2020 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 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.

Excite, Educate, Empower: Students engineering solutions to global problems

CONTEXT & NEED

"What we have out there is all we have; there is no more."
- Dame Ellen MacArthur, Founder and Chair of Trustees, Ellen MacArthur Foundation

Each year, the MATE ROV Competition brings together a global community of learners to tackle real-world problems from around the world. This year, the competition is challenging this community to tackle problems that impact the entire world. Plastics clogging our rivers, lakes, waterways, and ocean, from the surface to the bottom of the Mariana Trench. Climate change raising ocean temperatures, affecting the health of coral reefs. Contaminants in our waterways. You can find these scenarios from Pennsylvania to Portugal, Florida to Australia, the Western Pacific to the Mid-Atlantic, and Indianapolis to Indonesia.

This year the "client" is us – our global community – and the request for proposals (RFP) is simple: design and build a remotely operated vehicle and the necessary sensors and tooling to tackle the real-world problems of plastics in our ocean, climate change's impact on coral reefs, and the consequences of poor environmental practices on our inland waterways.

In all of three of these cases, your solutions will focus on remediation, meaning, cleaning up rather than fixing the root of these problems. Addressing the actual cause will take involvement from more than just the MATE ROV Competition community; it will take government agencies, non-governmental organizations (NGOs), corporations, small businesses, research institutions, professional societies, and the general public all working together.

Fortunately, momentum is building.

More and more companies are starting to take environmental, social, and governance (ESG) factors into consideration when making business decisions. ESG factors cover a wide range of topics that are not traditionally part of financial analysis, yet may be important financially when it comes to attracting employees, business partners, and, perhaps most importantly, customers. ESG factors include how corporations respond to climate change, how good they are with water management, how effective their health and safety policies are in the protection against accidents, how they manage their product

supply chains, how they treat their employees, and whether they have a corporate culture that builds trust and encourages innovation.

The term ESG was first used in 2005 in a study entitled "Who Cares Wins." The study was lead by the United Nations and involved 20 financial institutions from around the world. Its goal was to develop guidelines and recommendations on how to better integrate ESG factors into financial markets and researching and managing investments. At the end of the study, all of the institutions committed to start talking with their stakeholders – investors and corporations – about how to implement the study's recommendations. They were convinced that the only way to make changes and improvements is to get everyone on board.

Fifteen years later, there has been progress, but there is still a long way to go. The biggest challenge for most corporations is adapting to a new environment that favors smarter, cleaner, and healthier products and services and moving away from the mindset of the industrial era when pollution was tolerated, labor was just another cost (and not real people), and bigger was better (and meant more money). Getting everyone thinking the same way and viewing the world as Dame Ellen MacArthur does is going to take a lot more work. However, what we do here is a start.

And this is where your mission begins.

Task 1: The Ubiquitous Problem of Plastic Pollution

Task 2: The Catastrophic Impact of Climate Change on Coral Reefs

Task 3: Maintaining Healthy Waterways Part II: Delaware River and Bay

REFERENCES

https://www.forbes.com/sites/georgkell/2018/07/11/the-remarkable-rise-of-esg/#69fbf2881695
https://www.unglobalcompact.org/docs/issues_doc/Financial_markets/who_cares_who_wins.pdf
https://sustainabledevelopment.un.org/?menu=1300
https://www.ellenmacarthurfoundation.org/

TASK #1: The Ubiquitous Problem of Plastic Pollution

https://seabinproject.com/
https://theoceancleanup.com/great-pacific-garbage-patch/
https://www.weforum.org/agenda/2019/06/underwater-robots-have-found-microplastics-from-the-surface-to-the-seafloor/
https://www.washingtonpost.com/science/2019/05/15/he-went-where-no-human-had-gone-before-our-trash-had-already-beat-him-there/

TASK #2: The Catastrophic Impact of Climate Change on Coral Reefs

https://allencoralatlas.org/
https://www.nrdc.org/stories/scientists-are-battling-mysterious-pathogen-destroying-coral-reefs-floridas-coast

https://www.omao.noaa.gov/find/media/images/removal-crown-thorns-sea-stars-during-outbreak
https://ocean.si.edu/ocean-life/invertebrates/five-questions-shirley-pomponi-medical-sponge-hunter

TASK #3: Maintaining Healthy Waterways Part II: Delaware River and Bay

https://ansp.org/research/environmental-research/projects/watershed-protection-program/
http://www.inphotonics.com/raman.htm
https://usfwsnortheast.wordpress.com/2017/08/21/mussels-making-moves-for-water-quality/
https://usfwsnortheast.wordpress.com/2014/06/20/bringing-back-american-eels-in-the-susquehanna-river/
http://www.dnrec.delaware.gov/fw/Fisheries/Pages/ArtificialReefProgram.aspx

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.

