ABSTRACT

Established in 2023, General Engineering And ROV Specialists (GEARS) team currently consists of fourteen members with skills in engineering, problem solving, and creativity. GEARS was tasked with designing and constructing an ROV (Remotely Operated Vehicle) versatile enough to fulfill tasks related to oceanic and environmental challenges faced by researchers worldwide. Designed to address all challenges outlined by MATE efficiently, our newest robot, the Vaquita 4.0, is equipped with several key features to ensure its success. These features include six powerful Blue Robotics thrusters allowing smooth mobility and amplified speed, a specialized claw with enhanced dexterity, and a high-definition camera providing increased visibility. Having designed a robot to efficiently complete the tasks proposed by MATE, our team also strives to create robots capable of aiding in real-world challenges such as monitoring climate change and protecting ecosystems.

GEARS

General Engineering And ROV Specialists

Eastwood Schools | Montgomery, AL USA

Col. 3:23 – “Whatever you do, work heartily, as for the Lord and not for men.”

COMPANY INFO

2026 GEARS Team. Photo by Mr. Lee Sumner.

Name	Role(s)	Grade
Paul Flomer II	CEO	12
Grady Smith	CTO/ Driver	9
*Sean Holmes	COO	11
Richard Smith	CSO	8
*Connor Barger	Float lead	9
Sam Morris	Float Operator	9
*Ethan Ryczek	Tether Operator	10
Joshua Chung	Technician	10
*Riko Davis	Technician	7
*Noah Jeong	Technician	6
*Zachary Beasley	Technician	8
*Preston Ryczek	Programmer	9
*Luke Berreckman	Marketing Lead	11
*Evan Berreckman	Website Developer	8

** Indicates new members*

THEME

Inspired by the rugged North Atlantic, the 2026 MATE competition focuses on pushing performance within harsh environments and advancing discovery in under-ice ecosystems. Referencing the unique challenges of Newfoundland and Labrador, MATE aligns its mission tasks with the technical demands of cold-water research, showcasing how ROVs are essential for monitoring biodiversity and maintaining offshore infrastructure. MATE also emphasizes the role of cutting-edge technology in Environmental, Social, and Governance (ESG) initiatives, specifically regarding sustainable energy and polar exploration.

Mission Task #1: Seabed 2030

Highlighting Environmental Monitoring & Invasive Species Management

The rugged waters of the North Atlantic are home to diverse cold-water coral ecosystems and sensitive marine habitats. The preservation and documentation of these deep-sea sites is a primary goal for research institutions in Newfoundland and Labrador. To aid in this discovery, ROVs provide an effective way to remotely explore and catalog fragile coral colonies without disturbing the seabed. Environmental shifts and human activity necessitate constant observation to prevent habitat loss. Deploying advanced technologies like GO-BGC floats provides a solution, aiding researchers in collecting biogeochemical data and monitoring water quality in harsh, ice-prone regions. ROVs are essential for deploying and servicing these sophisticated sensors. Shifting from habitat monitoring to biodiversity threats, a major North Atlantic issue comes from the European Green Crab. These invasive predators compete with native Rock and Jonah crabs for resources and upset the ecological balance. Analyzing morphological traits and population density helps researchers track and manage both invasive and native species to protect the maritime economy.

European Green Crab

Mission Task #2: Smart Atlantic

Highlighting Offshore Infrastructure & Harsh Environment Research

Offshore energy platforms and subsea infrastructure in the North Atlantic provide a vital source of resources and regional industry. To combat the issue of extreme ocean energy and mechanical wear, robust inspection protocols are utilized to prolong the life of these structures and ensure operational safety. With the need to sustain these systems in turbulent waters, Ranger-class ROVs provide an efficient means of maintenance, easily navigating complex platforms to inspect components and monitor structural integrity. The implementation of these offshore structures comes the need to monitor the unique sea life surrounding them, particularly in deep-water zones. To provide an effective and non-invasive option, ROVs are utilized to safely identify and document species within cold-water habitats for scientific research. ROVs also aid in deploying specialized sensors on the sea floor to monitor environmental conditions and acoustic data during the operation of these high-latitude facilities.

