Ocean Observing Systems: Launching a New Era of Ocean Science & Discovery

This document has information about the **SCOUT** class missions, design and building specifications, competition rules, and engineering and communication requirements. Please see the **GENERAL INFORMATION** document for SCOUT class eligibility and other important competition information. (**Note:** There is no fee for participating in the SCOUT class.)

COMPETITION SCORING OVERVIEW

The SCOUT class competition consists of underwater missions, engineering presentations, and poster displays with the following scoring breakdown:

- Mission – 120 points (max)
  - Task #1 – 60 points (max), plus a time bonus
  - Task #2 – 60 points (max), plus a time bonus
- Engineering & Communication – 120 points (max)
  - Project reports – 40 points (max)
  - Engineering presentations – 50 points (max)
  - Poster displays – 30 points (max)
- Safety Check – 10 points (max)

IMPORTANT NOTE: Most regional events don't require you to prepare all three of the engineering and communication components. For example, the Monterey regional only requires the engineering presentation and poster display. Be sure to check with your regional coordinator about the components your company is required to do.

THINK OF YOURSELVES AS ENTREPRENEURS

As you prepare for the competition, the MATE Center is asking you to think of yourself as an entrepreneur. So, what is an entrepreneur and what skills does he or she possess? An entrepreneur organizes and manages a project or company – especially one that is challenging, involves some risk, and requires energy and creativity. The skills that are needed for such an undertaking include an understanding of business operations (from leadership to finances and research and development to marketing), the ability to work as an essential part of a team, and the ability to apply technical skills in new and creative ways. Entrepreneurs are innovative thinkers (and tinkerers!) who can use their resourcefulness to quickly adapt to changing technologies and changing work environments.

As entrepreneurs participating in the MATE competition, your first task is to create a company or organization that specializes in solutions to real-world marine technology problems. Here are some questions to help guide you.

- What is your company name?
- Who are its leaders – the CEO (chief executive officer – the "president") and CFO (chief financial officer who oversees the budget and spending)?
- Who is responsible for research and development (R&D)?
- Who is responsible for testing? Operations? Public relations and media outreach?
- What other positions might you need? (Depending on your personnel resources, more than one person may fill more than one role.)
- What is the name of your product(s) and what types of service(s) do you provide?
- Who are your potential clients?

In this case, the MATE Center and scientists, engineers, and technicians from the University of Washington are your "clients" and have defined the rules as well as the products and services you need to provide to solve the "problem" – or in this case, accomplish the mission.

Imagine that the MATE Center and the professionals from the University of Washington recently released a "request for proposals." A request for proposals (RFP) is a document that an organization sends out to ask for bids from companies for a product or service they need. The specifics of the RFP, including your product design, the rules of operation, and the tasks that you must accomplish, are described below.

MISSION OVERVIEW

Your mission is made up of the following tasks:
Task #1: Complete a primary node (60 points)
Task #2: Replace four scientific instruments (60 points)

Your company may get up to **TWO** attempts to complete each of these tasks (contact your regional coordinator to confirm the number of attempts that you will receive). The higher of the two scores will be added to your engineering and communication score (see the **Engineering & Communication** section below) to determine the total, overall score for the competition.

TIME

The time that your company will have to complete the mission tasks will depend on your regional. Contact your regional coordinator to determine how your missions will be set up and how long you will have for the mission tasks.

TIME BONUS

Your company will receive a time bonus if you:
1) successfully complete the mission tasks;
2) return your ROV to the surface under its own power so that it touches the side of the pool; and
3) physically touch your vehicle before the mission time ends.

How the time bonus is calculated will also depend on your regional. Your regional coordinator will tell you this when he/she explains how your missions will be set up and how much time you'll have to complete them.

GOOD LUCK!

The MATE Center would like to thank the John Delaney, Deborah Kelley, and Chuck McGuire of the University of Washington for their technical expertise and assistance with this year's mission scenario and tasks. We also thank the Center for Ocean Sciences Education Excellence Networked Ocean World (COSEE NOW) and Rutgers University for their contributions. We appreciate their vision and support in bringing "interactive oceans" to the 2013 competition teams and the entire ocean community!

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OCEAN OBSERVING SYSTEMS: TAKING THE PULSE OF THE OCEAN

The ocean is the planet's largest ecosystem. It significantly influences the earth's climate and impacts human society – from the food we eat to the energy we use.

Human society also impacts the ocean. There are currently 7 billion people on planet Earth; more than half the population lives or works near the ocean. Many countries depend on the income from goods and services associated with ocean activities, such as oil and gas, food, transportation, and recreation.

The pressure that we place on the ocean continues to increase – water pollution, overfishing, and ocean acidification are just a few examples. How the ocean responds to this pressure will impact all of us, either directly or indirectly. For example, patterns of ocean circulation and changing sea-surface temperatures link directly to patterns of drought and flooding on the continents, which in turn link directly to patterns of plentiful food and famine. It is important to better understand the ocean so that we can better manage it. Our future and the ocean's future depend upon it.

Meteorologists have used sensors to monitor and predict weather for the past two decades. Monitoring the ocean and predicting its "weather" has been much more difficult. Oceanographers who go to sea in ships are only able to study small areas of the ocean and for limited periods of time. Satellites help us to study a bigger area and for longer periods of time, but only at the ocean's surface. Scientists still need a better way to collect data and to do it continually throughout the ocean. The next step is to develop the technology that will allow scientists to keep sensors "permanently" in place on the surface of the ocean, in the water column, and on the ocean bottom.

Ocean observing systems are collections of instruments and sensors above and below the water that provide around-the-clock information about what is happening in the ocean (changing temperatures, currents, and salinity, for example.) Sensors on satellites miles above the Earth look at both large and small areas of the ocean surface, providing data about the temperature, color, and height of the water.

