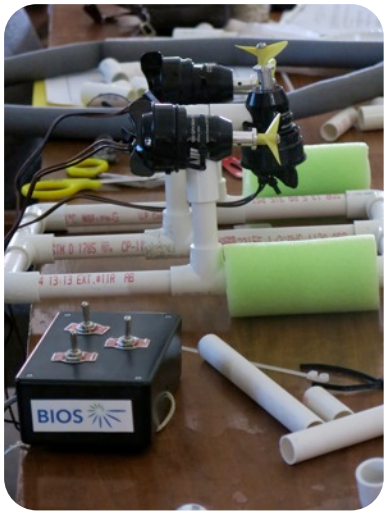
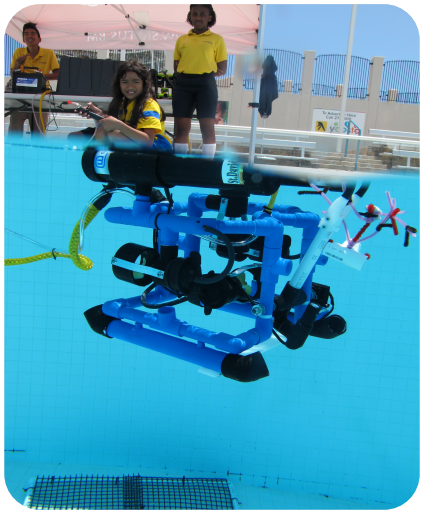
marine
mid atlantic robotics in education





2018 MATE Bermuda Regional Challenge Task Manual
BEGINNER

March 24th 2018

marine
mid atlantic robotics in education

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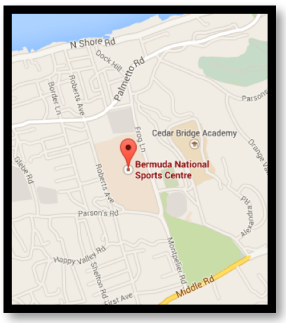
I. MARINE

Researchers at BIOS are expanding their ability to explore the ocean with the recent acquisition of undersea gliders, which are autonomous underwater vehicles (known as AUVs) programmed to travel thousands of miles at a time in pursuit of oceanographic data. To maximize the impact of this cutting-edge technology, BIOS has developed a multi-year underwater design and engineering program called Mid-Atlantic Robotics IN Education (MARINE). This program is designed to engage Bermudian students of all ages.

The program focuses on remotely operated vehicles (known as ROVs), hundreds of which are currently employed underwater around the globe by marine industries, underwater archaeologists, and scientific research programs. As Bermuda's students learn to build and test ROVs in the classroom, the MARINE program supports and enhances science, technology, engineering and mathematics (STEM) education. The experience of building ROVs fosters critical thinking skills, individual and group problem solving skills, and technological fluency.

The MARINE program reflects BIOS's commitment to expand the use of underwater vehicles within ongoing efforts to study and understand the complexity of ocean processes. Complementing this new focus, Ocean Academy leads ROV design challenges throughout BIOS's summer camps, and provides training and ROV kits to middle school classes during the school year. In 2018, Bermuda will host a regional ROV competition under the auspices of the Marine Advanced Technology Education (MATE) Center. The 2018 Challenge will be subject to the rules and regulations as designated by MATE.

II. 2018 ROV Angelfish Challenge



Where:
National Sports Center
#50 Stadium Cottage, Frog Lane
Devonshire DV01
Bermuda
Phone: +1 441-295-8085

When: April 22nd
(Rain Date: April 23rd)
9:00am - 3:00pm

III. Eligibility

Students are eligible to register for two of the Marine Advanced Technology Education (MATE) Center's levels in 2017; Beginner, Scout and Ranger. Beginner level teams will receive an ROV Angelfish kit with a value of $200.

