

**BYLAWS**  
**Graduate Faculty of the Interdisciplinary Ph.D.**  
**in**  
**Ocean Engineering and Marine Technology**

**Article I: Description**

The Graduate Faculty of the Interdisciplinary Ph.D. in Ocean Engineering and Marine Technology of the University of Maine, hereafter referred to as the Ocean Engineering Graduate Faculty, is an interdisciplinary faculty comprised on members from various departments within the university with the expressed purpose of applying engineering resources to the problems and research challenges associated with marine science research at the University of Maine.

**Article II: Purpose and Intent**

The objective of the Ocean Engineering and Marine Technology Interdisciplinary Group of the Graduate Faculty is to foster the application of engineering to the grand challenges faced in marine science research. The interdisciplinary faculty research group will be focussed on the provision of technology and engineering to facilitate the biological sciences as they apply to the oceans and the coastal ecosystems. Primary focus will be on Ph.D. level research in either departments in college of engineering or the school of marine sciences under the existing Interdisciplinary Doctor of Philosophy program. Additional purposes of the group will be to facilitate the use of resources with the College of Natural Sciences and the College of Engineering to provide critical mass for funding opportunities that would not be possible to pursue without a joint program. Periodic assemblies and seminars will also be organized to facilitate the communication between research groups within the university and with external organizations with an interest in the application of engineering to the exploration of marine systems. Use will be made of the support provided by existing MS level degree programs in the College of Natural Sciences and the College of Engineering.

**Article III: Membership**

The group will have a core and participating faculty. Core faculty will have responsibility for primary aspects of the academic preparation of the students, i.e., advising, coordinating courses between colleges, recruiting and planning. The core group at any one time will be made up of the faculty committees of the I.Ph.D. students who are in the program. It is up to the discretion of the external members to serve or not to serve in the core faculty group. If no I.Ph.D. candidates are currently in the program; the core committee will be comprised of the graduate committee of the most recent graduate. Additional faculty will be added to the core faculty group based on a nomination from their department. The nominated person must meet all of the requirements of the graduate school for membership on a committee of an I.Ph.D. student. Any other faculty will be listed as participating in the group based on an expressed interest in the activities of the group. Participating members are not required to meet the requirements set by the graduate school for participation on an I.Ph.D. committee.

**Article IV: Coordinator and Committee**

Group coordinator:

Core faculty within the program area will elect a program coordinator who will serve a three-year term. The program coordinator's responsibilities include:

- a. Administering the group's graduate course work (e.g., ensuring students meet requirements, coordinating paperwork with the graduate school, admissions, communication of efforts between advisors and other faculty).
- b. Organizing meetings of the program faculty. Meetings should be held at least once a semester.
- c. Represent the program on the Policy Advisory Committee of the School.

#### Committee of the Core Faculty:

The Committee of the Core Faculty (CofCF) will consist of the core faculty, who will elect a group coordinator. The coordinator will call meetings of the CofCF. The coordination committee will have the following responsibilities:

- a) Coordinate the graduate curriculum that is required of students from either a biological sciences or an engineering background who are admitted into the program
- b) Determine the acceptability of applications for admission to the graduate study
- c) Develop and maintain the process for admission to candidacy and other examinations required for the I.Ph.D. degree.

#### **Article V: Admissions**

The graduate admissions committee will consist of the entire core faculty who will advise the coordinator on admission and reviews standards for admission to the program. In particular, recommended course work to resolve the expected differences in student preparation will be made by faculty who are most familiar with the area of deficiency of the student. Applications found admissible by the committee will be forwarded to prospective advisors for further consideration.

#### **Article VI: I.Ph.D. Committee**

The committee for a Ph.D. degree must include a graduate thesis advisor, at least one other University of Maine faculty member, and a University of Maine member of the graduate faculty from outside the department of the advisor and an external reader who will be appointed to the graduate faculty. All of the faculty should have expertise related to the area of the thesis. The external reader must have sufficient credentials to be appointed to the graduate faculty and needs to be a recognized expert the area of the thesis. Generally the external reader will be a researcher in a laboratory, an independent research organization, a foreign researcher or a distinguished faculty member at another academic institution. The acceptability of the external reader will be based on publications, rank and recognition in professional societies (i.e. society fellow or equivalent) and the professional position held by the reader.