Radar towers on land collect information about the movement of the water at the surface, including the speed and direction of surface ocean currents. Sensors and instruments attached to stationary buoys collect information at the same location over long periods of time. Autonomous underwater vehicles or AUVs traveling below the surface collect information about water conditions. Instruments connected to networks of underwater hubs called "**nodes**" collect data continuously and send it back to land through fiber optic cables. These same cables also provide electrical power to the nodes and other equipment.

Now scientists can use the data collected by ocean observatories to forecast ocean conditions, much like meteorologists do for the weather. Better data and better forecasts can lead to better decisions that affect both the ocean and us.

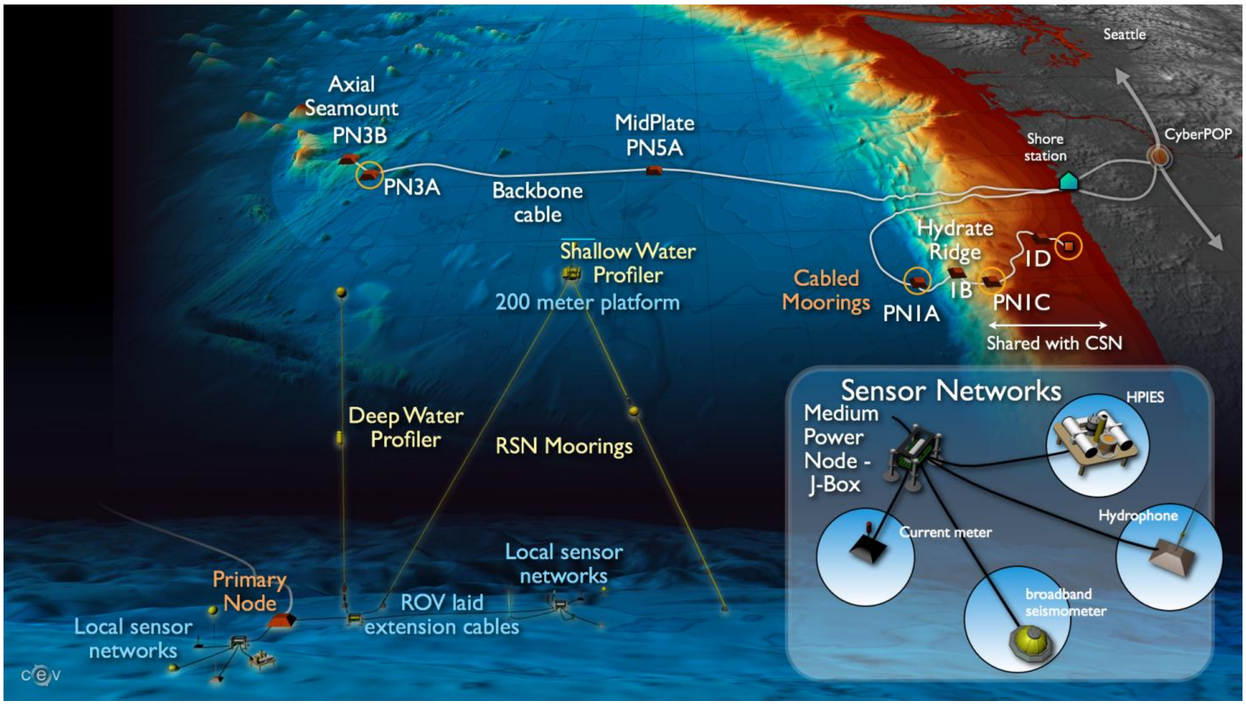
The global system of ocean observatories

The Ocean Observatories Initiative (OOI) is a project funded by the U.S. National Science Foundation (NSF). The goal of OOI is to build networks of sensors (aka ocean observing systems) to measure physical, chemical, geological, and biological properties on the ocean's surface, in the water column, and on the seafloor. The networks will include moorings, AUVs, and cabled seafloor systems that send data back to shore.

Scientists, engineers, and technicians at the University of Washington led the design and are now building a cabled sensor system called the Regional Scale Nodes (RSN), which will become OOI's first cabled ocean observatory, and the largest in the U.S.

When complete, the RSN will consist of nearly 1,000 kilometers of cable capable of providing electrical power and communications. To date, a ship has laid 900 kilometers of cable from a shore station in Pacific City, Oregon west across the Juan de Fuca tectonic plate to the Axial Seamount, then south along the Cascadia subduction zone to Hydrate Ridge. Seven primary underwater hubs or nodes have been installed. These nodes will serve as connection points for moorings and other instrumentation at Hydrate Ridge, Axial Volcano, and along shallow coastal sites west of Newport, Oregon.

The observatory is scheduled to start working in 2014 and operate for 25 years. Its data and video will be sent in real-time and will be available to users around the world, including scientists, educators, students, and decision-makers.



Regional Scale Nodes, OOI's first U.S. cabled observatory

The network is designed to be expandable. And, in our scenario, expansion is already starting to take place. Scientists, engineers, and technicians at the University of Washington recently released a request for proposals (RFP) for an ROV to extend the network of cables, nodes, and instruments at the Axial Seamount. They want to better understand the geology of a hydrothermal vent field located just north of the seamount. In addition to installing nodes, the RFP includes routine maintenance work on instruments located near the seamount.

This is where your mission begins.