Figure 1: Angelfish ROV kit

IV. Rules and Regulations

Beginner entries will be constructed using the following materials (materials are provided in the Angelfish ROV kit):

Angelfish Kit

- 3,500-gallon-per-hour bilge pump motors
- 30 feet of tether
- Zip ties
- 3 propellers
- 3 propeller shafts with screws
- A control box with three double pull/double throw switches
- PVC pipe
- PVC connectors
- Floatation material
- Banana plugs to plug into a 12v DC power source
- Fuse
- Wire caps

Not included but required for successful assembly of kit

- Pipe cutters
- Soldering iron
- Solder (one coil)
- Screwdriver (flat head and Phillips head)
- Hand drill
- Drill bits for control box
- Additional zip ties may be needed
- 12 volt batteries will be provided at the Challenge

For Beginner level, ROVs must be constructed from ½" PVC pipe ONLY. For SCOUT and Navigator levels, ROV can be built out of any materials. Teams may use larger PVC pipe for ballast.

V. Resources

The Marine Advanced Technology Education (MATE) program has created a list of resources and teaching modules for design instruction and engineering principals of

the Angelfish ROV. MATE has additionally created many videos that illustrate the entire process of assembling the kit, to aid teachers and sponsors in troubleshooting.

Videos can be streamed directly from the MATE website after sign up of initial free membership to MATE: http://www.marinetech.org/angelfish-videos/. Videos cover everything from wiring up your control box to inserting the fuse.

This team manual is an excellent source of information for terminology related to the Angelfish ROV:
http://www.marinetech.org/files/marine/files/Curriculum/Other%20Curriculum%20Resources/MIROV2MANUAL.pdf

VI. Judging

All judges will attend a meeting where they will be briefed on all product demonstrations. For product demonstrations there will be 2 judges at each station. There will be 1 in-water judge and 1 topside judge. Safety and sizing checks will be done prior to beginning the clock at each station.

For product interviews and marketing displays the same 3 judges will see all teams over the course of the Challenge.

VII. Frequently Asked Questions

Is this event open to the public?

Yes, this event will be free and open for the public to attend. Families and friends of competitors can view much of the Challenge from the bleachers, and there will be information available about the other educational opportunities BIOS offers. The concessions stand at the National Sports Center will be open during the Challenge.

Are the Angelfish kits reusable?

Yes, almost everything is made from highly durable parts that can be used over and over again. The motors are waterproof bilge pump motors that should run for ten or

more years; the control boxes are strong and water tight (but don't submerge them). Everything else can be taken apart and reused.

If trialing kits in salt water, be sure to thoroughly rinse them after use with freshwater to prevent rusting and corrosion.

Will teachers be able to keep the kits?

Yes, teachers will be able to keep the kits for subsequent use in their classrooms.

I have never soldered before, what should I do?

If you are unfamiliar with soldering, we suggest watching the video below. One of the problems that can occur with cheap soldering irons is that they may not get hot enough or they may get too hot. Make sure you have a good quality soldering iron and follow the safety advice provided with your soldering iron.

Here is a useful video on soldering components to circuit boards:
https://www.youtube.com/watch?v=Qps9woUGkvI

Notes on solder: Leaded solder is easier to use because of its lower melting point so the soldering iron does not have to be as hot or held to the board as long. Lead-free solder has more flux (acid) in it, which can irritate the eyes if touched by unwashed hands after soldering. W*e recommend 60/40 Rosin Core Solder in .032" (0.08mm) diameter.* This is available at Godet and Young and Gorham's.

Can a fourth motor be added to the Angelfish kit?

While the Angelfish kit has the capacity to run using four motors, competitors will only be able to use three motors during the Challenge at the Beginner level.

Navigators may add as many motors to their ROV as desired, but cannot exceed the 15-amp limit.

Can the tether be lengthened so the ROV can go deeper during the Challenge?

No, all of the skills will be able to be completed with the tether length provided. It is possible following the competition that teachers can increase tether length for future use of the Angelfish ROV.

Can our school practice?

Yes, teams can practice using their ROV in fresh or salt water. Please note the ROV will perform differently in fresh vs. salt water. Teams will have the opportunity to trial the race course on the day of the Challenge in the testing area. Additionally an in-pool test session will be organized ahead of the competition date.

