2018 MATE ROV COMPETITION: PRODUCT DEMONSTRATION AND SPECS BRIEFING

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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 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.

Jet City: Aircraft, Earthquakes, and Energy

CONTEXT

The Pacific Northwest area of Washington State is known for its beautiful and lively geography, sitting between the Olympic and Cascade Mountain ranges, their snowcapped peaks hiding temporarily dormant volcanoes and tectonic plates prone to earthquake activity. The combinations of volcanic eruptions and earthquakes have shaped this piece of North America, raising the mountains and creating rivers via the snow melt that flow into deepwater lakes. Earthquakes also cause mudslides, landslides, and lahars that have wiped out large forested areas and resculpted the terrain. A fjord ties the Seattle area to the rest of the world through the Pacific Ocean. Known as Puget Sound, this fjord was formed by these same earth-moving forces. Puget Sound is also susceptible to another earthquake effect: the tsunami.

Seattle's history reflects a wide variety of businesses based on the local geography and natural resources, beginning with logging, farming, and fishing and evolving to high-tech and bio-tech. In addition to this, Seattle is the birthplace of Starbucks, Microsoft, and Boeing, which is why Seattle is known as "Jet City." This only adds to the popularity of the Seattle and Tacoma ports that started booming during the Alaska gold rush. These ports continue to be some of the busiest ports on the west coast today.

The Pacific Northwest has been developed and is constantly changing, but a general reverence for the areas rugged beauty has been a constant. In light of growing concern for the humankind's impact on our world, people in the Pacific Northwest are leading efforts to research and quantify these effects. Brilliant young minds that grew into being on the cutting-edge of the manufacturing and high-tech industries are now coming together to develop renewable energy options and reduce the dependence on petroleum. Areas of previous industrial activity or environmental disasters are being restored. Invasive species are being removed, while both plant and animal native species are being reintroduced. Organized volunteers educate the public on how to responsibly enjoy all the natural beauty of the Pacific Northwest – and to fight to keep it for all to enjoy for generations to come.

NEED

The Applied Physics Laboratory at the University of Washington has issued a request for proposals (RFP) for a remotely operated vehicle (ROV) and crew that can operate in the salt and fresh water areas in the Pacific Northwest. The specific tasks for the ROV and operators include:

1) Locating the wreckage of a vintage airplane and returning its engine to the surface.
2) Installing or recovering a seismometer.
3) Installing a tidal turbine and instrumentation to monitor the environment.

Before launch and operations, the ROV must complete a series of "product demonstrations" staged at a swimming pool at various regional locations. (Depth requirements vary depending on competition class; see **SPECIFICATIONS** below.) Companies that successfully complete the product demonstrations and deliver exceptional engineering and communication components (e.g. technical documentation, engineering presentations, and marketing displays) will be awarded the contract.

REFERENCES

Aircraft

- http://www.boydski.com/diving/wreck_dives.htm
- http://kuow.org/post/whats-bottom-lake-washington-planes-trains-and
- http://www.memorieshop.com/Seattle/LakeWashington/
- http://www.nwrain.com/~newtsuit/recoveries/lkwash/lkwash.htm
- http://www.cnn.com/2017/08/19/us/uss-indianapolis-wreckage-found/index.html

Earthquakes

- http://www.crew.org/earthquake-information/history-of-earthquakes-in-cascadia
- https://pnsn.org/outreach/earthquakesources/csz
- http://www.interactiveoceans.washington.edu/story/Broadband_Ocean_Bottom_Seismometer
- https://uwerisobservatory.wordpress.com/what/

Energy

- http://depts.washington.edu/nnmrec/
- http://www.apl.washington.edu/project/project.php?id=seafloor_tidal_power
- http://blogs.dickinson.edu/ecoreps/2014/04/01/tidal-power-in-puget-sound/
- https://energy.gov/eere/articles/calming-waters-impact-turbulence-tidal-energy-systems
- http://deepzoom.com/

DESIGN BRIEF

Below is a summary of the product demonstrations organized by competition class. All three product demonstration tasks will be attempted in one product demonstration run.

EXPLORER

Aircraft

- Use flight data to determine the search zone for the wreckage
- Identify the aircraft using the tail section
- Remove debris from the engine using a lift bag*
    - Attach the lift bag to the debris
    - Inflate lift bag to raise debris
    - Move the debris from the wreck area
    - Release the lift bag from the debris using one of the following:
        - A manual release
        - A magnetic/reed switch release
        - WiFi or Bluetooth release
        - Frequency-selective acoustic release
- Return the engine to surface using a lift bag*
    - Attach the lift bag to the engine and inflate
    - Return the engine to surface, side of pool
- Return all lift bags to the surface side of the pool

*Teams must provide their own lift bags and release mechanism, which must be constructed as per the specifications outlined in the competition manual.

