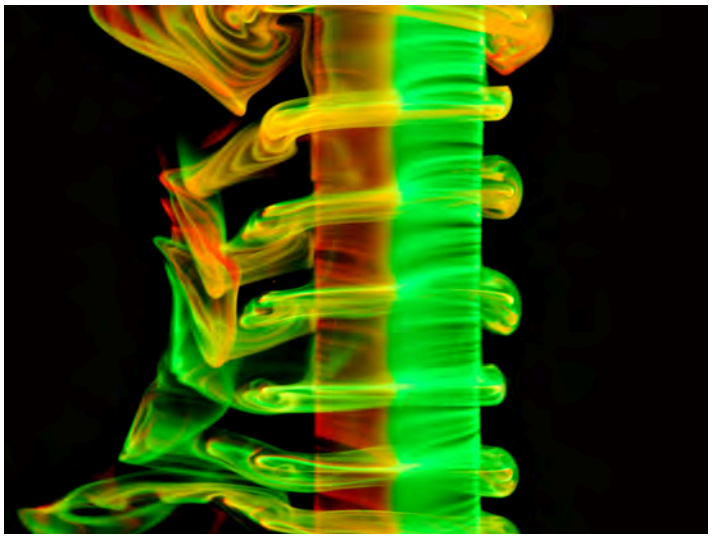
5 Department of Ocean and Resources Engineering

5.1 Overview



The Department of Ocean and Resources Engineering (ORE) offers graduate degrees within the rich and vibrant research environment of the School of Ocean and Earth Science and Technology (SOEST) and the University of Hawaii at Manoa (UH). The program options emphasize coastal, offshore, and resources engineering. The program is of modest size, currently with 21 MS and 12 PhD students and 8 faculty members. Extramural funding of about $2M per year (Figure I-1) helps support students participating in research and results in an average of 18 research publications and 259 citations per year. In the period 2007-2012 there were a total of 107 publications and 1557 citations. Thirty-five students graduated with jobs in industry, government, and academia. Of these students, 45 percent were international from 8 different countries.

Strengths

- Ocean Engineering is a strong and growing field with growing demand for graduates.
- The program received the highest possible level of ABET accreditation
- After-graduation placement of students is superb.
- Our advisory bodies are highly distinguished and very active and positive.
- Our program assessment procedures are active, successful, and fully vetted by ABET.

Weaknesses

- Program is small (8 faculty)
- Insufficient scholarship and/or assistantship support for students
- Minimal laboratory facilities

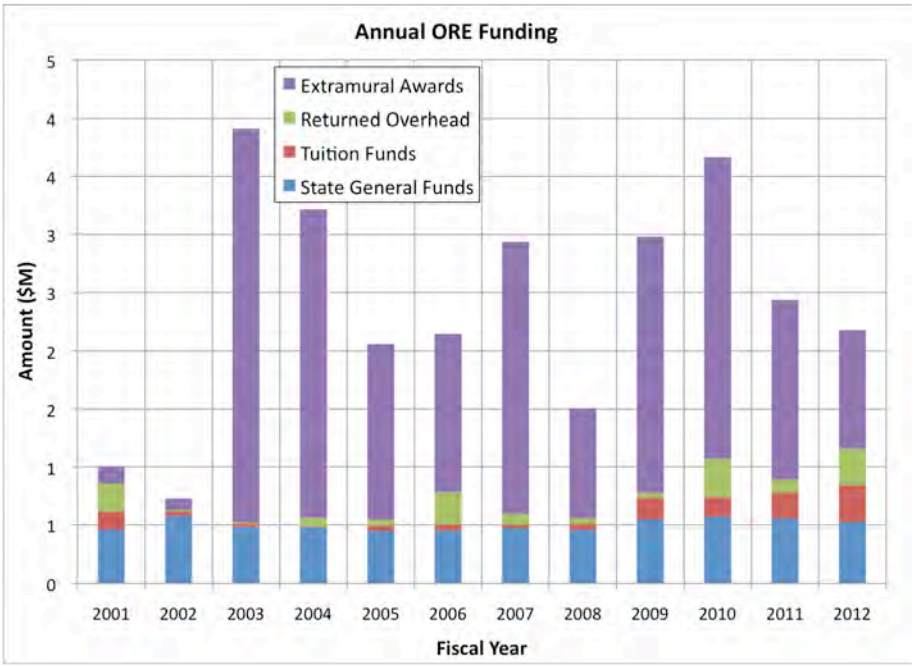
Opportunities

- Many local companies need engineering interns
- Offshore renewable energy is a growing area for research and development

Threats

- Declines in Federal spending make grants harder to get
- Training opportunities on offshore equipment (ships, observatories, ROVS) are becoming increasingly expensive and harder to come by.

The program began in 1966, founded by famed Coastal Engineer Dr. Charles Bretschneider. The Department was originally part of the College of Engineering. In 1987, the Department elected to join the newly formed School of Ocean and Earth Science and Technology (SOEST). The thought was that the Department would form the technology component of this school and grow under the increasing resources pumped into the newly formed school. This proved overly optimistic and the Department languished for some years. In the late 1990s the Department was further stressed by the closing of its major research facility, the J.K.K. Look Laboratory of Ocean Engineering, an aging off-campus facility. Beginning in 2002, under the leadership of Kwok Fai Cheung and a new vision of the Department in the SOEST Dean's office, a major turn around has been accomplished. At the MS level, ORE has been reviewed and accredited since 1977 by ABET (Accreditation Board for Engineering and Technology); over the last two ABET cycles. ORE has shown remarkable advancement. Fully accredited for 6 years in 2010, ORE received the highest rating of the five engineering programs on the UH campus. Since 2003, earlier gains have been consolidated with new faculty hires, significantly stronger support from the administration, additional space, many new grants, new marine facilities, an increased number of students, and much higher morale. New faculty have been hired (now 8 up from 4), new space has been made available, more student internships are available, the Kilo Nalu and the ALOHA Ocean Observatories have taken shape, a new computer cluster is available, a 25-foot boat has been obtained, a new arrangement has been undertaken with the Hawaii Undersea Research Laboratory (HURL) for the support of students and research and considerable research funding is available. The Department is growing comfortably, is optimistic and morale is high.