If you run into problems with your kit or have any questions, please contact Kaitlin (Kaitlin.noyes@bios.edu)

VIII. MISSION

The open ocean, and the Sargasso Sea in particular, is home to a diverse collection of organisms. Many are too small to swim against the ocean currents – these are the plankton. The Invertebrate Physiology Lab and Zooplankton Ecology Lab, at the Bermuda Institute of Ocean Sciences, led by Dr. Amy Mass and Dr. Leo Blanco-Bercial, are studying these microscopic critters. Drs. Mass and Blanco-Bercial are interested in not just which types of zooplankton are in the waters around Bermuda, but also their functions in moving nutrients up and down in the oceans' layers.

Microfossils are microscopic and single celled organisms that belong to the Kingdom Protista. Examples include calcareous nanofossils, foraminifera, diatoms, radiolarians and silicoflagellates. When plankton with skeletons die, their skeletons sink to the bottom of the ocean. Microfossils of these organisms can be found in cores taken through the bottom of the ocean. These microfossils can tell us a lot about what our past ocean was like!

Planktivores are aquatic species that feed on planktonic food such as phytoplankton and zooplankton. Many of these creatures have specialized mouths for feeding on these ocean drifting plankton.

Your mission is to build an ROV capable of maneuvering a net to collect plankton in the Sargasso Sea, collect and return plankton to the surface, identify these plankton and collect a sediment core from the bottom of the ocean to identify microfossils from the ocean floor. Your ROV will also need to deliver identified plankton to the most appropriate planktivore species.

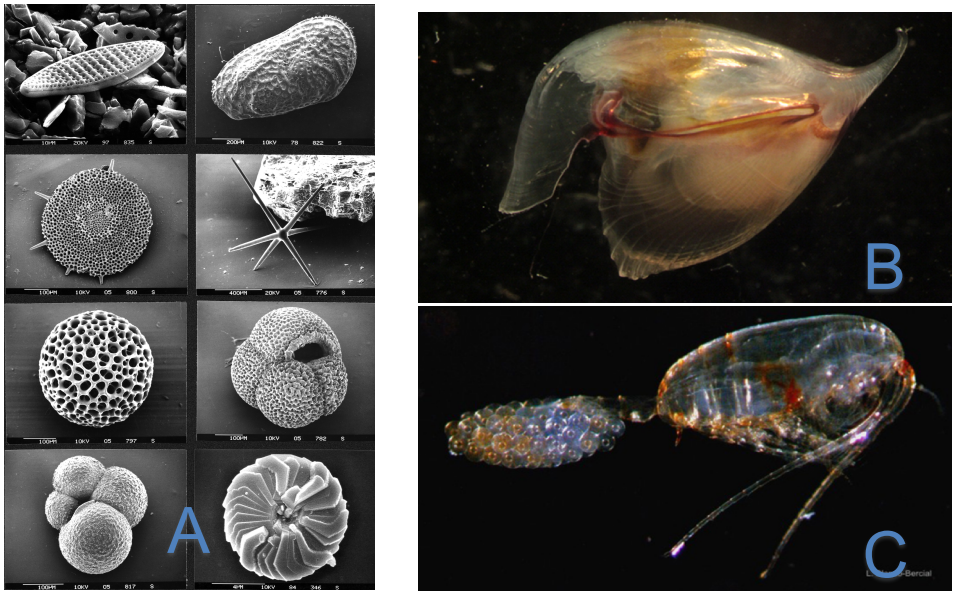


Figure 1: A. Scanning electron microscope images of microfossils (C/O Wikimedia Commons, B. A large warm water species of plankton, a shelled pteropod, occasionally found in Bermuda during the summer (Dr. Amy Mass). C. Female zooplankton carrying an egg sac (Dr. Leo Blanco-Bercial)