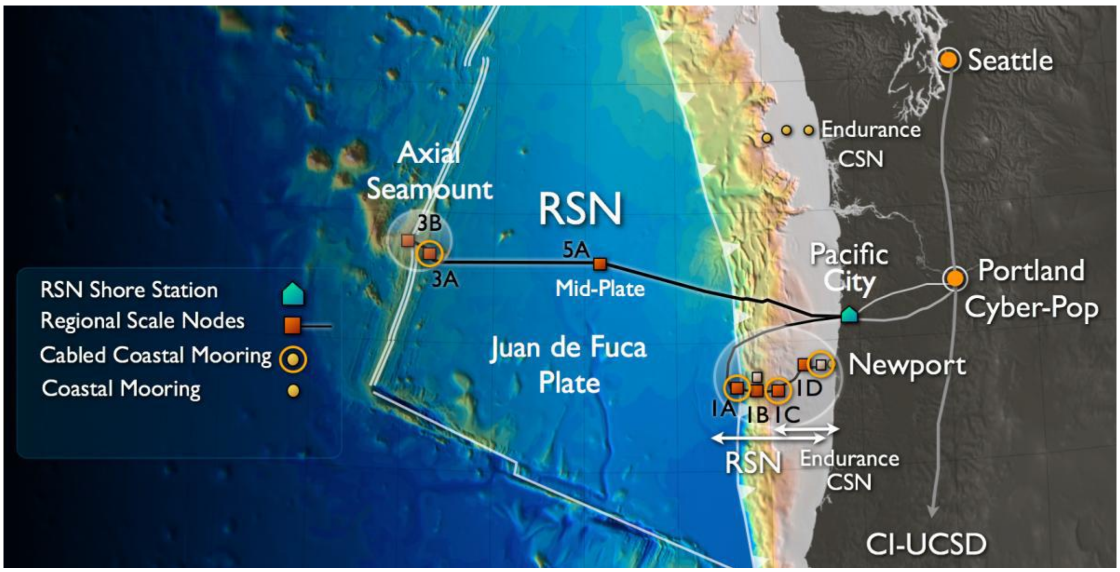
REQUEST FOR PROPOSALS (RFP)

1. General

a. RSN and Study Site Overview

The Regional Scale Nodes (RSN) cabled observatory off the coast of Washington and Oregon is part of the NSF-funded Ocean Observatories Initiative (OOI). The observatory currently consists of seven underwater "hubs" called primary nodes that are located on the Juan de Fuca tectonic plate. These nodes are connected by 900 kilometers of fiber optic cable that ends at a shore station in Pacific City, Oregon. The shore station provides power and allows for two-way communication to/from the nodes. The nodes and cable are the primary infrastructure, or the "backbone," of the RSN.

Each node consists of two components: the Backbone Interface Assembly (BIA) and the Science Interface Assembly (SIA). The BIA is connected to the backbone cable and is the "frame" of each primary node. The SIA fits down into and is connected to the BIA. The SIA includes ports that scientific instruments are plugged into to receive power and communications.



The RSN primary infrastructure, showing the location of the primary nodes

b. Purpose of this Document

This document contains the technical specifications and requirements for an ROV that is needed to:

- Install the SIA into the BIA of a primary node at the Axial Seamount then connect the BIA to the "backbone" fiber optic cable using the Cable Termination Assembly (CTA).
- Recover and replace scientific instruments (including an ocean bottom seismometer, an acoustic Doppler current profiler, a hydrophone, and a video camera) in designated locations on the seafloor.

2. Acronyms and Definitions

Ocean observatory work uses a number of acronyms, as do most professions. The following is a list of acronyms used within this document.

RSN: Regional Scale Node. The RSN is the cabled observatory.
BIA: Backbone Interface Assembly
SIA: Scientific Interface Assembly
CTA: Cable Termination Assembly

The **primary infrastructure** is the underwater component of the RSN that serves as the backbone of the observatory. It provides electrical power and two-way communication links from shore to the sensor network. It consists of cable and primary nodes**.**

3. Specifications

See the specific tasks as well as the **Design & Building Specifications and Safety Considerations** and the **Competition Rules and Information** described below.

4. Maintenance and Technical Support

The company will guarantee the ROV for the duration of the competition event. Repair or replacement will be at the company's expense. The company will provide at least one day of technical support to deal with any issues.

5. Shipping

Delivery of the ROV will be no later than the date of the nearest regional contest.

6. Evaluation Criteria

- Vehicle Performance
- Engineering & Communication:
    - Technical report and/or
    - Engineering presentation and/or
    - Poster display

References (for the scenario and the mission tasks):

John R. Delaney and Deborah S. Kelley, University of Washington School of Oceanography. *Next-Generation Science in the Ocean Basins: Expanding the Oceanographer's Tool-Box Utilizing Submarine Electro-Optical Sensor Networks.*

An Introduction to the Integrated Ocean Observing System (IOOS), www.cencoos.org/visual_media/classroom/IOOSintro/IOOSintro.htm

ASHES Virtual Site, http://www.pmel.noaa.gov/vents/nemo/explorer/ashes.html

Biofouling Protection for Marine Instruments, www.severnmarinetech.com

Biofouling, www.stccmop.org/blog/schillij/biofouling

COSEE NOW, http://coseenow.net/

Favali, P., De Santis, A., & Beranzoli, L. (2012). *Seafloor Observatories: A New Vision of the Earth from the Abyss.* Springer. ISBN: 3642113737, 9783642113734.

Hotaling, L., Sullivan, D., & Zande, J. (2007). The Sensor Revolution: Benefits and Challenges for the Marine Technical Workforce. *Marine Technology Society Journal, 41(3)*

Interactive Oceans, www.interactiveoceans.washington.edu

Ocean Observatories Initiative: Transforming Our Understanding of How the Ocean Works, www.oceanobservatories.org

Ocean Observing Systems, http://coseenow.net/about/ocean-observing-systems/

Physical Oceanography, Hydrology, Water Quality, and Modeling, http://kinneticlabs.com/pages/oceanographic.html

United Nations Department of Economic and Social Affairs. (2004). World Population in 2300, New York, 1-254.