The Department is one of 4 academic departments in SOEST. The other three academic departments are Oceanography, Meteorology and Geology and Geophysics. The school also has 8 other research units. There is healthy interaction and research collaboration between the units. SOEST is the largest research entity at the University with an annual budget in excess of $100 million and 250 PhD level faculty. The Department also enjoys a close working relationship with the College of Engineering.

5.1.1 Mission

The ORE mission is to provide high quality education, research and service to its constituents. The major goals of ORE are to: educate top quality ocean and resource engineers to meet the needs of Hawaii, the nation and the engineering profession; to conduct and disseminate research in the field of Ocean and Resources Engineering; and to provide service to the State of Hawaii, Pacific Basin and engineering profession through such opportunities as seminars, conferences, consulting, work with government agencies and professional societies. The goals of ORE and its mission statement map directly onto the goals of SOEST and the University. ORE provides about half the needed ocean engineers in the State of Hawaii each year. ORE's engineering services and research are critical to technical manpower development needs in the State.

5.1.2 Vision

The Department has a bold vision for the future. Over the last five years the department has consolidated its faculty and reworked its course content. The vision is to streamline our offerings that have now been carefully integrated to form a whole and complete ocean engineering package. Much thought has been given to providing the best ocean engineering experience to students given the available resources of a small department. The optimization of this process is nearly at hand. One more person needs to be hired to fill a recent vacancy and then this should be accomplished. As the Department is closely linked to the international ocean engineering community through its faculty serving important positions in a number of international engineering organizations, we are very well linked into the latest engineering thinking. Program decisions are made by the faculty as a whole in consultation with the Dean and academic administration of SOEST to ensure that the Department is in close alignment with the school. Through the SOEST executive committee (EXCOM) there is an excellent flow of information from the School leadership to the Department and vice versa.

5.1.3 Diversity

The Department student body is now about 40 percent international students. These students are from a dozen countries with Asian countries predominating. The Department is highly competitive and selective in accepting its graduate students; the students are high caliber and motivated. The learning atmosphere is very good and there is great respect for a diversity of backgrounds. The faculty work very hard to encourage and perpetuate this environment.

5.1.4 Reputation

The department has a stellar national and international background. As a fully accredited ABET program with no deficiencies or weaknesses, it is in the top couple of U.S. Ocean Engineering programs (most programs are noted as having at least one weakness on the ABET ranking). Recently Zhejiang University, the third-ranked university in China, ranked ORE as the most desirable department in the US to start a joint program with. Needless to say, the Department is

well satisfied with its stellar ABET ranking and the international attention it has garnered. A major problem for ORE is, in fact, handling all of the foreign attention and requests.

5.1.5 Peer programs

Per ABET there are eight ocean engineering programs in the U.S. (Table I-1), as well as several other departments that have ocean engineering specialties. Of the programs listed, UH compares with Florida Atlantic and the University of Rhode Island that are both public institutions of comparable size. UH is stronger than these other programs in its coastal research and resources area. Our unique location and environment plays a major role in this emphasis and leads to the additional strength of many sea-going activities involving a multitude of undersea vehicles, observatories, and testing capability.

Table I-1 Ocean Engineering Programs in the U.S.

Florida Atlantic University*	US Naval Academy
Florida Institute of Technology	University of Hawaii
Massachusetts Institute of Technology	University of Rhode Island
Texas A&M (College Station and Galveston*)	Virginia Tech

**with undergraduate ocean engineering programs*

The general quality of the ORE program is at least as high as the peer institutions. One of the difficulties in making comparisons is that these institutions specialize in different things. Those in Texas specialize in offshore oil. We have a strong ocean resources focus. The program in Oregon is associated with a civil engineering department, the program at UC Berkley is associated with a mechanical engineering department, and there are other similar examples. Several of the programs allow undergraduate majors. Nonetheless, in terms of grants received, and faculty productivity the department is clearly performing at a high level.

5.2 Research and Faculty

5.2.1 Faculty Description

There are eight faculty members in the Ocean and Resources Engineering Department. This is up from four during the last ABET review and in this challenging economic time represents a major commitment by the School to the growing importance of the Department. Of these eight faculty, six are tenured or tenure-track. All departmental faculty members are responsible for the instruction, research, and administration of the Ocean and Resources Engineering program:

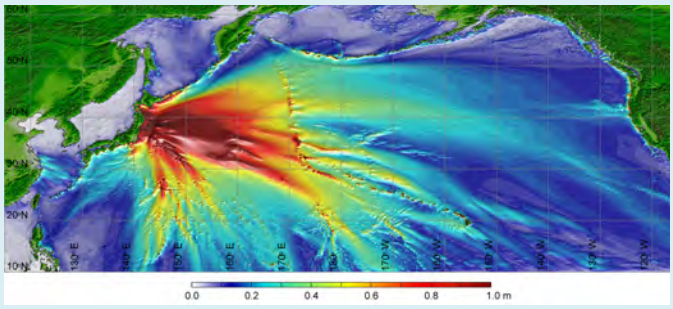
- K. F. Cheung, PhD, PE, Professor and Graduate Chair – Coastal and offshore engineering, hydrodynamics, computational methods, water wave mechanics, sediment transport
- R. C. Ertekin, PhD, Professor –Hydrodynamics/elasticity, ocean renewable energy, computational methods, nonlinear waves, offshore engineering.

- B. D. Greeson, PhD, U.S. Navy Captain (Ret.), Specialist and Chief Engineer, Hawaii Undersea Research Laboratory – Offshore engineering, hydrodynamics ROV/submersible operations
- B. M. Howe, PhD, Researcher and Chair – Ocean observation, seafloor cabled observatories, glider technology, acoustics
- G. C. Nihous, PhD, Associate Professor – OTEC, offshore renewable energy
- E.M. Nosal, PhD, Assistant Professor – Acoustics, applied mathematics
- E. G. Pawlak, PhD, Associate Professor – Coastal mixing processes, fluid dynamics, sediment transport; served until 2012, replacement position to be filled in mid 2013
- J. C. Wiltshire, PhD, Specialist and Associate Chair; Director, Hawaii Undersea Research Laboratory – Submersibles, ROVs, deep-sea mining technology, ocean energy systems

Throughout the rest of this report there are sidebars for each faculty member introducing them and illustrating their research with a figure. Brief biographical sketches, for further information on individual faculty are included as Appendix 5.1.