Earthquakes

- Prior to the competition, develop a inductive coupling connector capable of providing power at 5 volts, 1 amp, 5 watts to an ocean bottom seismometer (OBS).
- During the competition…
    - Insert the power connector into the port on the OBS
    - Power indicator LED is lit
- Prior to the competition, develop a device capable of receiving WiFi data.
- During the competition…
    - Level the OBS using data transmitted by one of the following:
        - The OBS via WiFi OR data
        - A bubble leveler
    - Receive and accurately display a seismograph data transmitted by the OBS via WiFi

Energy

- Use tidal data and nautical chart to determine the optimum region for a tidal turbine
- Use tidal current data to calculate the maximum possible megawatt generation at this location
- Install a tidal turbine in the optimum location
    - Install the base on the bottom
    - Install the turbine onto the base

    - Latch the turbine in place
- Install an Intelligent Adaptable Monitoring Package (I-AMP) to monitor area
    - Transport the I-AMP to its stand
    - Lock the I-AMP onto the stand
- Place a mooring a given distance from the base of the tidal turbine
    - Measure the given distance from the base
    - Place the mooring on the bottom – 5 points
- Suspend an Acoustic Doppler Velocimeter (ADV) at a given height on the mooring line
    - Measure the given distance above the bottom
    - Attach the velocimeter to the mooring line

Note: Additional WiFi protocol information will be included in the competition manual.

RANGER

Aircraft

- Use flight data to determine the search zone for the wreckage
- Identify the aircraft using the tail section
- Remove debris from the engine using a lift bag*
    - Attach the lift bag to the debris
    - Inflate lift bag to raise debris
    - Move the debris from the wreck area
    - Release the lift bag from the debris
- Return the engine to surface using a lift bag*
    - Attach the lift bag to the engine
    - Inflate the lift bag
    - Return the engine to surface, side of pool
- Return all lift bags to the surface side of the pool

*Teams must provide their own lift bags.

Earthquakes

- Prior to the competition, build an ocean bottom seismometer (OBS), cable with connector, anchor, and release mechanism as per the specifications outlined in the competition manual. The OBS, connector, anchor, and release will be deployed on the bottom by divers before the mission run.
- During the competition…
    - Disconnect the OBS cable connector from the power and communications hub
    - Place the cable connector in its holder
    - Close the door of the power and communications hub
    - Release the OBS from the anchor using one of the following:
        - A manual release
        - A magnetic/reed switch release
        - WiFi or Bluetooth release
        - Frequency-selective acoustic release
    - Return the OBS to the side of the pool

Note: Additional WiFi protocol information will be included in the competition manual.

Energy

- Use tidal data and nautical chart to determine the optimum region for a tidal turbine
- Use tidal current data to calculate the maximum possible megawatt generation at this location
- Install a tidal turbine in the optimum location
  - Install the base on the bottom
  - Install the turbine onto the base
  - Latch the turbine in place
- Install an Intelligent Adaptable Monitoring Package (I-AMP) to monitor area
  - Transport the I-AMP to its stand
  - Lock the I-AMP onto the stand
- Place a mooring a given distance from the base of the tidal turbine
  - Measure the given distance from the base
  - Place the mooring on the bottom
- Suspend an Acoustic Doppler Velocimeter (ADV) at a given height on the mooring line
  - Measure the given distance above the bottom
  - Attach the velocimeter to the mooring line
- Eelgrass habitat monitoring and restoration
  - Collect two samples of eelgrass for topside analysis
  - Transplant two eelgrass frames to a previously disturbed area

NAVIGATOR

Aircraft

- Use flight data to determine the search zone for the wreckage
- Identify the aircraft using the tail section
- Place a marker buoy at the wreck site
- Remove debris from the engine
  - Lift the debris
  - Move the debris from the wreck area
- Return the engine to surface using a lift bag*
  - Attach the lift bag to the engine
  - Inflate the lift bag
  - Return the engine and lift bag to surface, side of pool

*Teams may use the lift bags provided by MATE or provide their own.