Using Ocean Observing Systems in K-12 Education, http://marine.rutgers.edu/outreach/rtd/oos.htm

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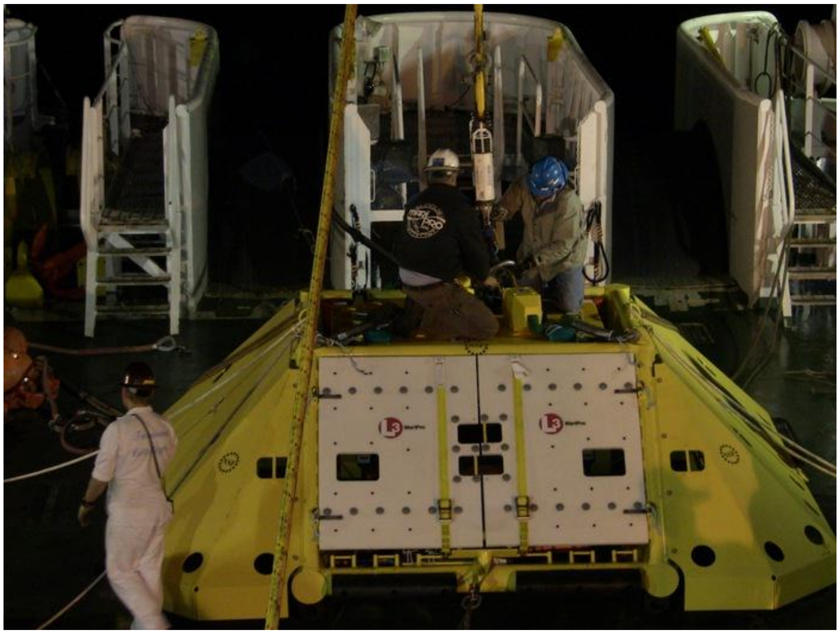
COMPETITION MISSIONS

Task #1: Complete a primary node.

Your company is required to complete the primary node by installing the Science Interface Assembly (SIA) into the Backbone Interface Assembly (BIA) and inserting the Cable Termination Assembly (CTA) into the BIA.



The backbone interface assembly of an RSN

This task involves the following steps:

- **Transferring the SIA to the seafloor – 5 points**
- **Installing the SIA so that it rests completely within the BIA – 25 points**
- **Removing the CTA from the seafloor – 5 points**
- **Inserting the CTA into the bulkhead connector on the BIA – 25 points**

Total points = 60

Mission notes:

Companies will install the SIA into the opening on top of the BIA. The BIA is constructed of a weighted milk crate. The SIA is constructed of ½-inch PVC framework. A PVC tee will act as a carrying point at the top of the SIA, but companies may carry the SIA in any manner they wish. Companies will receive one SIA at the mission station. The SIA will be on the pool deck and companies may attach it to their ROV as they set up at the mission station. Companies will receive 5 points when any part of the SIA PVC framework touches any part of the BIA milk crate. Companies will receive 25 points when the SIA is dropped inside the BIA and is no longer in contact with the ROV. If the SIA is dropped en route to the BIA, teams must retrieve it from the seafloor.

The SIA will weigh less than 2 Newton in water.

Once the SIA is installed into the BIA, companies must connect the main power cable (or CTA) to the node. The CTA is constructed from ½-inch PVC. A screw hook will act as the lift point for the CTA. The CTA will be sitting upright on the pool bottom within 2 meters of the BIA. Companies will receive 5 points when the ROV is in possession of the CTA, and the CTA is no longer in contact with the seafloor. Once removed from the seafloor, the CTA must be installed into the bulkhead connector on the BIA. The bulkhead connector is constructed from a 3-inch PVC pipe and a 3-inch knock out cap and will be located on the bottom edge of the side wall of the BIA milk crate that is facing the mission station. The bulkhead connector will be painted bright yellow so that it is easily visible. Velcro will attach the CTA to the bulkhead connector. Companies will receive 25 points when the CTA is installed into the bulkhead connector. If the CTA is knocked over during retrieval, or dropped during transport, your company must retrieve it to complete the mission.

The CTA will weigh less than 1 Newton in water.

Mission Prop Specifications:

See the SCOUT Class **Mission Prop Photos** documents for visuals.

Backbone Interface Assembly (BIA):

The backbone interface assembly is constructed from a milk crate. The milk crate will sit on the bottom of the pool with the open side facing up. Weight will be added to the milk crate to secure it to the bottom.

The bulkhead connector will be attached to the bottom edge of a side wall of the BIA milk crate. The bulkhead connector is constructed from 3-inch pipe and a 3-inch knockout cap (Home Depot part# **39102**).

To construct the bulkhead connector:

1. Cut a 7.5 cm length of 3-inch ABS or PVC pipe. Paint the pipe bright yellow.
2. Cut a 7 cm x 5 cm square of Velcro hooks. Attach the square of Velcro hooks to the inside surface of a 3-inch knock out cap. Insert the 3-inch knockout cap into one end of the 7.5 cm length of pipe.
3. Set a milk crate on the ground with the open side facing up. Use cable/zip ties to attach a 3-inch pipe with knockout cap to the bottom of one side wall of the milk crate.

Use a 30 cm x 30 cm paving brick (or other flat heavy object) to weight the milk crate to the bottom.

See SCOUT mission prop photo #1 and #2.

Science Interface Assembly (SIA):

The science interface assembly (SIA) fits into the top opening of the BIA. The SIA is constructed from ½-inch PVC pipe and is 19 cm long, 19 cm wide and 31 cm tall.