The ORE program has 13 additional cooperating faculty members from other research or academic units at the University of Hawaii. Their research areas include applied mathematics, marine acoustics, coastal processes, nonlinear water waves, ocean currents, ocean resources, seafloor mapping, sedimentology, and structural mechanics. Specifically, these faculty are:

- J. M. Becker, PhD, Associate Professor of Geology and Geophysics – Coastal processes, currents
- B. S. Bingham, PhD, Assistant Professor of Mechanical Engineering – Autonomous undersea vehicles, navigation and control systems
- B. Brooks, PhD, Associate Researcher, HIGP, Geodesy



Kwok Fai Cheung specializes in marine hydrodynamics, ocean wave modeling, and coastal flood hazards. He is the principal developer of the tsunami model NEOWAVE, which won the 2009 Benchmark Challenge sponsored by the National Science Foundation. The model is used by scientists around the world and distributed by UNESCO IOC to government agencies for tsunami inundation mapping. Dr. Cheung and his graduate and post-doctoral students have been using the NEOWAVE to update the tsunami inundation maps for Hawaii and to understand the source mechanism and impact of the 2011 Tohoku tsunami.

- M. Chyba, PhD, Professor of Mathematics – Robotic control theory and systems
- B. T. Glazer, PhD, Assistant Professor of Oceanography – Instrumentation
- R. H. Knapp, PhD, PE, Professor of Mechanical Engineering – Solid mechanics, design
- H. J. Krock, PhD, PE, Emeritus Professor of Ocean and Resources Engineering – Offshore energy systems, OTEC
- A. Malahoff, PhD, Emeritus Professor of Oceanography, former Director of HURL – Submersibles, seafloor engineering, energy systems
- S. M. Masutani, PhD, PE, Associate Researcher, Hawaii Natural Energy Institute – Thermodynamics, energy systems
- G. M. McMurtry, PhD, Associate Professor of Oceanography – Deep sea instrumentation
- M. A. Merrifield, PhD, Professor of Oceanography; Director, UH Sea Level Center – Statistics, coastal circulation, current flows and mixing
- H. R. Riggs, PhD, Professor of Civil and Environmental Engineering – Structural engineering, numerical methods
- J. R. Smith, PhD, Specialist (Marine Geophysical) and Science Program Director, Hawaii Undersea Research Laboratory – Marine mapping technology and instrumentation

The cooperating faculty members give seminars on their research, serve on student research committees, and advise students on their theses or independent research projects. Their involvement is critical in supporting students and rounding out thesis commit-tee structure. Their research enlarges the research base of the education program and provides a more diversified selection of research projects for the students.

Four affiliate faculty members from the engineering and scientific communities are currently serving on the faculty:

- W. Bucher, PhD, PE, Oceanit Laboratories, Inc., Honolulu, Hawaii
- D. Rezachek, PhD, PE, Alternate Energy Specialist, Energy, Resources, and Technology Division, Department of Business, Economic Development and Tourism, State of Hawaii, Honolulu, Hawaii
- J. Van Ryzin, PhD, PE, President and Senior Engineer, Makai Ocean Engineering, Inc., Kailua, Hawaii
- D. Vithanage, PhD, PE, Technical Director and Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii

These practicing professionals volunteer their time and bring in real-world engineering experience to the academic program. Most of them serve on student research committees and especially team-teach the capstone design project with the faculty. Their involvement is instrumental in preparing the students for the engineering profession.

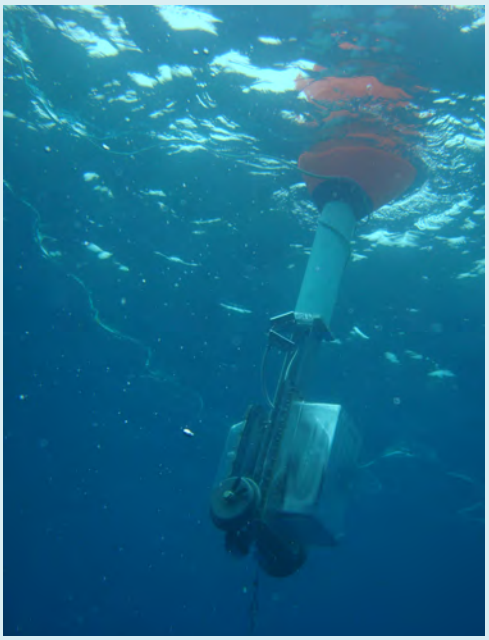
Table II-1. Faculty in the three option areas and supporting disciplines

Discipline	Faculty		
	Departmental	***Cooperating***	***Affiliate***
Coastal Engineering	K. F. Cheung* E. Pawlak*	M. A. Merrifield*	D. Vithanage*
Ocean Resources Engineering	G. C. Nihous* J. C. Wiltshire*	H. J. Krock S. H. Masutani	D. Rezachek*
Offshore Engineering	R. C. Ertekin* B. D. Greeson*	B. S. Bingham R. H. Knapp* H. R. Riggs	W. Bucher* J. Van Ryzin*
Oceanographic Engineering	B. M. Howe*	B. T. Glazer A. Malahoff G. M. McMurtry* J. R. Smith	
Applied Mathematics	E.-M. Nosal*	J. M. Becker M. Chyba	

**Faculty members with teaching duties in the Department*

Table II-1 shows the distribution of faculty in the three option areas and three supporting disciplines. The distribution is based on the faculty members' primary teaching duties and research in relation to the Ocean and Resources Engineering program. Most faculty members have research expertise in multiple disciplines, but only one is listed in the table for programmatic reasons. The faculty members with teaching duties in the program are indicated by an asterisk (*). The departmental faculty members cover all the core courses and most of the required courses in the three option areas. Three cooperating faculty members cover the one remaining required course and provide additional electives and team teaching support. The affiliate faculty members team-teach the capstone design with the departmental faculty to integrate the coursework in a major design experience. Cooperating graduate faculty members can chair student research committees and their diverse backgrounds are instrumental to the graduate education program. Although the departmental faculty is relatively small and spread thin in the three option areas, the department provides a truly first rate education program with sufficient breath and depth by leveraging of resources within the university and from the local marine industry.

