Abstract

Established in 2023, the GEARS team consists of six members with skills in engineering, problem solving, and creativity. Tasked with designing and constructing a versatile ROV capable of fulfilling oceanic and environmental challenges faced across the globe, our newest robot, the Vaquita 2.0, was meticulously developed and refined by our team. Vaquita 2.0 is equipped with: six powerful Blue Robotics thrusters allowing smooth mobility and enhanced speed; a specialized manipulator with 3D-printed “fingertips” for strong grip on objects of any size; and a high-definition camera for increased visibility. While our robot is designed to efficiently complete the tasks proposed by MATE, GEARS also strives to create robots capable of aiding in real-world challenges such as monitoring climate change and protecting ecosystems.

Theme

Inspired by the United Nations Decade of Ocean Science for Sustainable Development, the 2024 MATE competition focuses on the UN’s “10 Challenges for Collective Impact.” Centering on three key challenges from the original ten, MATE showcases how ROVs can help in furthering ocean research and protecting the environment. MATE also raises awareness of Environmental, Social and Governance (ESG) issues, such as ecosystem restoration efforts in Task #3 and climate change mitigation in Task #4.

Task 1

UN Challenge #7: Expand the Global Ocean Observing System

Ocean arrays provide essential information to better our understanding of ocean science. To ensure retrieval of data, ROVs are well equipped to undertake the task of deploying recovery floats and navigating problems that could arise during recovery.

The “Hercules” ROV, posted by Nautilus Live. Photo by Todd Viola.

Task 2

UN Challenge #7: Expand the Global Ocean Observing System

When deployed alongside new undersea cables, Science Monitoring And Reliable Telecommunications (SMART) cables provide a revolutionary system for data collection and ocean observation. These cables supply researchers with access to critical knowledge about the ocean environment and potential ocean-based threats. With versatile design and precision, ROVs could aid SMART cables in their deployments across the globe.

Task 3

UN Challenge #2: Protect and Restore Ecosystems and Biodiversity

To promote and ensure healthy ecosystems, ROVs can administer probiotics to diseased coral through syringes, sprinklers and irrigation systems. ROVs can also contribute to the reintroduction efforts of Lake Sturgeon, a once abundant species in the Tennessee River now endangered from habitat loss.

An Argo float in deployment, posted by Euro Argo. Photo by Oliver Dugornay.

Task 4

UN Challenge #5: Unlock Ocean-Based Solutions to Climate Change

Floats can collect crucial data for understanding our oceans and for predicting the effects of climate change. Efforts such as the GO-BGC Array project utilize float technology to gain insight into the chemistry and biology of the ocean, as well as to monitor climate activity. Data collected from these floats is essential for further research and to improve our planet.

Sources

“10 Challenges” *Ocean Decade*, https://oceandecade.org/challenges/

“About Us” *GO-BGC,* https://www.go-bgc.org/about-us

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“SMART Cables” *SMART Cables*, https://www.smartcables.org/smart

“What Is ESG?” *ESG.Org,* https://www.esg.org/what-is-esg

GEARS

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

Photo by Rachel Smith

Design Rationale

1. Movement

The Vaquita 2.0 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 perpendicular to the top of the vehicle’s frame, allowing it to ascend and descend smoothly. The remaining four thrusters are located on the four corners of the vehicle and provide horizontal movement. The 45° rotational position of these thrusters allows the vehicle to swivel in place or accelerate in any horizontal direction without rotating. These six thrusters provide the Vaquita 2.0 with enhanced maneuverability and speed, which are necessary for both the competition and commercial applications.

2. Manipulator

Utilizing a custom designed 3D-printed gripper, the Vaquita 2.0’s manipulator can grasp any sized object. To accomplish this, the manipulator uses two “fingers” that open and close by use of a linkage. The base of both “fingers” is connected by gears that ensure opposite rotation. Specially designed 3D-printed “fingertips” were fitted onto the manipulator to enhance its gripping ability. A brushless Blue Robotics motor is used to actuate the manipulator, operating safely when submerged underwater. This specialized manipulator allows the ROV to easily accomplish all MATE tasks.

