

**UNDERWATER ROBOTS:
A MODEL FOR INTERDISCIPLINARY ENGAGED LEARNING AT ELON**

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ABSTRACT

Designing and building a Remotely Operated Vehicle (ROV) to complete tasks modeled after real-world practical applications is a rich educational experience that is inherently consistent with the engaged learning model practiced at Elon. This project proposes to create a Winter Term course that centers on ROV building while teaching fundamental principles of math, science, and engineering. It further proposes to extend this experience to high schools, community colleges, and other four-year institutions in our area by hosting a workshop to teach other educators how to build ROVs so they may incorporate it in the curriculum at their home schools, and ultimately host a regional student ROV competition.

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BACKGROUND

According to the Marine Technology Society and the National Research Council, Remotely Operated Vehicles (ROVs) are robots that perform work underwater while the vehicle's operator remains in a comfortable environment. They are currently being used in a number of areas ranging from the petroleum industry as the workhorses of fuel exploration, pipeline building, and pipeline repair, to the telecommunications industry as the means of laying the fiber optic cable that make global communication possible, to fundamental scientific research for understanding underwater environments [1].

It is estimated that twenty percent of our nation's economy is based on ocean activities and that one in six jobs is ocean-related [2]. More recent data indicate that these numbers are growing as our nation's dependence on the ocean environment for energy, food, telecommunications, transportation, and exploration continually increases [3]. The commercial ROV industry mirrors the growth; for example, the Chairman and CEO of the industry leader, Oceaneering International, Inc., orchestrated an impressive seventy-five percent increase in its distribution of work class ROV systems from 2003 to 2004 to strategically place them in a position to provide the hardware, engineering expertise, and product development to remain competitive [4].

Despite the growing numbers, there is an apparent disconnect between industry and education because the current availability of programs geared toward educating and training individuals for the wealth of career opportunities is noticeably insufficient [5, 6]. To address this problem, the National Science Foundation supports the Marine Advanced Technology Education (MATE) Center, which is a national partnership of community colleges, high schools, universities, research institutions, marine industries, professional societies, and working professionals. Its mission is to improve marine technical education, and in this way help to prepare the nation's future workforce for ocean-related occupations.

PROJECT GOALS

This national center relies on regional partnerships to achieve its mission. Elon University is appropriately poised to establish a connection between central North Carolina and the MATE Center because two of its faculty members have successfully completed the MATE Center ROV Summer Institute for Faculty and there is currently only one other North Carolina institution, Cape Fear Community College, Wilmington, NC, partnering with the MATE Center. MATE partnerships have generated curricula designed to impart skills which employers find attractive, have led to the development of regional technical institutes for faculty and students, and have spawned regional student competitions [7]. The goals of this project align well with both the model of engaged learning practiced at Elon and the goals of the MATE Center; therefore, the overarching goal of this project is to establish a partnership. More specifically, the project goals are to create a new winter term course at Elon geared toward non-science majors, to organize a regional development institute, and to establish a regional student technical competition.

EVIDENCES AND IMPLICATIONS

The theme of the proposed course is the design and building of a ROV to complete tasks that simulate the work of current professionals in ocean-related fields. It is proposed to first offer this course during the 2008 Winter Term. The design and building of such a vehicle “involves a practical, working knowledge of math, physics, electronics, hydraulics, and engineering. It also requires budgeting, setting deadlines, documenting procedures and results, project management, communication, teamwork, critical thinking, continual problem solving, and producing deliverables on time—just like the real world” [8]. The course will also include culminating presentation and piloting experiences where students will explain the rationale behind their designs and launch their vehicle to test the effectiveness of their designs. All other class times would be filled with lectures, discussions, and smaller hands-on activities pertaining to the fundamental principles applied in vehicle design and use, such as buoyancy, basic electrical circuits, fluid mechanics, and project management.

Jones et al. [9] have developed eight indicators of engaged learning: vision, tasks, assessment, instructional models and strategies, learning context, grouping, teacher roles, and student roles.