Six of the departmental faculty members have education backgrounds in civil engineering, mechanical engineering, and naval architecture. These three distinctly different disciplines provide a broad coverage of the Ocean and Resources Engineering program. Prior industry experience includes oil companies, shipyards, and consulting firms specializing in coastal, offshore, harbor, and environmental engineering. Faculty were involved in a variety of engineering projects that range from preliminary design and feasibility assessment to detailed design and construction worldwide. One current and one emeritus faculty member are registered Professional Engineers in the state of Hawaii.



Cengiz Ertekin conducts research on a number of different areas in ocean engineering: ocean renewable energy, hydroelasticity, nonlinear shallow water waves and their impact on coastal bridges are a few to name. The photograph was taken during the in-ocean experiments of a heaving point wave energy converter (WEC). The project has been sponsored by ONR. The experiments have been completed successfully off the South shore of Oahu in June 2012. The goal of the ocean trials was to collect initial power generation profiles based on the WEC anchored to the sea floor in 70 ft of water depth.

The faculty members are also actively interacting with professional community groups. They are members of national and international professional societies, including:

- Acoustical Society of America
- American Geophysical Union
- American Meteorological Society
- American Society of Engineering Education
- American Society of Civil Engineers
- American Society of Mechanical Engineers
- IEEE Oceanic Engineering Society
- International Ship Structure Congress
- International Society of Offshore and Polar Engineers
- Marine Technology Society
- Society of Naval Architects and Marine Engineers
- Society of Mining, Metallurgy and Exploration (formerly Society of Mining Engineers)
- The Oceanography Society

Some faculty members have served as officers of these organizations and organized international conferences, such as:

- International Workshop on Very Large Floating Structures, Honolulu, Hawaii, 1999
- International Conference on Offshore Mechanics and Arctic Engineering, Mexico, 2003
- International Conference on Offshore Mechanics and Arctic Engineering, Honolulu, Hawaii 2009
- IEEE/MTS Oceans Conference, Honolulu, 2001 and 2011(co-chaired)

The faculty members are also active in professional community service and serve on various review and advisory committees, including:

- Land Erosion Control Advisory Committee, City and County of Honolulu
- Multi-Hazards Science Advisory Committee, Department of Defense, State of Hawaii
- Tsunami Technical Review Committee, Department of Defense, State of Hawaii
- National Tsunami Hazard Mitigation Program Coordination Committee
- Water Quality Advisory Committee, Department of Health, State of Hawaii
- International Science Advisory Board, Ocean Networks Canada
- Review of CTBTO Hydroacoustic Station Crozet
- Review of Marine Technology Institute

- Review of Nevada Institute of Renewable Energy Commercialization
- Advisory Committee, American Society of Mechanical Engineers, Ocean, Offshore and Arctic Engineering Division
- Board, Society for Mining, Metallurgy, and Exploration
- Board, International Marine Minerals Society

Faculty members in professional fields of study, such as engineering, are better teachers and researchers, if they continue to practice and apply their knowledge in the real world. This is also the most direct way to interact with the professional communities. Recently the faculty members have been involved in engineering projects with:

- Applied Technology Corporation
- Bishop Museum
- Belt Collins Hawaii, Ltd.
- Booz Allen Hamilton
- Dept. of Business, Economic Development and Tourism, State of Hawaii
- Makai Ocean Engineering, Inc.
- Navatek Ltd.
- Ocean Engineering Consultants, Inc.
- Oceanit Laboratories, Inc.
- PACE Technologies
- Pacific Disaster Center
- Sea Engineering, Inc.
- SSFM International
- Trex Enterprises Corporation - Maui
- U.S. Army Corps of Engineers, Mississippi Valley Division

In addition, the faculty members have worked as visiting researchers or professors at various institutes worldwide, including:

- Fluid Mechanics Research Group, Universidad de Jaen, Jaen, Spain
- Naval Surface Warfare Center Carderock Division, Maryland
- Department of Applied Physics, Christian Albrechts University, Kiel, Germany
- Department of Naval Architecture and Offshore Engineering, University of California, Berkeley, California
- Fluid Engineering Department, Universidad

Dan Greeson serves as the Chief Engineer of the Hawaii Undersea Research Laboratory (HURL). His research concerns deep submergence systems. As Chief Engineer, HURL, he is responsible for all engineering aspects of the Pisces manned submersibles, including maintenance of American Bureau of Shipping certification for the vehicles. In late 2011, the University of Hawaii, School of Ocean, Earth, Science and Technology, contracted with DOER Marine for the construction of a new 6000 meter capable remote operated vehicle (ROV) to be employed on both University research ships. This new system will significantly increase the oceanographic research capabilities of the University. Dr. Greeson is responsible for overseeing all engineering aspects of this project.

Carlos III de Madrid, Spain
- Royal Technical University, Stockholm, Sweden
- University of Washington, Applied Physics Laboratory

These research, scholarship, and professional activities are instrumental in maintaining the timeliness and diversity of the Ocean and Resources Engineering program. The cooperating and affiliate faculty members, who have backgrounds in biochemical engineering, civil engineering, geophysics, oceanography, ocean engineering, and mechanical engineering, and

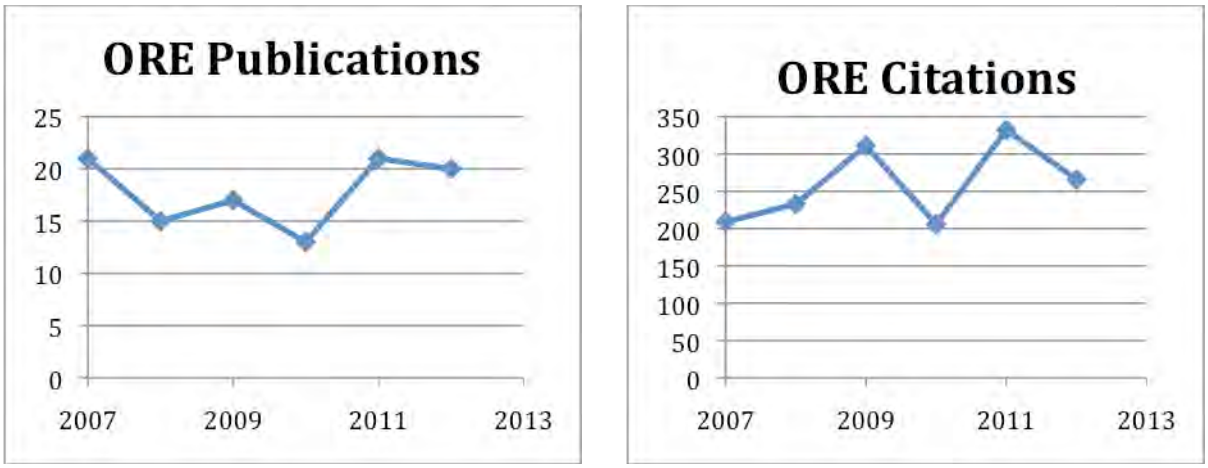


Figure II-1. ORE publication and citation history.

the same level of professional competency, add to the diversity of the program.