3. Tether

The ROV’s tether consists of four components: one 10-gauge 2-wire cable; an ethernet cable; a PVC 1/4"OD tubing; and a PVC 1/4"ID X 3/8"OD tubing. The 10-gauge 2-wire cable transmits 12-volt power to the ROV and prevents voltage drops from occurring. The ethernet cable sends signals to and receives data from the ROV. The two PVC tubes allow the tether to achieve neutral buoyancy, which reduces drag. The tubes also allow for future hydraulic applications.

4. Internal

The Vaquita 2.0’s control center is contained inside a Blue Robotics Watertight Enclosure, which protects the electronics from water damage and allows easy access to all electrical components. These components, including the camera and leak sensors, are run by a Blue Robotics Navigator Flight Controller. Positioned inside a glass dome is a 180° rotating camera that provides high-definition video.

Safety

GEARS highly prioritizes safety when designing products. A vent is installed onto the Blue Robotics Watertight Enclosure to allow for pressure testing and release. In addition, every thruster is fitted with a 3D-printed protective shroud. This prevents debris and personnel from becoming entangled with the thrusters. This would be disastrous for deep sea ROVs, posing the risk of becoming disabled kilometers under the sea. Finally, an expandable braided cable sleeve holds the wires, tubes, and ethernet cable together, reducing the risk of the tether snagging on field pieces.

Left: *The ROV’s four component tether, held in an expandable braided sleeve. The power cable, shown on top of the red tether holder, provides adequate current for the 12-volt power supplied to the ROV.* ***Right:*** *The Vaquita 2.0’s internal electronics. These components, including leak sensors and high-definition camera, are housed in a Blue Robotics watertight enclosure. Photos by Rachel Smith.*

Acknowledgments

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AFCEA Montgomery Chapter

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eXp Realty Team Evans

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Dogwood Forge

MATE ROV Competition Northern Gulf Coast

Cornerstone Celebrating 25 Years

StudioJASmith Architecture

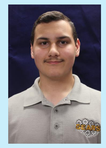
Basecamp

HeartWise A wholehearted approach to living.™

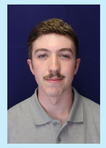
Schmidt Ocean Coalition

Dauphin Island Sea Lab Alabama Center for Marine Education and Research

Company Information



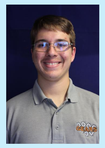
Caleb Anglin
10th | Chief Executive Officer / Float Operator



Nickolas Schmidt
12th | President / Project Manager

Jacob Shaffer
12th | Chief Technology Officer / Pilot

Rachel Smith
11th | Marketing / Data Analyst



Jonathan Pace
11th | Tether Operator / 3D Designer

Grady Smith
7th | Programmer / CAD Designer

Photos Courtesy of Lee Sumner

Company Evaluation

Teamwork/Collaboration

Through our experience in MATE and BEST Robotics, GEARS has learned the importance of teamwork and the significance of listening to all members’ ideas. Testing an idea is the best way to determine its efficiency. As a company, GEARS is committed to fostering an environment that respects and values our members’ opinions. By working together, we create more effective solutions than anyone could accomplish alone. The GEARS team understands that involving others encourages creativity and out-of-the-box thinking, leading to innovative ideas. It also provides a sense of support, creating a more enjoyable, motivating work environment. This competition has shown us the importance of maintaining communication to succeed together as a unified team.

Obstacles

During the design and implementation of the Vaquita 2.0, several unexpected factors frustrated the development process: key team members were unavailable for pivotal meetings; integration of an onboard flight controller took significantly longer than expected; and the unanticipated high-power demands of the Blue Robotics thrusters necessitated the design of a new tether. Together all three issues left the company with much less time than originally scheduled for constructing, testing, marketing, and documenting the ROV. These challenges were addressed by splitting company personnel into teams of two with each team responsible for one of these critical tasks. Each team had one employee as the lead for the work. Substantial responsibility was placed on each employee, but each task was then addressed by two team members working together instead of overloading one employee who had been burdened with overseeing, producing, and approving these critical items. This change facilitated cooperation and reliance between employees, broadened members’ knowledge across tasks, reduced wait times, and increased the speed for completing assignments.

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 are able to stay connected with company-wide announcements and direct messaging. Conveying timely information effectively is crucial to understanding one another and progressing towards our shared goal.