Earthquakes

- Pull the pin to release the seismometer from the elevator
- Remove the seismometer from elevator
- Deploy the seismometer into the designated zone on seafloor
- Level the seismometer
- Open the door of the power and communications hub

- Lay the seismometer cable through two waypoints
- Insert the seismometer cable connector into the port on the hub

Energy

- Use tidal data and nautical chart to determine the optimum region for a tidal turbine
- Install a tidal turbine in the optimum location
- Install an Intelligent Adaptable Monitoring Package (I-AMP) to monitor area
    - Install the I-AMP to its stand
    - Lock the I-AMP onto the stand
- Place a mooring a given distance from the base of the tidal turbine
    - Measure the given distance from the base
    - Place the mooring on the bottom
- Attach an Acoustic Doppler Velocimeter (ADV) at a given height on the mooring line
- Eelgrass habitat monitoring and restoration
    - Collect two samples of eelgrass for topside analysis
    - Transplant two eelgrass frames to a previously disturbed area

SCOUT

Aircraft

- Use flight data to determine the search zone for the wreckage
- Place a marker buoy at the wreck site
- Remove debris from the engine
    - Lift two pieces of debris
    - Move the debris from the wreck area
- Return the engine to surface using a lift bag*
    - Inflate the lift bag to raise the engine
    - Return the engine and lift bag to surface, side of pool
- After recovery, identify the aircraft using the tail structure and serial number

*Teams must use the lift bags provided by MATE, which will be connected to the engine at the start of the mission run.

Earthquakes

- Pull the pin to release the seismometer from the elevator
- Remove the seismometer from elevator
- Deploy the seismometer into the designated zone on seafloor
- Level the seismometer
- Open the door of the power and communications hub
- Lay the seismometer cable through one waypoint
- Insert the seismometer cable connector into the port on the hub

Energy

- Use tidal data and nautical chart to determine the optimum region for a tidal turbine

- Install a tidal turbine in the optimum location
- Install an Intelligent Adaptable Monitoring Package (I-AMP) to monitor area
    - Install the I-AMP to its stand
    - Lock the I-AMP onto the stand
- Place a mooring on the bottom
- Attach an Acoustic Doppler Velocimeter (ADV) on the mooring line
- Eelgrass habitat monitoring and restoration
    - Collect two samples of eelgrass for topside analysis
    - Transplant two eelgrass frames to a previously disturbed area

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, 30 amps DC. Conversion to lower voltages must be done on the ROV, not topside.
- 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: 5 meters.
- Maximum size: 92 cm in diameter. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size requirements.
- Maximum weight: 35 kg. See below for additional details on weight requirements.

RANGER

- 12 volts, 25 amps DC. Conversion to lower voltages is permitted topside and on the ROV.
- 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: 3 meters. Depth requirement may vary at regional competitions. Contact your regional coordinator or check your regional competition information document.
- Maximum size: 85 cm in diameter. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size and weight requirements.
- Maximum weight: 25 kg. See below for additional details on weight requirements.

NAVIGATOR *(only available at certain regionals)*

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source 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.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Anderson Powerpole connectors are required on all vehicles.
- 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. Any onboard electrical power source 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.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Anderson Powerpole connectors are required on all vehicles.
- Maximum size limit: None. See below for additional details on size requirements.

SIZE AND WEIGHT POINT VALUES

The Applied Physics Laboratory at the University of Washington has included an ROV size and weight requirement in the request for proposals (RFP). Smaller, lighter vehicles will be given special consideration and vehicles above a certain size and weight will not be considered.

All size and weight measurements will include the vehicle, all tools and components, and the tether. The following will NOT be included in the length or weight measurement:

- The topside control system and 1 meter of tether going into the control system
- EXPLORER class lift bag and release mechanism
- RANGER class OBS and lift bag(s)
- NAVIGATOR class lift bag(s) (if provided by the team)

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

Size		Weight (in air)	
< 64 cm diameter	+10 points	< 17 kg	+10 points
64.1 to 75 cm diameter	+5 points	17.01 kg to 25 kg	+5 points
75.1 to 92 cm diameter	+0 points	25.01 kg to 35 kg	+0 points

Vehicles above 92 cm in diameter, or greater than 35 kg in weight, will not be allowed to compete in the product demonstration.

RANGER

Size		Weight (in air)	
< 60 cm diameter	+10 points	< 12 kg	+10 points
60.1 cm to 75 cm	+5 points	12.01 kg to 17 kg	+5 points
75.1 cm to 85 cm	+0 points	17.01 kg to 25 kg	+0 points

Vehicles above 85 cm in diameter, or greater than 25 kg in weight, will not be allowed to compete in the product demonstration.

NAVIGATOR and SCOUT

Size	
< 48 cm diameter	+10 points
48.01 cm to 60 cm	+5 points

Vehicles above 60 cm in diameter will still be allowed to compete in the product demonstration, but will receive 0 points for size.

NOTE: In addition to the size and/or weight limitations described above, companies must be able to transport the vehicle and associated equipment to the product demonstration station and to the engineering 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 15, 2017; teams have from that date until the regional events in the spring of 2018 to construct their vehicles and prepare the engineering and communication components (technical documentation, engineering 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.