Hibernia oil production platform

Iceberg (Newfoundland)

Mission Task #3: Wind-Powered Oil Platform

Highlighting Cryospheric Research & Ice-Avoidance Technology

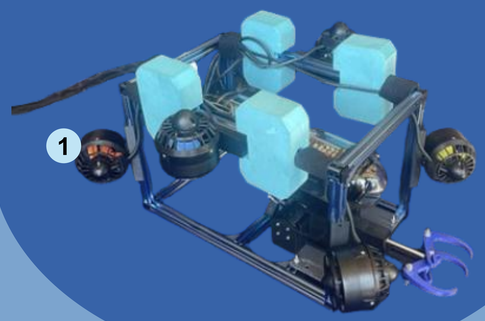
The Arctic and North Atlantic regions present extreme challenges for underwater exploration due to seasonal ice cover and freezing temperatures. To advance scientific research, Ranger teams must simulate under-ice operations where traditional surfacing is impossible. This mission requires precise navigation to deploy instrumentation beneath simulated ice sheets, ensuring that critical data collection continues in the world’s most remote environments. To protect expensive equipment from damage, ROVs are used to install and recover sensors that can detect hazardous ice conditions above. These tasks highlight the necessity of autonomous or semi-autonomous decision-making when communication with the surface is limited. By perfecting these maneuvers, Ranger companies demonstrate their ability to support global climate studies and ensure the safety of submerged assets in the cryosphere. This mission underscores the importance of technological resilience when operating in the "harsh environments" that define the 2026 competition theme.

European Green Crab: https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/europeangreencrab-crabevert-eng.html
Unlabeled coral photo: *Photo credit: Fisheries and Marine Institute of Memorial University* https://www.subcimaging.com/post/subsea-camera-rayfin-rare-coral-habitat-discovery
Iceberg (Newfoundland): https://www.newfoundlandlabrador.com/trip-ideas/travel-stories/famous-icebergs-of-newfoundland-and-labrador
Hibernia oil production platform: https://www.hibernia.ca/

DESIGN RATIONALE

This year, the GEARS robotics team has redesigned our ROV, the Vaquita 4.0, for the Ranger-class MATE ROV Competition. Aluminum beams and 3D printed connectors make up the main structure of the ROV because they are sturdy and relatively light. These materials create a robust rectangular frame to which all components of the vehicle are mounted.

Photo by Luke Berreckman

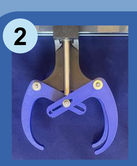


1 Movement

The Vaquita 4.0 utilizes six Blue Robotics thrusters to facilitate its movement. These powerful, water-resistant thrusters can generate up to 24.5 newtons of force. Two are positioned vertically on the top of the vehicle’s frame, allowing it to ascend and descend smoothly. The remaining four thrusters are located on the corners of the vehicle and provide horizontal movement. Their 45° angled placement allows the vehicle to swivel in place or move in any horizontal direction without needing to rotate. These six thrusters give the Vaquita 4.0 enhanced maneuverability and speed, especially when observing icebergs or investigating invasive species.

2 Claw

The Vaquita 4.0’s claw system was designed in SolidWorks and 3D printed in separate pieces, which were then assembled to allow for maximum flexibility in both design and application. The claw consists of two major sections: the gearbox and the gripper. The gripper includes two pieces that securely hold a 4-inch pulse linear actuator, which operates a pin that opens and closes the claw’s three talons. A circular extruded section of the gripper allows it to rotate smoothly within the gearbox. The gearbox includes a motor mount for a Blue Robotics M200 motor, which enables wrist movement. The motor rotates a worm gear that interlocks with a spur gear attached to the gripper base. This unique claw design provides enhanced dexterity, allowing the ROV to carefully perform maintenance on offshore platforms.

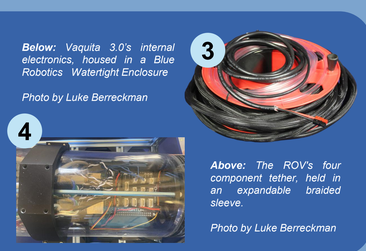


***Above:** A closeup of the ROV’s 3D printed claw, specifically the gripper component.*

Photo by Luke Berreckman.

