2016 MATE ROV COMPETITION: PRODUCT DEMONSTRATION 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.

From the Gulf of Mexico to Jupiter's Moon Europa: ROV Encounters in Inner and Outer Space

CONTEXT

Since its inception in 1958, the National Aeronautics and Space Administration (NASA) has accomplished many great scientific and technological feats in air and space. However, NASA's work and impact is not limited to aerospace. NASA technology also has been adapted for many non-aerospace uses by the private sector; the technique of freeze-drying food is one example.

The agency also plays a role in ocean science and exploration. NASA has been observing the oceans from space for decades. NASA launched Seasat, the first civilian oceanographic satellite, on June 28, 1978. Seasat was followed by Tiros-N. Today there are several ocean-observing satellite missions and an extensive scientific research community studying these data. Satellite data and modeling techniques allow scientists to map and monitor seasonal changes in ocean surface topography, currents, waves, winds, phytoplankton content, sea-ice extent, rainfall, sunlight reaching the sea, and sea surface temperature. During the last decade, forecasting models used NASA's satellite data to improve the ability to predict events such as the El Niño climate oscillation phenomenon and other global and regional climate cycles.

Similarly, global oilfield services provider Oceaneering International's work is not only in subsea oilfield production; the company's Entertainment Systems division contributes to the cutting-edge development of theme park technologies (think Disney!), including dark ride vehicles and show systems. Oceaneering also has divisions that focus on land surveying and mapping, video and data collection and management, and outer space.

Oceaneering's Space Systems (OSS) division develops, integrates, and applies both new and existing technologies to the challenges of operations in space and other harsh environments. OSS specializes in the design, manufacturing, certification, maintenance, and testing of thermal protection systems for rockets; equipment for humans to use in space; and robotic systems for military, space, and biological research applications. The Space Systems division of Oceaneering also provides specialized engineering and support services in these areas and in astronaut training at NASA's Johnson Space Center's Neutral

Buoyancy Laboratory (NBL) and Space Vehicle Mockup Facility (SVMF).

OSS is one of several in-house commercial tenants at the NBL/SVMF that supports NASA's programs. The company oversees astronaut training for extravehicular activities (EVAs or "spacewalks") and intravehicular activities (IVAs or activities that take place inside the spacecraft). It also teams with NASA scientists and engineers to find solutions to problems as well as ways to accomplish NASA priorities – such as recovering mission-critical equipment from the ocean floor and developing robots to explore oceans on other planets and natural planetary satellites in our galaxy.

In addition to working together, both NASA and Oceaneering partner with other organizations that have similar project interests and priorities. Given the location of their facilities, this includes organizations with scientific, commercial, and conservation efforts taking place in the Gulf of Mexico.

REFERENCES

- www.nasa.gov
- www.nasa.gov/europa
- http://science.nasa.gov/earth-science/oceanography/
- www.oceaneering.com

NEED

NASA and Oceaneering Space Systems (OSS) have issued a request for proposals (RFP) for a first-of-its-kind, dual purpose and single launch remotely operated vehicle that can operate in the harsh environments of both the deep ocean and outer space. Specifically, scientists and engineers at these organizations are in need of a robot that can 1) survive transport to Jupiter's moon Europa and operate in the ocean under its ice sheet to collect data and deploy instrumentation; 2) find and recover critical equipment that sank in the Gulf of Mexico after a recent series of testing programs; 3) collect samples and analyze data from oil mats located in the northern Gulf of Mexico to determine their origin ; 4) photograph and collect samples of deep-water corals to assess their health post-Deepwater Horizon oil spill; and 5) prepare a wellhead for decommission and conversion into an artificial reef.

Before launch and operations in inner and outer space, the robot must complete a series of "product demonstrations" staged in the 6.2-million gallon, 40-foot deep Neutral Buoyancy Lab (NBL). (Depth requirements vary depending on robot class; see **SPECS** below.) Companies that successfully complete the product demonstrations and deliver exceptional engineering and communication components (e.g. technical documentation, technical sales presentations, and marketing displays) will be awarded the contract.

DESIGN BRIEF

Below is a summary of the product demonstrations organized by competition class. Unlike 2015, the product demonstrations will not be separated into different runs; all five product demonstrations will be accomplished in one product demonstration run.

EXPLORER

Outer Space: Mission to Europa

- Measure the temperature of venting fluid.
- Determine the thickness of the ice crust using pressure measurements.
- Determine the depth of the ocean under the ice using pressure measurements.
- Connect the Environmental Sample Processor (ESP) to the power and communications hub:
    - Retrieve the ESP's cable connector from the elevator.
    - Lay the ESP cable through three waypoints.
    - Open the door to the port on the power and communications hub.
    - Insert the cable connector into the port on the power and communications hub.

Inner Space: Mission-critical equipment recovery

- Survey the seafloor to find and identify mission-critical NASA equipment.
- Place the equipment in a collection basket for retrieval by a crane at the surface.

Inner Space: Forensic Fingerprinting

- Collect and return two oil samples to the surface.
- Analyze a gas chromatograph of each sample to determine its origin.

Inner Space: Deepwater Coral Study

- Photograph corals and compare the images to previous years to assess their condition.
- Collect coral samples and return them to the surface for analysis.

Inner Space: Rigs to reefs

- Attach a flange to the top of the wellhead.
- Secure the flange to the wellhead with two bolts.
- Install a cap over the flange.
- Secure the cap to the flange with four bolts.