1. Research Productivity

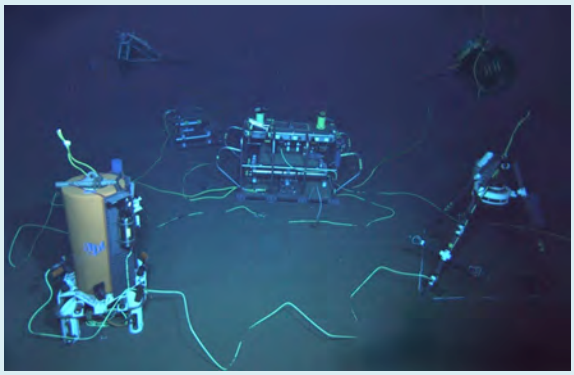
The ORE research productivity relative to faculty size is very high. The publication and citation history during 2007-2012 is shown in Figure II-1. The average publication rate is 18 per year for a total of 106 in this time period. The lifetime number of publications for all faculty is 306. The average citation rate is 257 per year for a total of 1544 in this period. The lifetime number of citations for all faculty is 3161. There is a slight, favorable upward trend in publications and citations.

The articles were published in the best national and international journals of direct relevance to the Ocean and Resources Engineering program. These journals included:

- *Engineering Analysis with Boundary Elements*
- *Fluid Dynamics Research*
- *Fluids and Structures*
- *Geophysical Research Letters*
- *IEEE Journal of Oceanic Engineering*
- *IEEE Journal of Selected Topics in Earth Observations and Remote Sensing*
- *International Journal of Heat and Fluid Flow*

- *International Journal for Numerical Methods in Fluids*
- *International Journal of Offshore Mechanics and Polar Engineering*
- *Journal of the Acoustical Society of America*
- *Journal of Coastal Research*
- *Journal of Energy Resources Technology*
- *Journal of Engineering Mathematics*
- *Journal of Engineering Mechanics*
- *Journal of Field Robotics*
- *Journal of Fluid Mechanics*
- *Journal of Geophysical Research*
- *Journal of Hydraulic Engineering*
- *Journal of Hydraulic Research*
- *Journal of the Marine Acoustics Society*
- *Journal of Marine Environmental Engineering*
- *Journal of Offshore Mechanics and Arctic Engineering*
- *Journal of Physical Oceanography*
- *Journal of Waterway, Port, Coastal, and Ocean Engineering*
- *Marine Technology Society Journal*
- *Marine Georesources and Geotechnology*
- *Mechanical Engineering*
- *Ocean Engineering*
- *Wave Motion*

Many of the publications were co-authored by students, who worked on their MS theses and PhD dissertations under the guidance of faculty members.



Bruce Howe specializes in acoustics for observing the ocean, and necessary sensor network infrastructure, including fixed and mobile platforms. Since June 2011, the ALOHA Cabled Observatory (ACO) is providing 1 kW power, 100 Mb/s network communications and precise timing to a seafloor node and instruments at 4728 m water depth 100 km north of Oahu. Station ALOHA is the field site of the Hawaii Ocean Time-series (HOT) program that has investigated physical and biogeochemical variability of the water column near-monthly since 1988. At 4728 m water depth, it is the deepest operating ocean observatory in the world. In addition to leading the development of ACO, Dr. Howe manages the SOEST Ocean Glider Facility. The Facility manages, deploys, and operates 10 Seagliders for a variety of project missions in Hawaii and the Central Pacific Ocean.

2. Research support

Research is one of the strengths of the ORE program. During the period 2007–2012, the faculty members received $11.0M ($16M when HURL is also included) of research grants and contracts as University of Hawaii Principal Investigators. Figure II-2 presents the Department funding profile over the last 10 years. On average the total Department funding is about $2.6M/year, extramural research is $1.8M/year, and state-funded salaries and administration is $0.8M/year.

One of the features of ORE is that it is a small faculty of 8 including a position to be filled and two part-time positions associated with the Hawaii Undersea Research Lab. Even with this small faculty a large number of students are supported on research projects.

Much effort is expended generating research grants and research support for students. Table II-2 highlights some of the recent support received by faculty members, and the number of students supported. Funding has been received from an impressive array of agencies.

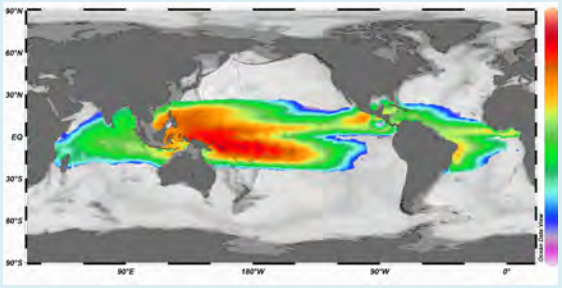
Table II-2. Recent selected ORE research grants

Title	Sponsor	Years	Amount	Personnel
Coastal Bridge and Port Vulnerability to Tsunami and Storm Surge	Hawaii Dept. of Transportation	2009-2013	$505,000	Ertekin 5 students
ALOHA Cabled Observatory: Operations and Maintenance	NSF	2012-2015	$1,233,155	Howe
Coupling of Coastal Wave and Computational Fluid Dynamic Models for Seakeeping Analysis	ONR	2012-2015	$504,326	Cheung 2 students
Improvements to Passive Acoustic Tracking Methods for Marine Mammal Monitoring	ONR	2012-2015	$186,000	Nosal 1 student
Hawaii National Marine Renewable Energy Center	DOE via HNEI	2010-2014	$680,000	Nihous 1 students
HURL Annual Funding (FY 2011)	NOAA	2011-2012	$2,100,000	Wiltshire 3 students

The Ocean and Resources Engineering program has strong ties with the Hawaii Undersea Research Laboratory (HURL) at the University of Hawaii. Administratively, HURL sits within the Department of Oceanography; see the separate HURL Self-Study elsewhere in this report for more detail. The Director of HURL, John Wiltshire, has been Department Chair and is presently Associate Chair of ORE since 2010. B. D. Greeson, PhD, US Navy Captain (Ret.), Certified Chief Engineer, is also the chief engineer of HURL. These two faculty members who have joint positions with HURL bring in expertise in acoustics, marine engineering, marine mining technology, ship-ROV-submersible operations and have a wealth of at-sea experience. Most importantly, their involvement provides students access to the HURL facilities, including sea going vessels, submersibles, ROVs and a range of deep-sea equipment and test facilities, and active hands-on experience with oceanographic instrumentation.