To construct the SIA:

1. Cut a 13 cm and four 5 cm lengths of ½-inch PVC pipe. Attack the middle opening of a ½-inch PVC tee to each end of the 13 cm length of pipe. Insert the 5 cm lengths of pipe into the side openings of both PVC tees.
2. Attach a ½-inch 90^{o} PVC elbow to the other end of each 5 cm length of pipe, 4 elbows total. Place the PVC assembly flat on the workspace and twist each 90^{o} elbow so the open side is facing upwards.
3. Cut four 15 cm lengths of PVC pipe. Insert these 15 cm lengths of pipe into the 90^{o} elbows that are facing upwards.
4. Cut two 4 cm lengths of ½-inch PVC pipe and four 5 cm lengths of PVC pipe. Insert both 4 cm lengths of PVC pipe into the side openings of a single PVC tee. Attach the middle opening of a PVC tee to the other end of the two 4 cm lengths of PVC pipe.
5. Insert the four 5 cm lengths of pipe into the side openings of both PVC tees. Attach a ½-inch 90^{o} PVC elbow to the other end of each 5 cm length of PVC pipe. Attach the 90^{o} elbows to the end of each 15 cm length of ½-inch PVC pipe.
6. Twist the PVC tee in the top middle of the assembly so the middle opening is facing upwards. Cut a 5 cm length of ½-inch PVC pipe. Insert this length of pipe into the middle opening of the PVC tee. Attach the middle opening of another PVC tee to the other end of the 5 cm length of PVC pipe.
7. Cut two 3 cm lengths of ½-inch PVC pipe. Insert these 3 cm lengths of pipe into the side opening of the PVC tee. Attach a ½-inch PVC coupling to the end of each 3 cm length of pipe. This is the top of the SIA. Twist the topmost PVC tee so it is parallel with the tee below it.

Add flotation inside the ½-inch PVC pipe so the SIA weighs less than 2 Newtons in water.

See SCOUT mission prop photo #3 and #4.

Cable Termination Assembly:
The cable termination assembly (CTA) is constructed from ½-inch PVC. 5 meters of 1/8-inch braided nylon and polypropylene rope (Home Depot part #**14068**, Home Depot SKU #**140287**, ACE Hardware part #**75851**) connect it to the BIA. A #6 screw hook (Home Depot part #**14671**) will act as the lift point for the CTA. The front of the CTA will be covered with Velcro loops.

To construct the CTA:

1. Drill a 3/16-inch hole into the center of a ½-inch PVC end cap. Insert the end of the 5 meter rope through the hole and tie an overhand knot in the rope to secure it inside the end cap.
2. Cut four 3 cm lengths of ½-inch PVC pipe. Insert two 3 cm lengths of pipe into opposite openings on a ½-inch PVC cross. Attach the end cap with the rope to one 3 cm length of pipe. Attach a ½-inch PVC coupling to the other 3 cm length of pipe.

3. Insert another 3 cm length of pipe into the other end of the ½-inch coupling. Attach a second ½-inch coupling to the 3 cm length of pipe.
4. Insert the fourth 3 cm length of pipe into the other end of the ½-inch coupling. Attach a ½-inch end cap to the 3 cm length of pipe.
5. Cut a 5 cm x 5 cm square of industrial strength Velcro loops (Home Depot Part #**90593**). Cover the front of the ½-inch end cap with the Velcro.
6. Drill a 1/8-inch hole in the coupling nearest the ½-inch cross. The hole should be 0.5 cm from the border of the coupling and the cross.
7. Insert a #6 screw hook into this hole. Continue to twist the hook into the hole until it screws into the other wall of the PVC coupling. Orient the end of the screw hook so it faces the PVC cross.

Add flotation/ballast as necessary to the CTA to achieve the desired weight in water.

See SCOUT construction photo #5 and #6.

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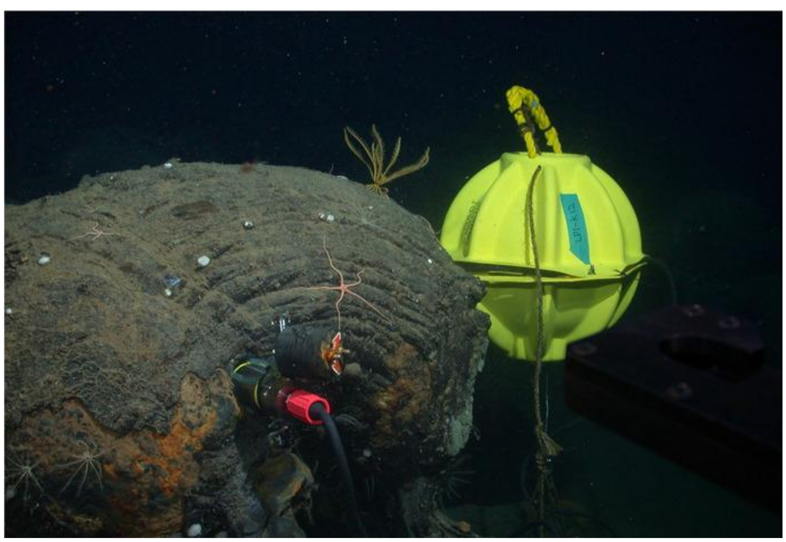
Task #2: Replace scientific instruments (60 points)

Your company is required to recover four scientific instruments, including an ocean bottom seismometer, from the seafloor and replace them with new ones. The old instruments must be returned to the surface.



An ocean bottom seismometer installed on the seafloor

This mission task involves the following steps:

- **Recovering four scientific instruments deployed in designated locations on the seafloor and returning them to the surface – 5 points each (20 points total)**
- **Deploying new scientific instruments into the designated locations on the seafloor – 10 points each (40 points total)**

Mission notes:

Eight scientific instruments are involved in this mission. Four "old" instruments (including an ocean bottom seismometer, an acoustic Doppler current profiler, a hydrophone, and a video camera) will be previously deployed in designated locations on the pool bottom while four "new" instruments will be on the surface in the mission control area. All of the instruments will be constructed out of ½-inch PVC pipe and will be identical in size and weight, but will be painted different colors. One set of instruments will be painted red; the other set will be painted yellow. Companies may attach one or more instruments to their ROV as they set up at the mission station.

The four designated locations on the pool bottom will be simulated by PVC squares. There will be one instrument in each location.

Companies may complete this task in any order they wish. For example, companies could deploy all four new instruments before recovering and returning the four old instruments to the surface. Or companies could deploy one new instrument and recover and return one old instrument at a time. Or companies could recover and return an old instrument from a designated location, return it to the surface, then deploy a new instrument in its place. It is up to each company to decide the order in which they complete this task.