RANGER

Outer Space: Mission to Europa

- Measure the temperature of venting fluid.
- Determine the thickness of the ice crust.
- Determine the depth of the ocean under the ice.
- Connect the Environmental Sample Processor (ESP) to the power and communications hub:
    - Retrieve the ESP's cable connector from the elevator.
    - Lay the ESP cable through two waypoints.
    - Open the door to the port on the power and communications hub.
    - Insert the cable connector into the port on the power and communications hub.

Inner Space: Mission-critical equipment recovery

- Survey the seafloor to find and identify mission-critical NASA equipment.
- Place the equipment in a collection basket for retrieval by a crane at the surface.

Inner Space: Forensic Fingerprinting

- Collect and return two oil samples to the surface.
- Analyze a gas chromatograph of each sample to determine its origin.

Inner Space: Deepwater Coral Study

- Photograph corals and compare the images to previous years to assess their condition.
- Collect coral samples and return them to the surface for analysis.

Inner Space: Rigs to reefs

- Attach a flange to the top of the wellhead.
- Secure the flange to the wellhead with one bolt.
- Install a cap over the flange.
- Secure the cap to the flange with two bolts.

NAVIGATOR

Outer Space: Mission to Europa

- Connect the Environmental Sample Processor (ESP) to the power and communications hub:
  - Retrieve the ESP's cable connector from the elevator.
  - Lay the ESP cable through two waypoints.
  - Open the door to the port on the power and communications hub.
  - Insert the cable connector into the port on the power and communications hub.

Inner Space: Mission-critical equipment recovery

- Survey the seafloor to find and identify mission-critical NASA equipment.
- Place the equipment in a collection basket for retrieval by a crane at the surface.

Inner Space: Forensic Fingerprinting

- Collect and return two oil samples to the surface.
- Analyze a gas chromatograph of each sample to determine its origin.

Inner Space: Deepwater Coral Study

- Collect coral samples and return them to the surface for analysis.

Inner Space: Rigs to reefs

- Attach a flange to the top of the wellhead.
- Secure the flange to the wellhead with one bolt.
- Install a cap over the flange.

- Secure the cap to the flange with two bolts.

SCOUT

Outer Space: Mission to Europa

- Connect the Environmental Sample Processor (ESP) to the power and communications hub:
    - Open the door of the power and communications hub.
    - Retrieve the ESP's cable connector from the elevator.
    - Insert the cable connector into the port on the power and communications hub.

Inner Space: Mission-critical equipment recovery

- Place four pieces of mission-critical NASA equipment into a collection basket.
- Return the collection basket to the surface.

Inner Space: Forensic Fingerprinting

- Collect and return two oil samples to the surface.
- Analyze a gas chromatograph of each sample to determine its origin.

Inner Space: Deepwater Coral Study

- Collect coral samples and return them to the surface for analysis.

Inner Space: Rigs to reefs

- Install a cap over the wellhead.
- Secure the cap to the wellhead with one bolt.

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.
- Depth requirement at the international competition: 12.2 meters.
- Maximum size: 85 cm. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size and weight requirements.

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.
- Depth requirement at the international competition: 4.6 meters.
- Maximum size: 75 cm. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size and weight requirements.

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.
- Maximum size limit: None. See below for additional details on size requirements.

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.
- Maximum size limit: None. See below for additional details on size requirements.

SIZE AND WEIGHT POINT VALUES

Launching payloads into orbit can cost NASA in excess of ~$20,000 USD per kilogram;* limiting the size and weight of objects launched into space is very important. In 2016, additional points will be given to vehicles under a certain diameter, and for EXPLORER and RANGER vehicles, under a certain weight.

All size and weight measurements will include the vehicle, all tools and components, and the tether. The topside control system and 1 meter of tether going into the control system will **NOT** be included in the length or weight measurement. To receive points for smaller sized vehicles, the two **largest** dimensions of the vehicle and tether must fit through a round hole of the following dimensions:

EXPLORER class

Size		Weight (in air)	
< 58 cm diameter	+20 points	< 17 kg	+20 points
58.1 to 64 cm diameter	+10 points	17.01 kg to 19 kg	+10 points
64.1 to 70 cm diameter	+5 points	19.01 kg to 22 kg	+5 points

RANGER class

Size		Weight (in air)	
< 48 cm diameter	+20 points	< 11 kg	+20 points
48.01 cm to 54 cm	+10 points	11.01 kg to 12 kg	+10 points
54.01 cm to 60 cm	+5 points	12.01 kg to 14 kg	+5 points

NAVIGATOR class

Size	
< 44 cm diameter	+10 points
44.01 cm to 54 cm	+5 points

SCOUT class

Size	
< 40 cm diameter	+10 points
40.01 cm to 48 cm	+5 points

*www.nasa.gov/centers/marshall/news/background/facts/astp.html

NOTE: In addition to the size and/or weight limitations described above, companies must be able to personally transport the vehicle and associated equipment to the product demonstration station and to the technical sales presentation room. The ROV systems must be capable of being safely hand launched.

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 product demonstration 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 operational principles. Using or re-using commercial components is also permitted, provided that team members evaluate, understand, and can explain their engineering and operational principles. Teams will be questioned extensively on their overall design and component selections during their technical sales presentations.

TIME

The complete competition manual will be released by November 1, 2015; teams have from that date until the regional events in the spring of 2016 to construct their vehicles and prepare the engineering and communication components (technical documentation, technical sales presentations, and marketing displays). Visit the MATE web site at www.marinetech.org or request to be added to the MATE competition listserv to ensure a timely delivery.