3. Research and teaching load

ORE is a graduate only department and as such is highly research oriented. The average faculty member has 3-5 active grants and is supporting several students. The typical teaching load is two classes a semester not including directed reading, thesis work and general advising. Advising a wide range of students takes most faculty members at least 8-10 hours a week given the large number of students in the Department and small number of faculty.



Gerard Nihous has devoted much of his career in the private sector and at UH and now in ORE to marine renewable energy development. One of his current research interests is to explore how Ocean Thermal Energy Conversion (OTEC) power plants might interact with the oceanic environment. The figure shows OTEC power density estimates (kW/km^2) for a global production of 7 TW. The large seawater flow rates required for Ocean Thermal Energy Conversion (OTEC) may prove limiting for this technology if they alter the vertical thermal structure of the oceans. Ongoing studies using an ocean model suggest that maximum OTEC production may reach about 20 TW, but power production with limited environmental effects would be lower. All indications are that a global output of 7 TW as illustrated would have little impact.

The teaching load for ORE faculty is lower compared to other engineering departments at the University of Hawaii because of the emphasis on research in the ORE program. The full-time departmental faculty members teach between 3 and 6 credit hours per semester and cover the bulk of the coursework. Drs. Greeson and Wiltshire (the two HURL faculty members) and Dr. Bruce Howe on a research appointment, teach 3 credit hours per academic year consistent with their appointments. ORE is an advanced-level program. The faculty members spend a significant portion of their time advising students on their research work at the MS and PhD levels. The departmental faculty members are primarily responsible for academic advising and carry a major portion of the research advising duties by serving as research committee chairs. The cooperating faculty members are also actively involved in the students' research work. Many of them have chaired and served on research committees. They bring in research expertise not covered by the departmental faculty and provide additional research funding to support graduate students. Profs. Becker and Merrifield were formally ORE faculty and continue to work closely with the Department. Several of the affiliate faculty members have also served on student research committees and provide insights from the perspective of the industry.

4, 5. Balancing and linking research and learning

Research and creative activity are central to ORE. Much of the graduate learning in ORE is experience based such as the capstone design class. This is an excellent opportunity to merge the day-to-day experience of our affiliate faculty with the aspirations of our students.

6. Adjunct and part-time faculty

ORE does not use part-time or adjunct faculty members as we believe it is important for the students to have real time access to faculty members to give a tight and highly productive experience. In the support of these endeavors ORE has excellent library and computer resources.

7. Recruitment

ORE has recruited three new faculty members in the last five years: Howe and Nosal in 2008 and Nihous in 2009. There is presently a position being filled to replace Dr. Geno Pawlak who has left for an excellent job at UC San Diego. ORE has developed an efficient way to recruit outstanding faculty using the network of contacts we have developed over the years working with engineering associations. Faculty retention has not been a problem as the Department is growing and morale is high. Each time a position comes up for replacement the faculty consider how best to integrate this into our current mix of expertise and whether the changing demands of the field suggest a change of emphasis of sub-discipline. We are also advised by our national/international advisory panel on the mix of expertise we have and any additions that would be appropriate. One addition that has been suggested would be to have a faculty member with some expertise in structural analysis likely including finite element design.

8. Faculty Awards and Recognition

- J. Wiltshire: The 2011 President's Citation Award, Society for Mining, Metallurgy, and Exploration
- K. F. Cheung: 2010, Scientific Application and Public Contribution Award, Honolulu Department of Emergency Management
- K. F. Cheung: 2010, Commendation from Mayor of the City and County of Honolulu

5.3 Academic Programs

5.3.1 Program Description

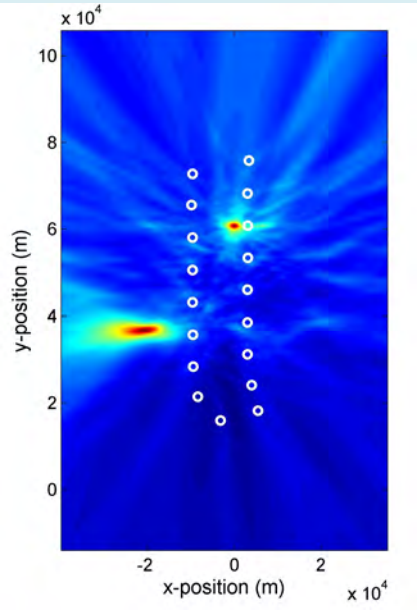
Ocean and Resources Engineering is an advanced-level program and relies on the students' undergraduate education or remedial courses offered at the University of Hawaii to fulfill the ABET requirements which include:

1. A general education component including economics, management, and humanities;

2. One year of college level mathematics and basic science; and
3. One and one-half years of engineering science and design.

For administrative purpose, these are classified as pre-program requirements that all students entering the advanced-level program must satisfy. Students with ABET accredited undergraduate engineering degrees satisfy these requirements and can directly proceed to the ORE program. In some cases, students with an electrical or chemical engineering degree are required to make up some undergraduate courses required by the program such as fluid mechanics and solid mechanics.

Students with undergraduate engineering degrees from foreign countries are carefully evaluated to assure that they satisfy the requirements in the ABET Professional Component. The Department Chair reviews the transcript along with the student at the preliminary conference. All the courses taken by the student are categorized according to the ABET requirements for an ocean engineering program. Based on past experience, most foreign students have more rigorous training in mathematics, science, and engineering topics than their US counterparts. These students have extensive experience in the use of design code and most have a capstone design or practical training (similar to co-op in the U.S.) every year complementing their coursework. Most of the foreign students, however, have a general education component that focuses on economics, management, and engineering practice. The Department views that being from a different culture itself is a general educational experience that fulfills ABET requirements well, and therefore, does not require these students to take additional courses in humanities.