Companies will receive 10 points for each new instrument deployed into a designated location. A successfully installed instrument must be standing upright and have both "legs" completely within the designated location. "Legs" may be touching the PVC of the designated location, but must be completely within the location. (See below for a description of the instruments, including its "legs.")

Companies will receive 5 points for each old instrument recovered and returned to the surface. Successfully recovering and returning a scientific instrument to the surface means that the instrument is secure on the pool deck. If an instrument previously returned to the surface is accidentally dropped into the pool, companies must retrieve it again to get full points and be eligible for time bonus.

Mission Prop Specifications:

See the SCOUT Class **Mission Prop Photos** documents for visuals.

Scientific instruments:
Each scientific instrument is constructed from ½-inch PVC pipe. Each mission station will have eight instruments.

To construct a scientific instrument:

1. Cut two 12 cm, two 8 cm, two 3 cm and four 5 cm lengths of PVC pipe.
2. Attach a ½-inch 90° elbow to each end of 12 cm length of PVC pipe. Insert an 8 cm length of pipe into the other opening of each 90° elbow.
3. Attach the side opening of a ½-inch PVC tee to the other end of each 8 cm length of pipe. Turn the two middle openings of the tees so that they face each other. Insert the other 12 cm length of pipe into the middle openings of both tees.
4. Insert the 3 cm lengths of PVC pipe into the other side openings of the PVC tees. Attach the middle opening of a PVC tee to the other end of each 3 cm length of PVC pipe. Twist the PVC tees so they are parallel to each other and perpendicular to the rest of the OBS.
5. Insert a 5 cm length of PVC pipe into each side opening of the PVC tees.

Add flotation into the top of each instrument to achieve the desired buoyancy.

Each instrument will weigh less than 1 Newton in water.

Paint four instruments yellow and four instruments red.

See SCOUT mission prop photo #7.

Designated location:
The designated location is a PVC square that is 50 cm x 50 cm (inside length).

To construct the designated area:

1. Cut four 46 cm lengths of ½-inch PVC.
2. Use four ½-inch 90° elbows to form the PVC into a square.
3. Use steel rebar, cement, or other weights to hold this square securely on the bottom of the pool.

Paint the designated location a color that is easily visible on the pool bottom.

See SCOUT mission prop photo #8.

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DESIGN AND BUILDING SPECIFICATIONS AND SAFETY CONSIDERATIONS

- Your company's ROV and control box must be built by the student members with only advice and guidance from teachers, mentors, and parents.

- Your ROV may be built out of the materials of your choice. However, no parts may damage or leave a residue in the pool. Warning labels should be posted on potentially hazardous components of your ROV system.

- **When you arrive at the competition, your ROV will go through a safety inspection.** If the safety inspectors find a potential concern, you will have until the time of your mission run to correct it. However, you must correct it before your ROV is allowed to enter the water. **The safety inspection is worth a total of 10 points!** See the SCOUT class safety inspection sheet posted at www.marinetech.org/missions-specs--scoring for details.

- Safety must be a priority when designing and building your ROV. For example, no fish hooks or other sharp payload tools as they could injure divers in the water.

- Safety must also be a priority when operating your ROV poolside. Keep an eye out for tripping hazards. Make sure that your connections to the battery or power supply are not lying in pools of water on the deck. Be sure to secure any equipment so that it does not fall off the mission station table, damage the deck, or cause injury.

- Loose fitting clothing, jewelry, and long hair could all become safety issues. Consider securing long shirts or baggy pants, removing jewelry, and tying back long hair when working on or operating your ROV.

- **ROV MOTORS MUST BE WATERPROOFED!** No exceptions. You may use already waterproofed motors (bilge pump motors, etc.) or you may choose to waterproof small electrical motors. Methods for waterproofing electric motors can be found on the competition web site www.marinetech.org as well as in the little yellow book "Build Your Own Underwater Robot and Other Wet Projects."

- **NEW for 2013!!! – PROPELLER PROTECTION**
  Propellers must be enclosed inside the frame of the ROV or shrouded. **Teams that have propellers protruding outside of their frame will not pass the safety inspection and will not be allowed to compete.**

- A 12-volt "car" battery or comparable power source with a 15-amp fuse will be provided. You will connect to this power source via banana jacks (female ends will be provided; you must provide the male ends). **Your ROV must operate at or below 15 amps when underwater.**

- **NEW FOR 2013!!! – CIRCUIT PROTECTION**
  All teams must have a 15-amp (or less) fuse on the positive side of their vehicle's electrical circuitry in order to pass the safety inspection. The fuse should be located within 30 cm of the connection to the MATE power supply. The MATE power supply provided at each pool station includes an in-line 15-amp fuse, but each team needs to protect their system with an additional fuse. **If your vehicle is not protected with a fuse in addition to the fuse provided on the MATE power supply, YOUR VEHICLE WILL NOT PASS THE SAFETY INSPECTION and will not be allowed to compete.**

- Lasers are prohibited and cannot be used in any way on the vehicle or on the surface.

- **NEW for 2013!!! – FLUID POWER**
  Teams are allowed to use pneumatics (air power) or hydraulics (water power) on their vehicles provided that
  - Only hand/foot powered pneumatic and hydraulic pumps are allowed. **NO ELECTRICAL PUMPS** of any type will be allowed. **NO PRESSURIZED GAS CYLINDERS** of any type will be allowed.
  - Teams may only use water as their hydraulic fluid. No other materials may be used.
- Teams may not have closed pressure accumulators on their vehicle. Any container that teams pump air into MUST be open to the pool environment. For example, variable buoyancy containers must have an open bottom or a hole drilled into them so that excess air pumped in will bleed out into the environment. At no time should the pressure inside a container build above the ambient pool pressure. Pneumatic actuators are permitted as long as they are operated by a hand or foot pump.

  Note: Any holes drilled in the container should be at least ¼-inch.