TASK #1: THE UBIQUITOUS PROBLEM OF PLASTIC POLLUTION

EXPLORER / RANGER

- Seabin – "Cleaning up our ocean one marina at a time"
    - Disconnect the old power connector to the recently installed Seabin
    - Remove a previously installed Seabin's mesh catch bag
    - Install a new mesh catch bag into the Seabin
    - Reconnect a new power connector to recently installed Seabin
- Remediation: Removing plastic pollution from top to bottom
    - Remove floating plastic debris from the surface
    - Remove a ghost net from midwater
    - Remove plastic debris from the bottom of the Mariana Trench

NAVIGATOR / SCOUT

- Seabin – "Cleaning up our ocean one marina at a time"
    - Disconnect the power connector on the Seabin
    - Remove a previously installed Seabin's mesh catch bag
    - Install a new mesh catch bag into the Seabin
    - Reconnect the power connector to Seabin
- Remediation: Removing plastic pollution from top to bottom
    - Remove floating plastic debris from the surface
    - Remove a ghost net from midwater
    - Remove plastic debris from the bottom of the Mariana Trench

TASK #2: THE CATASTROPHIC IMPACT OF CLIMATE CHANGE ON CORAL REEFS

EXPLORER

- Autonomously fly a transect line over a coral reef
    - Autonomously or manually map points of interest on the reef
- Use image recognition to determine the health of a coral colony by comparing its current condition to past data
- Propagate corals onto the reef
    - Remove coral fragments from the nursery structure
    - Outplant coral fragments to designated locations on the reef
- Cull an outbreak of Crown of Thorn sea stars
- Collect samples of sponge species for pharmaceutical research

RANGER

- Autonomously or manually fly a transect line over a coral reef
    - Map points of interest on the reef
- Use image recognition or manually determine the health of a coral colony by comparing its current condition to past data
- Propagate corals onto the reef
    - Remove coral fragments from the nursery structure
    - Outplant coral fragments to designated locations on the reef
- Cull an outbreak of Crown of Thorn sea stars
- Collect samples of sponge species for pharmaceutical research

NAVIGATOR

- Fly a transect line over a coral reef
    - Map points of interest on the reef
- Determine the health of a coral colony by comparing its current condition to past data
- Propagate corals onto the reef
    - Remove coral fragments from the nursery structure
    - Outplant coral fragments to a designated location on the reef
- Cull an outbreak of Crown of Thorn sea stars
- Collect samples of sponge species for pharmaceutical research

SCOUT

- Fly a transect line over a coral reef
- Propagate corals onto the reef
    - Remove coral fragments from the nursery structure
    - Outplant coral fragments to a designated location on the reef
- Cull an outbreak of Crown of Thorn sea stars

- Collect samples of sponge species for pharmaceutical research

TASK #3: MAINTAINING HEALTHY WATERWAYS PART II: DELAWARE RIVER AND BAY

EXPLORER

- Retrieve a sediment sample from inside a drain pipe to analyze for contaminants
    - Deploy a device* into the pipe to collect a sediment sample
    - Return the sample to the surface
    - Determine the type of contaminant(s) present in the sediment sample
- Estimate the number of mussels in a mussel bed
    - Deploy a quadrat
    - Count the number of mussels in the quadrat
    - Estimate the number of mussels in the bed
    - Estimate the total amount of water filtered by the mussel bed
- Eel restoration
    - Remove a trap full of eels from a designated area
    - Place an empty eel trap in a designated area
- Autonomously or manually create a photomosaic of a subway car submerged to create an artificial reef

RANGER

- Retrieve a sediment sample from inside a drain pipe to analyze for contaminants
    - Deploy a device* into the pipe to collect a sediment sample
    - Return the sample to the surface
    - Determine the type of contaminant(s) present in the sediment sample
- Estimate the number of mussels in a mussel bed
    - Deploy a quadrat
    - Count the number of mussels in the quadrat
    - Estimate the number of mussels in the bed
    - Estimate the total amount of water filtered by the mussel bed
- Eel restoration
    - Remove a trap full of eels from a designated area
    - Place an empty eel trap in a designated area
- Create a photomosaic of subway car submerged to create an artificial reef

NAVIGATOR

- Retrieve a sediment sample from inside a drain pipe to analyze for contaminants
    - Return the sediment sample to the surface
    - Determine the type of contaminant(s) present in the sediment sample
- Estimate the number of mussels in a mussel bed
    - Deploy a quadrat

    - Count the number of mussels in the quadrat
    - Estimate the number of mussels in the bed
    - Estimate the total amount of water filtered by the mussel bed
- Eel restoration
    - Remove a trap full of eels from a designated area
    - Place an empty eel trap in a designated area

SCOUT

- Retrieve a sediment sample from inside a drain pipe to analyze for contaminants
    - Return the sediment sample to the surface
    - Determine the type of contaminant(s) present in the sediment sample
- Estimate the number of mussels in a mussel bed
    - Retrieve a sample of mussels
    - Estimate the number of mussels in the bed
    - Estimate the total amount of water filtered by the mussel bed
- Eel restoration
    - Remove a trap full of eels from a designated area
    - Place an empty eel trap in a designated 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 company 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 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 company 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: 2.5 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

In light of some of the environments in which the ROVs will be operating, an ROV size and weight requirement has been included 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 (including the EXPLORER or RANGER device used to retrieve the sediment sample from inside the drain pipe, 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 and RANGER non-ROV device to power the Seabin if removable from the ROV
- Quadrat for estimating the number of mussels

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**	**< 20 kg**	**+10 points**
64.1 to 75 cm diameter	**+5 points**	**20.01 kg to 28 kg**	**+5 points**
75.1 to 92 cm diameter	**+0 points**	**28.01 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**	**< 15 kg**	**+10 points**
60.1 cm to 75 cm	**+5 points**	**15.01 kg to 20 kg**	**+5 points**
75.1 cm to 85 cm	**+0 points**	**20.01 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 30, 2019; teams have from that date until the regional events in the spring of 2020 to construct their vehicles and prepare the engineering and communication components (technical documentation, engineering presentations, and marketing displays). Visit www.materovcompetitionorg or request membership on the MATE competition listserv to ensure a timely delivery.