Eva-Marie Nosal works on underwater acoustics, bioacoustics, inverse methods, and signal processing. A primary goal of her research is to develop and apply signal-processing techniques to detect, classify and track sound sources using autonomous hydrophone arrays. The source of interest can be geophysical (e.g. earthquake), anthropogenic (e.g. boat), or biological (e.g. marine mammal). The bottom-mounted hydro-phones of the Pacific Missile Range Facility (PMRF) in Hawaii provide ideal data for such work. Various species (including sperm whales, hump-back whales and minke whales) can be tracked through the range, as illustrated, in the likelihood surface, where red/blue shows high/low probability of animal presence (circles are bottom hydrophones). Such results provide important information about marine mammal bioacoustics and behavior.

The Department also accepts students with undergraduate degrees in mathematics and science. These students usually have a broad-based general education component and satisfy the requirement for mathematics and science. Some students knew they would enter graduate engineering programs and had taken basic courses in engineering mechanics before being admitted into the program. Similar to the foreign students, the Department Chair reviews the transcript with each student at the preliminary conference and categorizes all the courses according to the three areas of the Professional Component and additional requirements of the ABET Program Criteria. These students are required to make up deficiencies in undergraduate engineering courses. The Department Chair serves as the advisor to these students to assure that all pre-program requirements are satisfied consistently. Students can structure their pre-programs based on their intended specialization in the ORE program.

The core courses, along with the basic-level engineering courses in the pre-program, cover the subject matter essential to an ocean engineering program as outlined in the ABET Engineering Criteria. The option-area and elective courses allow students to specialize in an ORE discipline. The capstone design project integrates the pre-program and the advanced-level program coursework into a major design experience and introduces students to non-technical issues commonly encountered by practicing engineers. The project simulates work in a consulting firm and prepares students for professional practice. The students gain research techniques and learn the latest technologies in an ORE discipline through the thesis or independent project.

A flow chart (Figure III-1) shows the prerequisite structure of the program's courses and the required 31-credit progression toward a master's in Ocean and Resources Engineering followed by the students. Table III-1 lists the classes taught in a typical year with instructor, number of credits, and fraction of class time devoted to lecture, lab, discussion, presentation, etc.

Curricula

1. ABET review, 2. Changing discipline

The ORE curricula has been extensively reviewed by ABET and positively commented on. ABET recommended no change to the curricula as it closely mirrors the very extensive requirements for engineering schools. Unlike some other disciplines, the essential core subject matter of ocean engineering, such as buoyancy and stability, water wave mechanics, hydrodynamics and basic acoustics are essentially applications of classical applied physics and once understood in principle do not radically change over time. The change comes in engineering applications such as the use of new computer design tools and new materials or new areas of application such as offshore renewable energy. ORE is both true to the original material and incorporates the new into its classes. In general this does not require the shift of resources.

3, 4, 5. Scholarship, research and creative activity, and adaptation.

Scholarship, research and creative activity are particularly brought into the curriculum in terms of the students research theses and projects and the capstone design class. Each year these are different and reflect new knowledge as well as the changing needs of society.

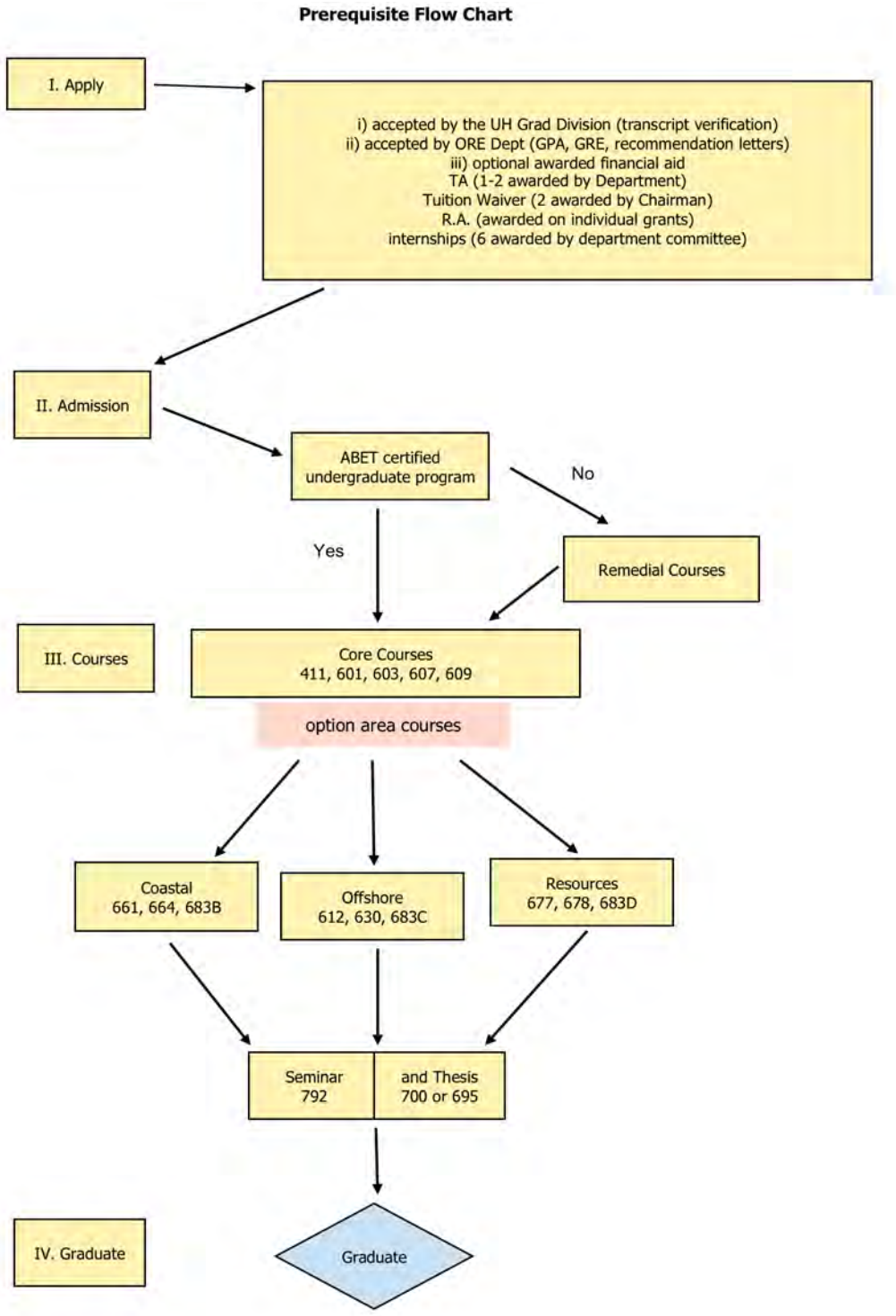


Figure III-1 Flow chart showing the progression of classes for the three options.