- Cameras and monitors are permitted, but aren't needed as you are allowed to look into the pool to drive your ROV. If you do choose to use a camera(s), the cameras(s) and monitor(s) must operate off of a separate DC battery (12-volt maximum) that you provide. This battery must be fused at 3 amps maximum. MATE will not provide you with these devices. Only the camera(s) and monitor(s) are permitted to operate off of this battery; your vehicle's motors and all other associated equipment (manipulators, etc.) must be powered off of the 12-volt battery provided by the contest organizers. **NO AC POWER IS PERMITTED WHATSOEVER**. In other words, you can't plug your ROV into a wall socket!

- Radio transmitters that operate on a separate battery are permitted.

- Closed-toed shoes are required on the pool deck and anytime you are working on your ROV. Safety glasses or goggles should be worn when working on your ROV.

- You must be able to carry, launch, and deploy your ROV and any associated equipment by hand. All propellers must operate under the water line.

- Your ROV must be able to maneuver in 3 dimensions and in a pool up to 12 feet deep. Seven-meter tethers are recommended. Check with your regional competition coordinator about the pool depth at your event.

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COMPETITION RULES AND INFORMATION

- **NEW for 2013!!!** During the contest, you may have up to **4 student members** of your company at the mission station operating your ROV. However, there is no limit to the number of students who can be involved in the design and construction of your vehicle. There is also no limit on the number of students who can help to create the poster or participate in the engineering presentation.

- Only student members of your company and contest officials are allowed poolside. Teachers, mentors, and parents must remain in the bleachers or other area designated for spectators.

- Penalty points:
  - Diver assistance – minus 5 points each time assistance is given
  - Pulling on the tether – after an initial warning, minus 5 points
  - Blowing one fuse – no penalty points but the clock does not stop
  - Blowing 2 fuses – no penalty points but the clock does not stop
  - Blowing 3 fuses – this is the end of your mission run and your ROV must exit the water. Your company can keep any points that you've received prior to blowing the fuse, but will receive a 5 point penalty for pulling on the tether to remove your ROV.

- A repair table with electricity for soldering irons and other power tools will be available.

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ENGINEERING & COMMUNICATION

The ability to effectively communicate information about your vehicle and the design and building process is equally as important as how well your vehicle performs. Strong communication skills are also an essential part of good business practices. To emphasize this point, the competition includes project reports, engineering presentations, and poster displays.

IMPORTANT NOTE: Most regional events don't require you to prepare all three of these engineering and communication components. Be sure to check with your regional coordinator about the components that your company is required to do.

PROJECT REPORT

Prior to the competition, your company will submit a project report that will be reviewed and evaluated by a group of judges who represent science, exploration, government, and industry. Keeping a project notebook is a good business practice that will help your company with this report. Documenting your company's progress, including your research, designs (regardless of whether or not they work), experiments, vehicle specifications, testing, expenditures, and donations, will provide you with both content and reference information to help you organize your report.

The deadline for submitting this report will vary amongst regionals. Contact your regional coordinator to find out yours.

The judges will evaluate and award a score (40 points max). Judges' scores and comments will be returned to you shortly after the event.

The guidelines and required components for the project report are:
Note: Make sure to label any and all figures, graphs, diagrams, and photographs.

- **Length is less than 10 pages**
- **Font size of at least 12 points (font type can vary)**
- **All measurements are in metric units**
- **Title page** that includes:
  - Your company's name
  - School, club, or community organization's name, city, and state. If you are an international company, include the city and country.
  - **COMPLETE** list of the members of your company and their role (CEO, CFO, pilot, etc.). You can also include grade level/career goals and expected graduation date.
  - **Names of** your instructor(s) and/or mentor(s)
- **Abstract (150 words or less)** that is concise and clearly summarizes the project.
- **Photograph(s) of your completed ROV**
  You are permitted to make changes to your vehicle between the time you submit your report and the competition; however this must be a photo(s) of your completed, intact vehicle, not photos of individual part or tools.
- **Budget/expense sheet**
  Keep an accounting of how much money you raised and/or spent. In addition to funds, list any items (building materials, equipment, travel stipends, etc.) that were donated, the organization or individual who made the donation, and an estimate of the item's value. See the examples of technical reports from previous competitions (www.marinetech.org/tech-reports) for examples of how to create a budget sheet.

- **Electrical schematic**
  Make sure to highlight safety features such as circuit breakers and fuses. This schematic may be NEATLY drawn by hand or created using a CAD software program.
- **Design rationale** presented in a clear and logical manner. This section should comprise the bulk of your report. It should focus on the technical side of your vehicle and include a discussion of how your ROV was built or adapted to perform to the mission tasks.
- *New in 2013!* To emphasize the importance of safety when working with underwater technology, we are now requiring a section on **SAFETY**. This section should describe the steps that your company has taken to identify and fix any safety concerns in order to make sure that your vehicle and its operation are **SAFE**.
- **Description of at least one challenge** that your company faced and how you overcame it. This can include both a technical challenge and a challenge related to working as a team.
- **Description of at least one lesson learned or skill gained** during the design and building process.
- **Discussion of future improvements**
  How would you improve your ROV for "next year?"
- **Reflections on the experience**
  This can be written from the point of view of your company as a whole or individual members of your company can contribute a reflection. It can include personal or professional accomplishments that you achieved as a result of participating in the competition.
- **References**
  List any books, journal articles, magazines, trade publications, web sites, and professional advice that you used as sources of information.
- **Acknowledgements**
  Please recognize the companies, organizations (including the MATE Center), professionals from industry, and/or mentors who helped to support your company by donating funds, building supplies, equipment, site visits to facilities, time, and/or technical expertise. You can include organizations and/or individuals that provided logistical and/or moral support (e.g. your parents, siblings, or pets). Companies competing in regional events should also acknowledge regional contest supporters.

ENGINEERING PRESENTATION

During the competition, your company will present to a group of judges who represent science, exploration, government, and industry. Your presentation should describe 1) the engineering behind your vehicle's design, 2) how it operates, and 3) any possible safety issues. It should also highlight any innovations or creative solutions to solving the mission tasks. After the presentation, the judges will ask the members of your company questions about your ROV.