***Below:** Vaquita 3.0’s internal electronics, housed in a Blue Robotics Watertight Enclosure*

Photo by Luke Berreckman



***Above:** The ROV’s four component tether, held in an expandable braided sleeve.*

Photo by Luke Berreckman

3 Tether

The ROV’s tether consists of four components: one 10-gauge 2-wire cable, an Ethernet cable, a PVC 1/4" OD tube, and a PVC 1/4" ID x 3/8" OD tube. The 10-gauge cable transmits 12 volts of power to the ROV and minimizes voltage drops. The Ethernet cable sends and receives data between the ROV and the control system. The two PVC tubes allow the tether to achieve neutral buoyancy which reduces drag.

4 Internal

The Vaquita 4.0’s control center is housed in a Blue Robotics Watertight Enclosure, which protects the electronics from water damage while allowing easy access. A 180° rotating camera is located inside a glass dome to provide high-definition video. All these components—including the camera and leak sensors—are run by a Blue Robotics Navigator Flight Controller.

Safety

At GEARS, safety is always a priority when designing products. A vent was added to the Watertight Enclosure to allow for pressure testing and safe release. Each thruster is equipped with a newly designed 3D-printed protective shroud to prevent entanglement with debris or personnel. Finally, an expandable braided cable sleeve secures the wires, tubes, and Ethernet cable together, reducing the risk of the tether snagging on shipwrecks or harming wildlife.

Mission Task #4: MATE Floats

Highlighting Global Ocean Observing Systems

Separate from the primary ROV, teams must design a Non-ROV Device (NRD) inspired by the Global Ocean Biogeochemistry (GO-BGC) array. This float must demonstrate "ice-avoidance" capabilities by using sensors to assess water chemistry and temperature as it ascends. If the float's algorithm detects simulated ice, it must autonomously reverse course and descend to a safe depth rather than surfacing. This task challenges Ranger teams to integrate complex sensors and automated logic into a secondary vehicle, simulating real-world efforts to map the chemical and biological health of the entire ocean. These floats are critical for long-term data collection in polar regions where human presence is restricted by environmental extremes.

ACKNOWLEDGEMENTS

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MATE ROV COMPETITION Northern Gulf Coast
NEXT LEVEL Bootcamp

COMPANY EVALUATION

Teamwork/Collaboration

Being involved in the MATE underwater robotics competition has taught our team how important teamwork and collaboration are. At GEARS, we try to ensure that all members feel included and heard. We’ve learned that the best way to figure out if an idea works is to simply try it. Everyone has something to bring to the table, and when we listen to each other, we produce better solutions. When the team is on the same page, everything runs smoother. Especially this year, with so many new members to teach and integrate into the team, it’s been highly important to ensure a balance of experienced members and new members to ensure learning while keeping everyone safe and efficient. We’ve seen that working together gets much more done than trying to figure it out alone. It also allows the whole experience to be more enjoyable and keeps us motivated. As a team, we’re proud of what we’ve accomplished so far, and we know that staying connected and working as a team helps us keep moving forward.

Creativity

GEARS utilizes creative methods to solve problems and achieve our goals. Because our budget was not high enough to buy a commercial underwater claw, we decided to update the design and build a new claw. This allowed us to specialize the claw to perform the requirements for this year’s competition. Specifically, the claw must rotate for grabbing objects at different angles. Most of the claw's components were designed in SolidWorks and 3D printed, allowing flexibility in design, simple assembly, and convenient modification of individual parts. However, we also incorporated metal gears which can handle strain that would break 3D printed pieces. The design of the claw is split into two main sections: the gear box and gripper. Secured inside the gripper is a linear actuator that operates the gripper’s talons. The gripper fits into a circular hole in the gear box, allowing it to rotate. Utilizing a metal worm gear and spur gear, a motor mounted inside the gear box rotates the gripper like a wrist. This unique claw design is cost effective and allows for greater flexibility and efficiency. We also worked to integrate the new aluminum frame this year, forcing us to design and print new connectors for the beams.

Communication

GEARS recognizes communication is essential for completing tasks and meeting deadlines. To easily track assignments and breakdown tasks, our team utilizes Basecamp, a web-based tool for project management. Through Basecamp, members stay connected with company-wide announcements and direct messaging. Additionally, our task schedule is hosted on Basecamp, allowing members to quickly check their assignments and deadlines to stay on track. Conveying timely information effectively is crucial to understanding one another and progressing towards our shared goal.