#### **Article VII: Voting and Amendments**

Each member of the core faculty will have one vote. A quorum of 33% of the core faculty will be required to hold a meeting of the group. A quorum of 50% will be required for a valid vote on any item at a group meeting. Voting can either be held at a meeting or through an e-mail or other means if required obtaining a quorum.

Amendments to the by-laws shall be submitted to the core members of the group at least 48 hours prior to a meeting. Comments are then open prior to the meeting. Approval of at least two-thirds of the faculty is required to adopt amendments.

# **Proposed Interdisciplinary Group Title: Ocean Engineering and Marine Technology**

**M. L. Peterson <sup>1</sup>**

**J. Riley <sup>2</sup>**

**Mission: Advance the development of tools and procedures required to explore, study and further the responsible and sustainable use of the oceans**

## **Program Objectives**

### **Program Rational**

The biological sciences continue to be the most important area of growth in activity for federal research and development funding<sup>3</sup>. At the same time, biological systems are emerging as an alternative model for engineering systems. Thus, a key area of growth for both engineering and the biological sciences exists in the gap that separates these disciplines. However, for the University of Maine, as one of the smaller comprehensive research universities, it is not possible to compete in every field of research. Biological sciences are difficult for the university in the absence of a medical or veterinary medicine program. Thus, a traditional biomedical engineering program is difficult to develop. As for any organization, the general focus areas should be clearly identified niches for which the State and the University have a clearly defined interest. "Niche markets" include areas in which the state and university clearly has either an interest or a strong existing research area. Fields such as paper, wood composites and marine sciences have not only strong existing research activity within the state but also have a clear economic and social importance within the state. Other areas such as geographic information systems and micro-sensors represent strong research areas within the university that are not necessarily uniquely associated with state industry. In this context, it is thus important to identify areas of potential leveraging of resources and fields in which the University of Maine can build areas of strategic focus while at the same time leveraging growth in federal funding.

Of the research units on campus that have shown strong growth, the School of Marine Sciences is the only research unit that is clearly tied to the biological sciences. Marine Sciences is important to the identity of Maine. Growth in opportunities and protection of worldwide resources may also become a dominant factor in the next century. However, many of the technical barrier issues in marine sciences, like medicine, are associated with the technology required to understand a complex environment. Large programs that are being developed for long term observation and monitoring of the coastal United States and world's oceans have more in common with an engineering research program than with traditional biological research. However, GoMOOS and other integrated sustained ocean observing systems have been created and sustained by oceanographers. Data integration activities from the GoMOOS buoys at the University of Maine have made use of the strong activity in the areas of mapping and remote sensing. This collaboration demonstrates the potential for using strengths in engineering research to support the School of Marine Sciences. Further potential on this project alone includes sensors, instrumentation and materials programs in electrical and

---

<sup>1</sup> Associate Professor, Mechanical Engineering

<sup>2</sup> Professor, School of Marine Sciences

<sup>3</sup> National Science Foundation, National Patterns of R&D Resources: 2000, <http://www.nsf.gov/sbe/srs/nprdr/start.htm>

mechanical engineering that are relevant to the marine science research. Areas of emerging importance in the School of Marine Science such as optical sensors, complement existing strengths in engineering of acoustic sensors that is done in both Electrical and Mechanical Engineering. Other emerging areas of research include the work with biomimetic locomotion in Mechanical Engineering and the existing program on autonomous control of AUV's in Computer Science. Like other programs, both of these areas exist in a boundary area between the School of Marine Science and Mechanical Engineering or Computer Science.