The judges will evaluate both your presentation and responses to their questions and award a score (50 points max) based on your presentation and how you answer their questions. Judges' scores and comments will be returned to you shortly after the event.

All of the members of your company should participate in the engineering presentation and you should have your ROV with you. Be sure to organize your information and practice your presentation in advance. Ask your instructors, mentors, and parents for feedback. Practicing will help you to work out any “kinks” and be more comfortable talking in front of the judges.

Depending on your regional, this may be a presentation and a question and answer period OR a question and answer period ONLY. Either way, you should be prepared to talk about your vehicle and answer questions about it and your team.

Here are some examples of the questions that the judges might ask:

- How did you decide on the shape of the vehicle and the materials used to build it?
- How much did it cost to build your vehicle?
- What type of tool(s) did you design to accomplish the mission tasks and why? How does the tool(s) work?
- How many thrusters (motors) does your vehicle have? Why?
- How did you determine how much flotation to add to your vehicle?
- What is stability? Why is it important to think about stability when designing your ROV?
- If you are using the same vehicle as last year, why? What are the advantages? What, if any, modifications or additions did you make?
- Did you develop a safety checklist? What other safety precautions have you taken?

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POSTER DISPLAY

Your company is required to create a poster that will be on display during the competition event. Your poster display should be a clear and concise presentation about your company and how you designed and built the specialized tools to complete the mission tasks. During the competition, your company’s display will be evaluated and scored by judges who represent science, business, government, industry, and education and outreach.

While some poster judges will have a technical background, others will have a communications, marketing, or public relations backgrounds. In addition, there will be visitors to the competition who may not completely understand what an ROV is or how it is used. You can think of these visitors as potential future clients who may hire you, but have a limited understanding of it (i.e., you need to explain your technology, the tasks, and "sell" them on YOUR products and services.) Design your poster to communicate to these "clients."

Each company will have a space approximately 3-feet x 3-feet for its display. Depending on your regional, tables may or may not be provided. Contact your regional coordinator for more information.

Each judge will award a poster score (30 points max). Judges' scores and comments will be returned to you shortly after the event.

GENERAL GUIDELINES

- **Font size that is clearly legible from a distance of 1.5 meters**
- **Choose a font style and use it throughout**
- **All measurements are in SI units (metric).** Exceptions include ½-inch PVC pipe and other items described or sold in imperial units.
- **Include headers (see REQUIRED COMPONENTS below)**
- **Photos should be clear and high-quality for the print sizes that you choose**
- **EVERY PHOTO MUST HAVE A CAPTION!** No caption = no credit for that photo. Also include photo credits if the photo was not taken by someone in your company.
- **Items that you MAY include in your poster or have on display include:**
    - Posters, papers, dioramas, and/or models.
    - Photo journals
- **Items that you MAY NOT include in your poster:**
    - Flip charts on the poster board
    - Video screens on or in the actual poster board

REQUIRED COMPONENTS

Note: The following are REQUIRED headers. These headers not only assist the judges in evaluating your display, they also make your poster easy to read.

- **Company name and school, club, or community organization name**
  Make sure that your company name is in large, bold font (larger than any other font on your poster). Include your school, club, or community organization name as well as your company name. Include your geographic location (i.e. city and state).

- **Abstract (concise – 150 word limit)**
  Include a written introduction to your company and how your company designed and built a specialized ROV and tools to complete the mission tasks. Make sure to relate the mission to how ROVs are used in the installation and maintenance of ocean observing systems. Don't assume that your audience knows what an ROV is or the details about ocean observing systems.

- **Company staff information**
  Include photo(s) (group or individual) of all of the members of your company. Provide a brief description of each member. This description should include the person's name, role in the company (e.g. CEO, CFO, pilot, marketing and communications specialist, etc.) and their qualifications, such as grade level, career goals, etc.

- **ROV Design**
  Include good photos and descriptions.

  - Include photos of your ROV. Make sure to identify the various parts of your vehicle.
  - Include photos or drawings of any special features or tools on your vehicle and how these features relate to the mission tasks.

- ***New in 2013!* Safety**
  This section should describe how you have made safety your company's top priority when designing, building, and operating your vehicle. Make sure that you keep in mind that you are describing your safety practices to someone who may or may not be familiar with technical terms.

- **Competition Theme**
  More than half of the population of the planet now lives or works near the coast. Many countries rely on the income from goods and services associated with ocean activities.

  The pressure that we place on our ocean continues to increase – water pollution, overfishing, and ocean acidification are a few examples of our impact. How the ocean responds to this pressure will impact all of us. For example, patterns of ocean circulation and changing sea-surface temperatures relate directly to patterns of drought and flooding on the continents, which in turn can be linked directly to patterns of food and famine. It is important to better understand the ocean so that we can better manage it. Our future and the ocean's future depend upon it.

  As our dependence on the ocean continues to grow along with the world population, this "theme" section challenges you to research the future health of the ocean and our society. Rather than copying information that you find on the Internet, take the time to think through the challenges that we face and how ocean observing systems can help to address them. You can choose to focus on a technical, economic, or societal issue. In addition to the Internet, you are encouraged to contact individuals (such as a local scientist or resource manager) who can offer their views.

- **Company evaluation**
  Answer the following questions:

  - What was the most rewarding part of this experience?
  - What has been the greatest lesson learned from this experience?

- If you were to do this again, what would you do differently?

- **Acknowledgements**

  Please recognize any companies, organizations (including the MATE Center), professionals from industry, and/or mentors who helped to support your company by donating funds, building supplies, equipment, site visits to facilities, time, and/or technical expertise. You can include organizations and/or individuals that provided logistical and/or moral support (e.g. your parents, siblings, or pets). Regional competition teams should also acknowledge regional contest supporters.