IX. DEMONSTRATIONS

DEMONSTRATION #1: SIZING

Maximum Point Value for Task = +10 bonus points

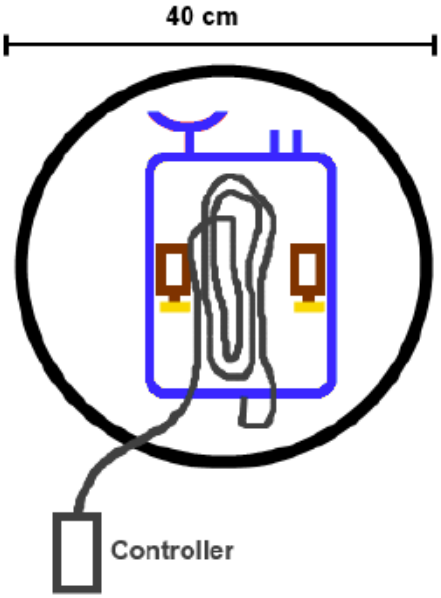
Sizing

Size measurements will be made using the two largest dimensions of the ROV. Two flat discs with 40cm and 48cm diameter holes will be located at the safety check area for teams. Companies will place their vehicles on the measuring table and, when ready, ask a judge to make the size measurement. The vehicle measurement must include the vehicle, all manipulators/tools to be used in the product demonstration, and the vehicle's tether. The control system and 1 meter of tether may be outside of the measurement circle. Companies must present their completely assembled ROV for measurement; companies may **not** detach manipulator arms or other equipment for the measurement.

The ROV must fit into the two largest dimensions of the disk to receive bonus points. If the ROV and all its equipment fit within the hole of 40cm in diameter, the company will receive 10 bonus points. If the ROV and all its equipment fit within the hole of 48cm in diameter, the company will receive 5 bonus points. If the ROV and all its equipment do not fit within the hole of 48cm in diameter, the company will receive no bonus points, but can still compete in the product demonstration.

If manipulators act on a swivel system they can be moved inside the frame, but can not be detached. The companies' largest/longest manipulator must be attached for the product demonstration.

There are no weight restrictions for the ROV.



DEMONSTRATION #2: TIMING

Maximum Point Value for Task = +10 bonus points

Companies will have **20 minutes** to enter the station, mobilize their ROV, and complete as many of the 5 tasks as possible in the time allotted. The clock will continuously run even when the ROV is out of the water having any modifications made.

There will be a 10 point time bonus if companies complete all 4 tasks in 15 minutes or under from the time they enter the station.

DEMONSTRATION #3: SAFETY

Maximum Point Value for Task = 10 points

1. Propellers must be enclosed inside the frame of the ROV or shrouded. Companies that have propellers protruding outside of their frame will not pass the safety inspection and will not be allowed to compete.

2. All power provided to your ROV system must be obtained from the Challenge power supply. This is a singular point of connection; all power to your ROV must pass through the provided fuse on the supply **and** the single fuse in your wiring.

3. MARINE will provide a nominal 12 volt power source at the product demonstration station.

4. Voltage may never be increased above the nominal 12 volts anywhere in the ROV system.

5. The ROV **must** have a 15A maximum fuse in the positive power supply line.

6. ROV systems are allowed 2 replacement fuses during the product demonstration run. In the event that the ROV system blows the third fuse during the product demonstration, the product demonstration run will be over and no additional points will be earned. Note: MARINE will have some fuses on hand, but it would be wise for companies to bring additional fuses.

7. All electrical components going into the water must be waterproofed. ROVs with electrical connections that are exposed to the water and not sealed will not be permitted to enter the pool. Disposable motors (motors with no waterproofing) are not permitted. Taping a connection only with electrical tape does not constitute a sealed connection. The process of sealing electrical connections must include methodologies such as, but not limited to, silicone RTV, hot melt glue, epoxy, self-vulcanizing tape, and enclosing the connection inside a housing.

8. Onboard electrical power is not allowed. All power for the vehicle must come down the tether. Batteries (9-volt, AAA, AA, etc.) are **not** allowed under any circumstances.

9. Control systems must be built in a neat and workmanship like manner. Loose components and unsecured wires may not pass safety inspection. All wires entering and leaving the control system must have adequate strain relief and wire abrasion protection as the wires pass through the box.

DEMONSTRATION #4: PRODUCT INTERVIEW

Maximum Point Value for Task = 40 points

Companies will be interviewed by an industry panel and asked to explain their design and how it will meet the four tasks.