Thus current areas of great strategic importance in the marine sciences have a clear overlap between the School of Marine Sciences and various departments in the College of Engineering. The proposed program would focus on expanding collaboration and expanding research in those existing areas of overlap. Shared resources can be exploited to develop a program in Ocean Engineering and Marine Technology without requiring additional external resources. Instead the program would create an umbrella for the work that is emerging across campus that joins the College of Engineering with the School of Marine Sciences. Many of these activities clearly have a home in the existing departments because of their focus. However, other activities are so clearly interdisciplinary that a new program is required to help define the program. It is also likely that a new applicant pool of technically trained students could be created if a new program that allowed engineers to work in marine science research were defined.

The focus of the program would be distinct from many existing programs in as much as it would emphasize the development of tools and use of analytical methods from the engineering disciplines in order to enhance marine science research. The program would not attempt to develop activity in such traditional ocean engineering areas as coastal structures, naval architecture or marine engineering. The focus of the program will be on <sup>1</sup>:

- A multi-disciplinary ocean and marine program
- Engineering principals will be applied to areas of importance in marine biology and physical oceanography
- Advance the development of tools and procedures required to explore, study and further the responsible and sustainable use of the oceans
- Provide outreach for the campus and the state to create a broader understanding of the relevance of engineering to the marine sciences and the relevance of marine sciences to other technologies

The proposed effort will focus on the development of a joint MS/Ph.D. program between the School of Marine Sciences and the College of Engineering at the University of Maine. This program will be focussed on the development of tools and technologies that are traditionally within the realm of engineering which are needed to extend the current state of marine sciences research. Marine science research is broadly defined in this context as the development of fisheries and marine resources and the studies of ecology and biology of the marine environment. The tools and technologies that are of interest are not only the instruments required for the scientific research in these field, but also the analytical tools that are required for the interpretation of the data. Engineering associated with the planning and technology needed to minimize the impact of human activities on the marine ecological systems is a particular focus.

Future expansion of the efforts into traditional areas of Ocean Engineering will look closely at strategic alliances. In particular, some emerging collaboration with Memorial University in Newfoundland would provide opportunities to make use of the facilities at the CRC Institute for Marine Dynamics. This alliance would bring all of the traditional coastal and naval architecture skills into the effort. This alliance would enable the University of Maine to participate in one of the top two or three Ocean Engineering programs in the North America within five years. By maintaining the focus of our program on the sensors and tools for Marine Science Research, we would also complement the existing efforts in the United States and establish a unique niche. While several physical oceanography programs exist that are similar to the vision proposed, focussing the efforts on the engineering portion of the effort would clearly distinguish the program.

## Program Goals

The focus of this program would be on the development of a graduate program and research activity in the area of Ocean Engineering and Marine Technology. An undergraduate program is not anticipated in the

---

<sup>1</sup> Adapted from the mission of the Marine Technology Society <http://www.mtsociety.org>

immediate future, although extensive opportunities exist for work at the senior level and in the capstone experience for both the School of Marine Science and for the College of Engineering. Introduction of an undergraduate program in Ocean Engineering would create significant problems for the management of a clearly interdepartmental and intercollege program for a program that does not have a well-established demand.

What would very strongly distinguish the program from existing graduate programs in the college of engineering is that a degree in an engineering discipline will not necessarily be required for admission to the program. From the initial stages, the program will assume that a broad range of applicants will be attracted to the program, including but not limited to, the biological sciences, marine sciences, mechanical engineering, electrical engineering and physics. A course sequence will be developed which will allow a broad range of entrants to the program to finish the degree in a reasonable amount of time. At the same time it is critical to ensure that the required foundation has been provided that will allow the graduates to be treated as the engineer on a marine science research program.

