to the ROV's used on the Mars mission? What would be some differences needed in their designs?

3. Why are most ROV's tethered?

4. Why would ship wrecks be preserved better in deeper water than in shallower water?

5. Research and develop a timeline to describe the progress of underwater exploration from the early 1900's to present day. How has the technology used changed? What new information was discovered with each improvement in underwater-exploration technology?

6. Research and report on the following people or events that contributed to our early understanding of the ocean depths:
   (a) Leonardo da Vinci
   (b) Cornelius van Drebbel
   (c) "Rigid helmet diving suit"
   (d) The "*American Turtle*"
   (e) Bathyspere

References

DSV Alvin. Available: http://en.wikipedia.org/wiki/DSV_Alvin
Remotely Operated Vehicle. Available: http://en.wikipedia.org/wiki/ROV#History
Titanic wreck location. Available: http://www.titanic-titanic.com/titanic_wreck_location.shtml
National geographic. Available: http://news.nationalgeographic.com/news/2005/09/photogalleries/giant_squid/photo9.html
Coelacanth: the fish out of time. Available: http://www.dinofish.com/

Other Sites of Interest

How do our local school's stack up in international ROV competitions?
Check it out at
http://www.marinetech.org/rov_competition/

Interested in Junior High School robotics? Learn more at First LEGO League
http://www.usfirst.org/jrobtcs/flego.htm

Activity

Valuable objects are often hidden underwater beyond our normal reach. Whether it is oil and gas within our continental shelf or treasure that was aboard a sunken ship, we may want to find and retrieve these materials. Engineers are scientists who are trained to use their understanding of science to solve problems. Engineers design and build devices to solve the problems encountered in their work. In this activity you will have an opportunity to act as an engineer as you brainstorm in a group and come up with a design to solve a problem.

The Problem:

A coin is contained in a wooden chest that has dropped off the side of a wharf in 10 metres of water. The box is cubic and measures 30 centimetres along one side. The box sits flat on the sea floor. It has a small square door centered on one side measuring 10 cm wide. The door swings up.

Your challenge is to design a vehicle to retrieve this coin without moving the box. Your design must include the following features:

- It must be remotely operated.
- It must be tethered.

Procedure:

Your design must include a detailed sketch of the vehicle including dimensions so that if the materials were available the device could be constructed. You must write a short operations manual giving a list of instructions to operate your device.

Evaluation:

Points will be awarded according to the following rubric:

Detailed materials list	-	10%
Propulsion system design	-	20%
Navigation system design	-	20%
Coin retrieval system design	-	20%
Operations Manual	-	20%
Accuracy of design	-	10%