Example of questions during product interview:

1. How did you decide on the shape of your ROV and the materials to build it?
2. What design trade-offs did you make? Can you explain why?
3. What type of tool(s) did you design to accomplish the product demonstration tasks and why? How does the tool(s) work?
4. How did you determine how much floatation to add to your vehicle?
5. Why is it important to think about stability when designing your ROV?
6. Did you develop a safety checklist? What other safety precautions have you taken?

Preparing for your product presentation

• Make sure that every member of your company has a good, general working knowledge of your vehicle, even though they may have specialized in one specific aspect of its design and construction.

• Research the specifications of the components that you use in your vehicle. Be familiar with such numbers as the amount of propulsive force the thrusters produce, the weight of your ROV, etc.

• Encourage each member of your company to keep a project notebook. Before the competition, set up a time where you compare notebooks. One member might have written more information about your ROVs electrical system, while another might have included details about buoyancy that others forgot. This exercise will help to refresh everyone's memory about the design and building process. If your company submitted technical documentation, make sure all company members have read it and are familiar with it. This exercise will help to familiarize everyone with all aspects of the project.

• Generally, you will have more to say about your ROV than can be presented in 5 or 10 minutes. That is why it is critical to organize your material and practice communicating it. However, avoid coming across as having memorized your presentation. Judges want to see that you are prepared and understand the information, not that you can simply recite a rehearsed speech from memory. Ask your instructors or mentors to give you feedback.

DEMONSTRATION #5: MARKETING DISPLAY

Maximum Point Value for Task = 50 points

Your company is required to create a display that will be showcased during the competition event. Your display should be an informative, clear, and concise presentation about your company and how you designed and built the specialized tools to effectively complete the product demonstrations. During the competition, your company's display will be evaluated and scored by a completely different group of working professionals – individuals who will represent science, business, government, industry, and education/outreach.

While some judges will have a technical background, others will have a communications, marketing, or public relations background. 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 the technology (i.e., you need to explain your technology, the tasks, and "sell" them **your** products and services.) Design your display to communicate to this type of audience.

Each company will have a space approximately 3-feet x 3-feet for its display. Depending on your region, tables may or may not be provided. Each judge will award a score (50 points max). Judges' scores and comments will be returned to you shortly after the event.

General guidelines:

- Use a 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 on your marketing display:
    - Diagrams or sketches (CAD drawings, for example). The diagrams should be clearly labeled with a brief explanation that is understandable to a general, non-technical audience.

Required components of the marketing display:

These headers not only assist the judges in evaluating your display, they also make your marketing display easy to read.

1. 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 marketing display). Include your school, club, or community organization name as well as your company name. Include your geographic location (i.e. parish. If you are an international company, include the city and country.

2. 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 product demonstration tasks. Make sure to relate the product demonstration to how ROVs can be used in the real world. Don't assume that your audience knows what an ROV is or the details about the competition tasks. You can view this section as a summary of your company information, ROV design, and theme.

3. Company 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.

4. ROV design

This section should be the bulk of your marketing display. It will be worth the most points.

- Why did your company build your ROV the way that you did?
- Present your ROVs "Features and Benefits." Features are the physical aspects or specifications for your vehicle, and benefits are what those features provide for the customer. For example, a feature might be a 1 horsepower thruster; the benefit would be the ability to make headway in a 2 knot current.
- Highlight your vehicle's safety features.
- Include photos of your ROV. Make sure to highlight the various systems of your vehicle.
- Include photos or drawings of any special features of your vehicle and how these features relate to the product demonstration tasks, safety, general operations, etc. This is the most important part of your design description.

5. Competition theme

Describe this year's competition theme and how technologies are being used to understand plankton in the Sargasso Sea.

Rather than repeating information that you find within the competition manual or on the Internet, take the time to think through the competition challenges and their significance in the real world. You can choose to focus on the technical, economic, or socioeconomic issues. In addition to the Internet, you are encouraged to contact individuals (such as a local scientist or industry professional) who can offer their views. You should include appropriate photos, diagrams, or sketches with captions. Be sure to appropriately cite your references/sources at the bottom of this section.