### **Research Focus:**

Initial focus of the program will be on support of existing activities. The existing activities within the College of Engineering and School of Marine Sciences include:

- GoMOOS System
- Marine Sensor Development
- GIS and Large Data Integration
- Wave and flow tank studies
- Suction cup tag development for cetacean research
- College of the Atlantic and Allied Whale research activities
- Economic impact of marine resources

The most important research focus of the department would be aspects of the integrated sustained ocean observing system in which the University of Maine has existing technical strengths. In addition to the data integration and characterization that is ongoing with the Department of Spatial Sciences and Engineering, the network will provide a platform for the newest aquatic sensors. The sensors must be capable of measuring chemical substances and biological materials that are currently only measured in a laboratory environment using labor intensive techniques. With the combination of sensor development expertise at the University of Maine (e.g. LASST) and the expertise in deploying, testing and characterizing marine sensors (SMS and Engineering), sensor development is a natural direction for integrated research from engineering and aquatic sciences.

As a new program it is important that the university create a strong identity within the technical community. In a traditional technical field that identity is created both by graduating highly qualified students and by publishing research in the peer reviewed journals. The American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers and the Society for Naval Architecture and Marine Engineering all have journals that look at the interaction of these field with Marine Sciences. However all of these societies have an identity that excludes the interests of at least a portion of the constituency for the proposed effort. It is proposed that the initial focus of the program be on the conferences and journal of the Marine Technology Society and on engineering related marine science publications. Broader focus journals such as Oceanic Engineering International with the links to Memorial University may also be strategically important. This focus is intended to increase the visibility of the program and identify potential funding sources for future work. Most immediately important, there is no doubt that an integrated sustained ocean observing system will require skilled technical personal for operation and design. This is the direction of the new MSc program in Operational Oceanography at Rutgers University. The University of Maine would have the potential to serve this role very well with a focussed effort that combines the strengths of the College of Engineering and School of Marine Sciences.

## Program Content

One of the key elements that will distinguish the program from both traditional ocean engineering programs and many physical oceanography programs is the active recruitment of graduate students both from the biological sciences and from engineering. As such, a clearly defined sequence of courses is proposed that will allow students from either engineering or marine science to contribute to the interdisciplinary research in the program.

### Course work for Students with Engineering BS Degree

#### **Typical Engineering courses**

MEE644 Engineering Analysis  
MEE471 Vibrations  
MEE453 Experimental Mechanics  
ECE 533 Advanced Robotics  
ECE486 Digital Signal Processing  
SIE550 Engineering Databases and Information Systems

#### **Some Additional Engineering courses**

MEE388 Design II (EE BS only)  
MEE433 Solar-Thermal Energy  
CIE 549 Numerical Methods in Engineering  
ECE552 Wave Propagation  
ECE 466 Sensor Technology and Engineering  
MEE450 Composite Materials  
MEE500 Research Methods

#### **School of Marine Sciences course work**

SMS449 Engineering in Aquaculture  
SMS541 Physical Oceanography  
SMS322 Biology of Marine Vertebrates  
Semester-by-the Sea, SMS352, SMS480, SMS481

### Course work for Marine Sciences BS Degree

#### **Expected B.S. Background Courses**

MAT228 Calculus III  
MAT258 Introduction to Differential Equations with Linear Algebra  
PHY121, PHY122 Physics

#### **Typical Engineering Course Work**

MEE150 Statics  
MEE270 Dynamics (requires MEE150 + MAT 228)  
MEE230 Thermodynamics (requires MAT127)  
MEE251 Strength of Materials (requires MAT 127 + MEE150)  
MEE360 Fluid Mechanics (requires MEE230 + MEE270)  
ECE210 Electrical Networks (requires MAT127 + PHY 122)

#### **School of Marine Sciences course work**

SMS449 Engineering in Aquaculture  
SMS501 Biological Oceanography  
SMS541 Physical Oceanography

## **State Economic Impact**

Probably the greatest resources for the state of Maine are the seacoast and associated tourism, aquaculture and fisheries. It is felt in that this component of the state economy is most in need of economic development. The proposed program not only is intended to focus on the research and support of these industries, but also to encourage federal support of the basic research required to ensure the health of these resources. In addition to the paper and wood products industries, Maine is clearly associated with the marine resources of the state. The University of Maine should exploit this strength and identity to every degree possible. The tremendous growth of the School of Marine Sciences in number of faculty and research resources indicates the importance of the issues and the potential for growth for the institution. At the same time, Marine Sciences is the most logical niche for the university to move into the biological research which now makes up a majority of federal research dollars.