Vision refers to students being energized about, taking responsibility for, and evaluating their own learning [9]. Students in the proposed course are likely to find building an underwater robot a unique, exciting experience that challenges many of them to think in ways that they never have before and accomplish tasks that they never dreamed possible. Students will begin the course with existing skill sets and knowledge, and it will be self-evident how effective they were in learning and applying the fundamental science and management concepts to achieve the assigned task when they pilot their vehicles.

Engaged learning tasks should be challenging, multidisciplinary, and reflect current and future workplaces [9]. Assigned tasks in the proposed course will mirror the MATE Center approach, which is to select themes that reflect recent accomplishments or problems faced in the ocean workplace. The tasks are inherently interdisciplinary and complex and using a team-based approach encourages peer collaboration.

Jones et. al note that assessment should be performance-based, where students examine their own work to assess their own learning [9]. Assessment will include traditional tools such as homework, quizzes, and tests to gauge mastery of the fundamental underlying principles for ROV design and building; however, a more transformative assessment will come in the form of the culminating presentation where students justify their designs and give explanation for their successes and failures.

The instructional models and strategies indicator refers to the fact that instruction should be interactive, engaging, and generative [9]. ROV design and building is a hands-on, dynamic activity that results in a tangible product; therefore, it truly is a model for interdisciplinary engaged learning as the title of this proposal reads.

The remaining four indicators (learning context, grouping, teacher roles, and student roles) state that engaged learning is collaborative where the instructor serves as a “facilitator, guide, and learner” and students are “explorers” and “cognitive apprentices” [9]. Teaching and learning is expected to occur at all

levels and will be strongly encouraged in the proposed course. The teams will be the focal points of peer-learning as students work together to learn and apply knowledge and skills necessary to design and build a functional vehicle. As the instructor, I will be learning from their experiences in class and the unique perspectives the students, and use that knowledge to improve my teaching and strengthen my understanding of the connections between theory and practice. Individual students will be asked to maintain reflection journals throughout their experience to facilitate their self-engagement. Additionally, exceptional students will be encouraged to consider serving as teacher assistants in subsequent years.

The second and third goals of the proposed project reflect my desire to extend the ROV engaged learning approach beyond the Elon campus. Following completion of the initial ROV Winter Term course, I propose hosting a summer faculty development workshop at Elon to teach others how to build a ROV and use ROV technology, science, design and engineering to support their academic programs. Participants would further be encouraged to organize at least one student team to compete in a ROV competition. The final proposed goal is to organize a central North Carolina student ROV competition to be held at Elon. Elon is an ideal location for these events because it is in central North Carolina in close proximity to several other academic institutions, including high schools, community colleges, and four-year colleges and universities, all of which would be invited to participate at the appropriate level. Although not explicitly stated as a goal, a natural progression from the three proposed project goals is to share these experiences with the greater scientific community. The National Science Teachers Association Journal of College Science Teaching and the North Carolina Academy of Science Journal of the North Carolina Academy of Science would be appropriate choices for submitting manuscripts. The professional meetings sponsored by the aforementioned organizations would be ideal places to present my work.

PROPOSED TIMELINE AND BUDGET

The proposed project is expected to result in a deliverable each academic year. The anticipated timeline is as follows:

Date	Proposed Project Deliverable
Winter Term 2008	ROV Course for Non-Science Majors
Summer 2008	Faculty Development Workshop
Winter Term 2009	ROV Course for Non-Science Majors
Spring 2009	Central NC Student ROV Competition

Fall 2007, Spring 2008, and Fall 2008 would be critical planning and preparation times for the proposed events. Planning would include purchasing the required materials, which are estimated to be about \$200 per ROV, complete with a video camera, control system, and power supply. Five teams of four seem to be a reasonable number of students to manage in a course of this nature with the assistance of a teacher assistant. Lastly, supplies for the proposed faculty workshop, student competition, and conference travel should also be included to give an approximate budget over the two year period as follows:

Budgeted Item	Approximate Cost
ROV Materials (10)	\$2000
Teacher Assistant	\$800
Workshop and Competition Supplies	\$200
Conference Travel	\$1000

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