2015 MATE ROV COMPETITION: MISSION TASK AND SPECS BRIEFING

MATE Competition Philosophy

The MATE ROV competition is about **student learning**.

It is designed to be an event that challenges **students** to apply the physics, math, electronics, and engineering skills they are learning in the classroom to solving problems from the marine workplace.

Mentors (teachers, parents, working professionals) are expected to limit their input to educational and inspirational roles and encouraged to focus on the benefits of the **learning process** and not simply on "winning" the competition.

ROVs in Extreme Environments: Science and Industry in the Arctic

CONTEXT

Located ~2,100 km south of the Arctic Circle, St. John's is the capital of the province of Newfoundland and Labrador, Canada. The oldest city in North America, St. John's offers an enticing combination of old world charm, unique architectural, historic and natural attractions, and is located in close proximity to spectacular coastlines, historic villages, and a diverse selection of wildlife.

The city is also home to Memorial University of Newfoundland's Marine Institute (MI) and the National Research Council's Ocean, Coastal, and River Engineering (OCRE) and their world-class facilities. MI houses the world's largest flume tank, with a water capacity of 1.7 million liters and water velocity ranging from 0–1 meters per second. The flume tank's viewing gallery has a 20 meter-by-2 meter viewing window and seats 150 people. The OCRE includes an ice tank and offshore engineering basin. In the ice tank, the water surface can be frozen and the air temperature maintained at a uniform –30 to 15 degrees Celsius to simulate the polar environment. The offshore engineering basin is used to simulate the extreme ocean environment; waves, wind, and currents can be controlled to achieve various sea states.

A number of scientists who work in polar environments are based in St. John's or use it as a starting point for their research in the Arctic. Similarly, several companies involved in oil and gas operations on the North Atlantic continental shelf are headquartered in St. John's, while a number of others have offices there. Both polar researchers and offshore oil and gas companies use the facilities at MI and the OCRE to test the equipment that supports their science and operations before heading out to sea. Both also employ technicians and engineers to design, build, and operate this equipment both in the "lab" and in the field.

NEED

The polar science community and the offshore oil and gas industry are in need of remotely operated vehicles that can conduct 1) ***SCIENCE UNDER THE ICE*** that includes counting species and sampling organisms, deploying an instrument, and collecting data about an iceberg; 2) ***SUBSEA PIPELINE INSPECTION & REPAIR*** that includes replacing a corroded section of oil pipeline and preparing a wellhead for delivery of a Christmas tree; and 3) ***OFFSHORE OILFIELD PRODUCTION & MAINTENANCE*** that includes testing the grounding of anodes on the "leg" of an oil platform, measuring the height of a wellhead, and controlling the flow of oil through a pipeline.

DESIGN BRIEF

Below is a summary of the mission tasks organized by competition class.

EXPLORER

1) SCIENCE UNDER THE ICE (international venue = ice tank)

- Maneuver through a 75cm x 75cm hole in the ice.
- Collect a sample of algae from the underside of the ice sheet.
- Collect an urchin located on the seafloor.
- Use a species identification handbook to identify and count species of sea star.
- Deploy a passive acoustic sensor in a designated area.
- Measure the dimensions of an iceberg and calculate its volume.
- Use coordinates to map the location of the iceberg.
- Use the location, heading, speed, and keel depth to determine the threat level of the iceberg to area oil platforms.

2) SUBSEA PIPELINE INSPECTION & REPAIR (international venue = offshore engineering basin)

- Conduct a CVI (close visual inspection) of an oil pipeline for corrosion.
- Turn a valve to stop the flow of oil through the pipeline.
- Examine a gauge dial to determine that the pipeline oil pressure is zero.
- Measure the length of the section of corroded pipeline.
- Attach a lift line to the corroded section.
- Cut (simulated) the section of corroded pipeline.
- Remove the section of corroded pipeline and return it to the surface.
- Install and secure an adapter flange over both cut ends of the pipeline.
- Install a gasket into a wellhead.
- Insert a hot stab to simulate injecting corrosion prohibiter into the wellhead.

3) OFFSHORE OILFIELD PRODUCTION & MAINTENANCE** (**international venue = flume tank)

- Test the grounding of anodes by measuring the voltage of specified points along the "leg" of an oil platform.
- Determine which anode(s) is not properly grounded.
- Measure the height of a wellhead from the seafloor.
- Use a map to determine the pathways of flow through a pipeline system.
- Turn valves to ensure that oil will flow through the specified pathway.
- "Push" water through the pipeline system to verify that oil will flow through the correct pathway.
- Determine the average flow rate of the water current.

RANGER

1) SCIENCE UNDER THE ICE (international venue = ice tank)

- Maneuver through a 75cm x 75cm hole in the ice.
- Collect a sample of algae from the underside of the ice sheet.
- Collect an urchin located on the seafloor.
- Use a species identification handbook to identify and count species of sea star.
- Deploy a passive acoustic sensor in a designated area.
- Measure the dimensions of an iceberg and calculate its volume.
- Use coordinates to map the location of the iceberg.
- Use the location, heading, speed, and keel depth to determine the threat level of the iceberg to area oil platforms.