## **Resources Required**

A key element of this proposal is the lack of an immediate need for additional resources. The program is particularly well suited to EXISTING expertise in the university. Expansion of the program can utilize existing programs in such a way that the critical mass of involved faculty, and associated synergies are increased. The program can however assist in identifying strategic areas of opportunity for growth in both the School of Marine Sciences and the College of Engineering. Future growth in both areas can be directed to those opportunity areas in which the initial success in teaching and research can be expanded.

## **Competing and Alternative Programs**

Several overlapping and competing listings were used to determine what other programs exist in related areas. This was meant to provide insight into the related programs to form a basis for further investigation. While initial (and perhaps long-term) focus is not on an undergraduate degree, the listing of ABET accredited Ocean Engineering programs was used as an initial filter on possible competing efforts. The following nine universities are the only accredited Ocean Engineering Programs in the United States. The nine schools are:

1. Florida Atlantic University,
2. Florida Institute of Technology,
3. University of Florida,
4. University of Hawaii at Manoa,
5. Massachusetts Institute of Technology,
6. University of Rhode Island,
7. Texas A&M University,
8. United States Naval Academy,
9. Virginia Polytechnic Institute and State University.

A second source of programs that may or may not have a different focus comes from the listing of student sections for the Society for Naval Architecture and Marine Engineering (SNAME). These programs are somewhat more focussed on Naval Architecture. Exceptions exist however, and it is important to include these programs since a number of the departments have the potential to compete. For example, University of California/Berkeley, Department of Naval Architecture and Ocean Engineering, which specifically includes Ocean Engineering in the name of the Naval Architecture Department. Other programs such as Webb Institute and Maine Maritime Academy have a very different focus from the proposed program. One important aspect of the SNAME listing is that it shows universities in Canada that may also have complementary

programs. The Canadian Universities present excellent opportunities for teaming because of the University of Maine's location and type of program.

The relevance of these programs is primarily where the engineering program co-exists with a school of marine sciences or oceanography. The following are the SNAME student chapters organized by region, non-university affiliate chapters are excluded:

**Central Region**

Institut Maritime du Quebec  
University of Michigan  
University of New Orleans SNAME Chapter  
University of New Orleans, Ship and Offshore University Laboratory  
Florida Atlantic University  
Florida Institute of Technology  
Texas A&M University/College Station  
Texas A&M University/Galveston

**Northeast Region**

Memorial University of Newfoundland  
Maine Maritime Academy  
Massachusetts Institute of Technology, Department of Ocean Engineering  
MIT Course 13 Student Engineering Association  
Massachusetts Maritime Academy  
U.S. Coast Guard Academy  
U.S. Merchant Marine Academy  
Stevens Institute of Technology  
SUNY Maritime College - Fort Schuyler  
Webb Institute

**Pacific region**

University of Hawaii  
California Maritime Academy  
University of California/Berkeley,  
Department of Naval Architecture and Ocean Engineering  
University of British Columbia  
University of Washington

**Mid-Atlantic Region**

U.S. Naval Academy  
Virginia Polytechnic Institute

Some examples of oceanography departments that have activities with at least some of the faculty who have interests related to the proposed effort are,

- Massachusetts Institute of Technology, Woods Hole Oceanographic Institution
- University of Washington, School of Oceanography
- Rutgers University, Graduate Program in Oceanography is centered in the Institute of Marine and Coastal Sciences
- Rutgers University, MSc. in Operational Oceanography is the most direct competitor to the proposed program

However, these programs are all programs that would have the potential for collaboration. None of the universities, with the possible exception of Rutgers, offer a degree that directly competes with the proposed effort. Additional insight into the potential competitors and collaborators may be obtained from editorial board members for the targeted journals and committee leadership from the technical societies.