6. Company evaluation/market assessment

Answer the following questions:

- How would you characterize your company's overall success?
- What do you consider as strengths of your company and the ROV you designed?
- What areas do you see needing improvement?
- What was the most rewarding part of this experience?
- What would you do differently next time?

7. Acknowledgements

Please recognize your sponsors (companies, organizations, professionals from industry, and/or mentors) and the type of support that they provided (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).

DEMONSTRATION #6: PRODUCT

Maximum Point Value for 4 In-pool Tasks = 190 points

Task #1 Plankton collection with net through water column

Maximum Point Value for Task = 40 points

Mission: Fly through the water column of the Sargasso Sea at 3 feet from the surface and continue to catch plankton at 1 foot from the surface without letting the tethered net or ROV touch the hula-hoop

A. Fly through Sargasso Sea water column at 3-foot depth with towed net without ROV touching frame – 10 points
B. Fly through the Sargasso Sea water column at 1-foot depth with towed net without ROV touching frame – 10 points
C. Fly through Sargasso Sea water column at 3-foot depth without towed net or rope touching hula-hoop – 10 points
D. Fly through Sargasso Sea water column at 1-foot depth without towed net or rope touching hula-hoop – 10 points

The steps of this task must be completed in order.

A successful fly through begins with the ROV running through the mounted hula-hoop without any part of the ROV frame and manipulator or towed rope and net touching the hula-hoop mounted at 3 feet below the pool surface. The entirety of the ROV frame, rope and net must be through the hula-hoop for successful completion of parts A and C. The second hula-hoop will be 1 foot from the surface of the pool. The ROV will then proceed to the second hoop, which will be 3.5 feet from the first. The ROV again must clear the hula-hoop entirely with frame, manipulators and towed net. The tether may touch the hoop, but the ROV and manipulators, rope and net may not. If the ROV and/or net hits the hula-hoop it will not be eligible for those points on a second try, but may proceed to the second hoop.

A successful completion of Task 1 will be of the ROV, rope and net clearing both hula-hoops without any part of the frame, manipulator, rope or net touching the hoop. The hula-hoop will be 71cm in diameter, weighted at the bottom and suspended with floats on top. Please note that hoops do move back and forth slightly in the pool, adding to the challenge.

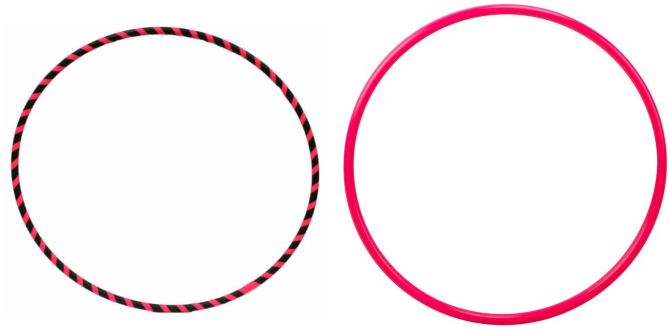


Figure 2: Weighted hula-hoop 71 inches in diameter will be suspended off the bottom and anchored via sash weights to the bottom of the pool.

Figure 3: Plankton net measuring 13 inches long and weighing 23.4 grams. Rope is 1/8” nylon rope and 5 feet will be provided for attaching to eye.

Figure 4: 1/8” x 5 feet of nylon rope will be provided for the Challenge. Students can configure the rope at whatever length desired, but all 5 feet of rope must travel with the ROV.

TASK #2: LIVE PLANKTON RECOVERY AND IDENTIFICATION

Maximum Point Value for Task = 80 points

Mission: Find and return mission-critical plankton samples to the pool deck

A. Recover four plankton samples from the water column above the seafloor - 5 points each (20 total) **B. Bring the four plankton samples to the net elevator - 5 points for each plankton that is placed in the net elevator (20 total)** **C. Bring four plankton samples to the pool deck - 5 points for each (20 total)** **D. Identify each of the 4 plankton samples with provided guide - 5 points for each (20 total)**

There will be **four** plankton samples on the bottom of the pool. For every plankton companies retrieve and successfully lift off the bottom of the pool, the company will receive 5 points. For each sample that is placed in the net elevator, companies will receive 5 points. For each plankton sample that is brought to the pool deck via net elevator, companies will receive an additional 5 points. Companies will be asked to identify each of the 4 plankton species against a guide of some of the most common plankton in the Sargasso Sea.