2) SUBSEA PIPELINE INSPECTION & REPAIR (international venue = offshore engineering basin)

- Conduct a CVI (close visual inspection) of an oil pipeline for corrosion.
- Turn a valve to stop the flow of oil through the pipeline.
- Examine a gauge dial to determine that the pipeline oil pressure is zero.
- Measure the length of the section of corroded pipeline.
- Attach a lift line to the corroded section.
- Cut (simulated) the section of corroded pipeline.
- Remove the section of corroded pipeline and return it to the surface.
- Install and secure an adapter flange over both cut ends of the pipeline.
- Install a gasket into a wellhead.
- Insert a hot stab to simulate injecting corrosion prohibiter into the wellhead.

3) OFFSHORE OILFIELD PRODUCTION & MAINTENANCE (international venue = flume tank)

- Test the grounding of anodes by measuring the voltage of specified points along the "leg" of an oil platform.
- Determine which anode(s) is not properly grounded.
- Measure the height of a wellhead from the seafloor.
- Use a map to determine the pathways of flow through a pipeline system.
- Turn valves to ensure that oil will flow through the specified pathway.
- "Push" water through the pipeline system to verify that oil will flow through the correct pathway.

NAVIGATOR *(only available at certain regionals)*

1) SCIENCE UNDER THE ICE

- Maneuver through a 60cm x 60cm hole in the ice.
- Collect a sample of algae from the underside of the ice sheet.
- Collect an urchin located on the seafloor.
- Use a species identification handbook to identify and count species of sea star.
- Deploy a passive acoustic sensor in a designated area.

- Measure the dimensions of an iceberg and calculate its volume.
- Use coordinates to map the location of the iceberg.

2) SUBSEA PIPELINE INSPECTION & REPAIR

- Conduct a CVI (close visual inspection) of an oil pipeline for corrosion.
- Turn a valve to stop the flow of oil through the pipeline.
- Examine a gauge dial to determine that the pipeline oil pressure is zero.
- Measure the section of corroded pipeline.
- Attach a lift line to the corroded section.
- Cut (simulated) the section of corroded pipeline.
- Remove the section of corroded pipeline and return it to the surface.

NOTE: The NAVIGATOR class does not attempt the offshore oilfield production and maintenance mission.

SCOUT

1) SCIENCE UNDER THE ICE

- Collect samples of algae from the underside of the ice sheet.
- Collect urchins located on the seafloor.
- Deploy a passive acoustic sensor in a designated area.

2) SUBSEA PIPELINE INSPECTION & REPAIR

- Turn a valve to stop the flow of oil through the pipeline.
- Remove sections of corroded pipeline.
- Install new sections of pipeline.
- Turn a valve to start the flow of oil through the pipeline.

NOTE: The SCOUT class does not attempt the offshore oilfield production and maintenance mission.

SPECS

What follows is a summary of the electrical and fluid power requirements for each competition class. The complete design and building specifications will be included within the competition manual.

NOTE: Watch for new safety requirements and additional, detailed electrical specifications within the competition manuals.

EXPLORER

- 48 volts, 40 amps DC. Conversion to lower voltages must be done on the ROV, not topside. Onboard electrical power is not permitted.
- Pneumatics and hydraulics are permitted provided that the team passes the MATE Fluid Power Safety Quiz and follows the specifications included within the competition manual.

- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.

RANGER

- 12 volts, 25 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Onboard electrical power is not permitted.
- Pneumatics and hydraulics are permitted provided that the team passes the MATE Fluid Power Safety Quiz and follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.

NAVIGATOR *(only available at certain regionals)*

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Onboard electrical power is not permitted.
- Manually-powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included within the competition manual.
- Lasers are NOT permitted.
- Camera is required.

SCOUT

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Onboard electrical power is not permitted.
- Manually-powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included within the competition manual.
- Lasers are NOT permitted.

RESOURCES

Teams are permitted to use the materials of their choice provided that they are safe, will not damage or otherwise mar the competition environment, and are within the defined design and building specifications.

Teams are encouraged to focus on engineering a vehicle to complete the mission tasks; when considering design choices, teams should ask themselves which one most efficiently and effectively allows them to solve the problem. Re-using components built by previous team members is permitted provided that the current team members evaluate, understand, and can explain their engineering and operation. Using or re-using commercial components is also permitted, provided that team members evaluate, understand, and can explain their engineering and operation. Teams will be questioned extensively on this during their engineering presentations.

TIME

The complete competition manual will be released by November 15, 2014; teams have from that date until the regional events in the spring of 2015 to construct their vehicles and prepare the engineering and communication components (technical reports, engineering presentations, and poster displays). Visit the MATE web site at www.marinetech.org or request to be added to the MATE competition listserve to ensure a timely delivery.