Figure 4: CubeSats have a dimension of 21cm x 17cm x 23cm. For companies that competed in 2016 and 2017, these are the mission critical CubeSats and sea urchins. Plankton will be suspended within the cube. Please note cubes will sit horizontally vs. vertically for the 2018 plankton challenge.

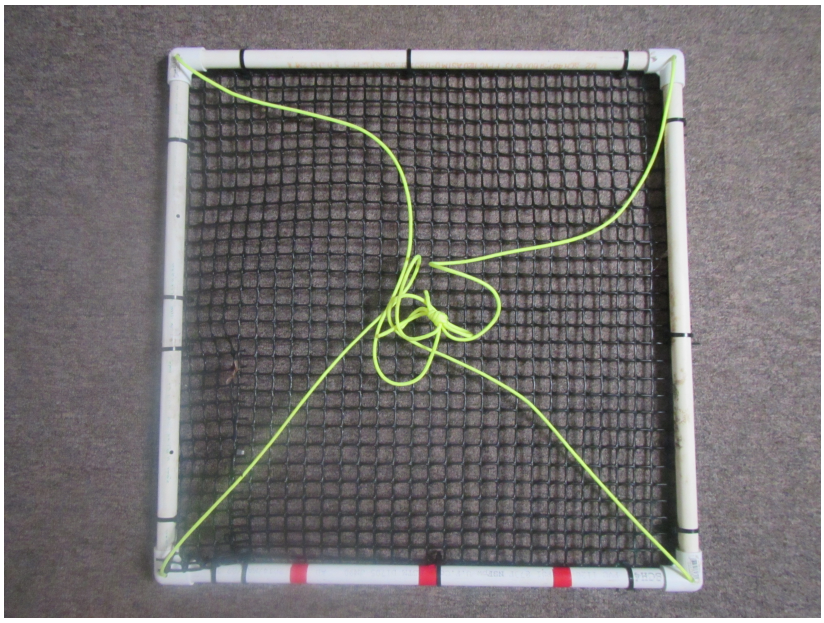


Figure 5: 3 x 3 foot net elevator with rope to pool deck for plankton retrieval.

TASK #3: MICROFOSSIL CORE RECOVERY

Maximum Point Value for Task = 40 points

Mission: Collect two core samples of microfossils from the seafloor and return the samples to the surface for analysis.

A. Collect two microfossil samples from bottom of pool – 5 points each (10 total) **B. Return the samples to the surface – 5 points each (10 total)** **C. Analyze the specimens and identify them using a guide – 10 points each (20 total)**

Ocean sediment cores will be situated on a 5-gallon bucket lid. Samples will be constructed from a 3-inch PVC tube that is 9" long. Inside the core will contain a microfossil sample. Companies must bring the core to the surface, remove the sample and identify the correct microfossil with a provided guide.

Once both core samples are on the pool deck, companies can begin to identify the species of fossil inside the PVC T. They will have a binder with 10 known microfossil species in the Sargasso Sea. They will compare their samples vs. those in the binder and will report their match to the judge. If a company incorrectly identifies the fossil, they may not re-analyze that fossil again. Companies may not guess each of the microfossil species if they have not retrieved both samples.

Figure 6: 5-gallon bucket lid will be secured at the bottom of the pool. Microfossil samples will be contained within the 3" x 9" PVC tube. 2-1/8" nylon ropes will float for pick up of core sample. Microfossils will be contained within the core.

TASK #4: PLANKTIVORE FOOD WEB CHALLENGE

Maximum Point Value for Task = 30 points

Mission: Use your plankton samples to identify the common prey of a planktivore.

A. Under control of your ROV place plankton sample retrieved in Task 2 under the appropriate planktivore within the hula-hoop under the critter - 15 points each (30 total)

Up to four plankton samples can be obtained from Task 2 with cubes retrieved and brought to the pool deck. Only two samples will fit alongside two planktivores floating on the top of the pool and anchored above a hula-hoop. Companies must have retrieved their plankton and brought it to the pool deck before making an attempt at the Food Web Challenge. Companies may lower their plankton cube back into the pool by the side, but they may not toss or use their ROV to lower the plankton to the appropriate hula–hoop. There will only be one correct answer for each organism floating in the pool. Plankton sample MUST fit entirely inside the hoop to collect the 15 points and choice must be identified by in-water judges.

Companies only have one chance at each planktivore/plankton, predator/common prey association.

Some common organisms that eat plankton include corals, manta rays, whale sharks, humpback whales (and other baleen whales), leatherback turtles, sergeant majors etc.

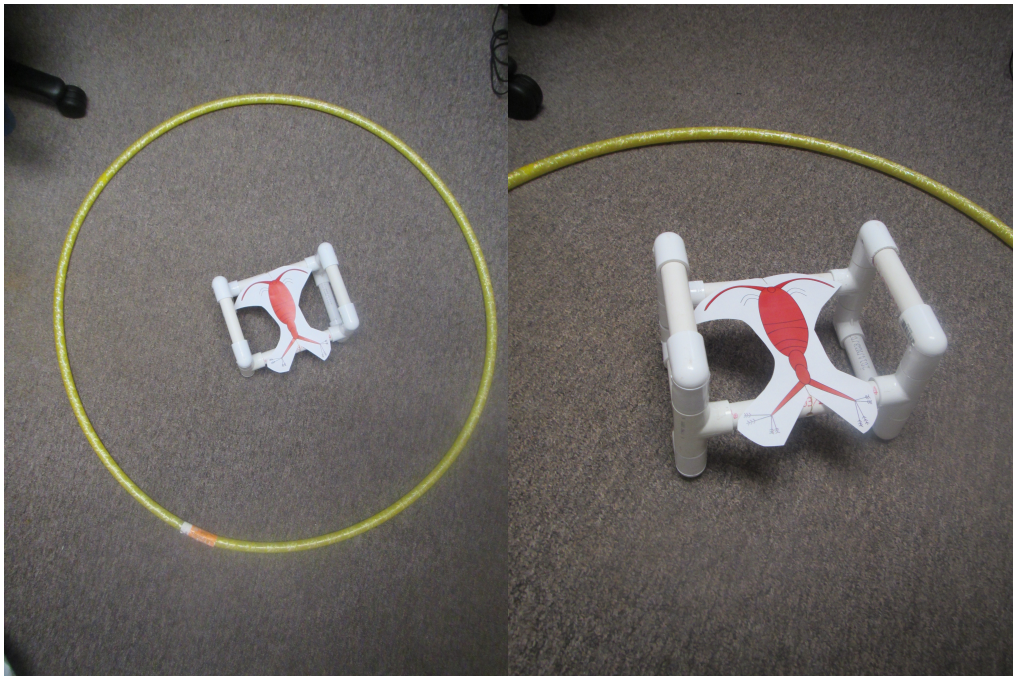


Figure 7: 71” diameter hula-hoop which will lie on the pool floor. The appropriate plankton diet must be placed below the designated plankton eater. Planktivorous animals will float above the hula-hoop on the surface of the pool and be tied to a fishing weight in the middle of the hula-hoop.

Scoring

The maximum total points that can be scored in the 2018 ROV Angelfish Challenge in Bermuda for Beginner level is 310 points.

190 Maximum Total Points in Product Demonstration
40 Maximum Total Points for Product Interview
50 Maximum Total Points for Marketing Display
10 Points for Safety Demonstration
+ 10 Point Size Bonus
+ 10 Point Time Bonus

310 Points

Scoring Breakdown

Demonstration Number			Maximum Points
1. Sizing			+ 10 Bonus
2. Timing			+ 10 Points
3. Safety			10 Points
4. Product Interview			40 Points
5. Marketing Display			50 Bonus
6. Product		Task 1	40 Points
		Task 2	80 Points
		Task 3	40 Points
		Task 4	30 Points