Table III-1. Typical Course and Section Size Summary for 2008-2009

Course	Title	Faculty	Sections	Enrollment	Lecture[1]	Lab[1]	Other[1]
ORE/OCN 330	Mineral and Energy Resources	Wiltshire	1	15	100		
ORE 411	Buoyancy and Stability	Ertekin	1	6	100		
ORE 500	Master's Plan B/C Studies	various	as needed				100
ORE 601*	Ocean & Resources Engineering Lab	Pawlak	Fall 2009		25	75	
ORE 603	Oceanography for Ocean Engineers	Nosal/Pawlak	1	14	95		5
ORE 607	Water Wave Mechanics	Cheung	1	5	100		
ORE 608	Probability and Statistics for Ocean Eng.	Merrifield	1	5	100		
ORE 609	Hydrodynamics of Fluid-Body Interaction	Ertekin	1	5	100		
ORE 612	Dynamics of Ocean Structures	Greeson	Cancelled Spr 09 Instructor at sea	8 (Spring 2008)	100		
ORE 630	Structural Analysis of Ocean Engineering	Knapp	2010	8 (Fall 2006)	100		
ORE 641*	Environmental Fluid Dynamics	Pawlak	2010	3 (Spring 2007)	90	10	
ORE 642	Marine Environmental Remediation	Krock (retired)		4 (Spring 2005)	80	20	
ORE 654	Applications in Ocean Acoustics	Howe	Fall 09		80	20	
ORE 661	Coastal and Harbor Engineering	Cheung	2010	10 (Spring 2008)	100		
ORE 664*	Nearshore Processes & Sediment Transport	Pawlak	2010	9 (Spring 2006)	80	20	
ORE 677	Marine Renewable Energy	Nihous	1	9	100		
ORE 678	Marine Mineral Resources Engineering	Wiltshire	1	5	50		50
ORE 695	Plan B Master's Project	various	as needed				100
ORE 699	Directed Reading/Research	various	8				100
ORE 700	Thesis Research	various	as needed				100
ORE 707	Non linear Wave Theories	Ertekin	2010		100		
ORE 766	Numerical Ocean Engineering	Nosal	1	6	50	45	5
ORE 783B	Capstone Design – coastal engineering	Cheung	1	4			80% Group Discussion 20% Student Presentation
ORE 783C	Capstone Design – off-shore engineering	Cheung	1	3			80% Group Discussion 20% Student Presentation
ORE 783D	Capstone Design – ocean resources eng.	Cheung	1	3			80% Group Discussion 20% Student Presentation

Course	Title	Faculty	Sections	Enrollment	Lecture[1]	Lab[1]	Other[1]
ORE 792	Seminar in Ocean and Resources Engineer.	Pawlak/Nosal	2	7	100		
ORE 800	Dissertation Research	various	as needed				100

[1] *The appropriate percent for each type of class for each course (e.g., 75% lecture, 25% laboratory).*
** ORE 601, 641 and 664 are taught by Dr. Eugene (Geno) Pawlak who was on sabbatical leave.*

Assessment

6. Learning outcomes

The graduate program in Ocean and Resources Engineering channels the students' previous education and work experience to ocean-related engineering careers. Students upon graduation will have Program Outcomes as follows:

1. A broad education necessary to understand the impact of engineering solutions in a global and societal context;
2. An ability to apply knowledge of mathematics, science, and basic engineering topics that include statics, dynamics, fluid mechanics, solid mechanics, and probability and statistics;
3. Proficiency in the core program that comprises hydrostatics, oceanography, water waves, fluid-structure interaction, underwater acoustics, laboratory and at-sea experience;
4. Working knowledge of at least one of the three option areas that include coastal, offshore, and ocean resources engineering;
5. An ability to use the techniques, skills, and latest engineering tools necessary for ocean and resources engineering practice;
6. An ability to identify, formulate, and solve ocean and resources engineering problems;
7. An ability to design and optimize engineering systems to meet the needs of the marine community;
8. An ability to work independently and function on multi-disciplinary teams;
9. An appreciation of professional and ethical responsibilities;
10. An ability to communicate effectively to technical and non-technical audiences;
11. An awareness of the latest research and contemporary issues in and beyond the marine community, and;
12. Recognition of the need for, and an ability to engage in life-long learning and continuing professional development.

As described above, at the graduate level the program depends on the students' prior education and remedial undergraduate courses outside the Department to fulfill Program Outcomes 1 and

2. The coursework, capstone design, and independent research together deliver Program Outcomes 2 through 10, while attendance of seminars and participation in student and professional activities addresses Program Outcomes 11 and 12.

7. Assessment evidence

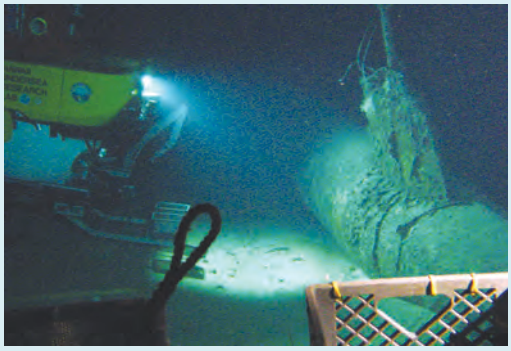
A group of 12 rubrics are used to assess both the effectiveness and achievement of the program outcomes and objectives. These rubrics are:

Direct Measures:

1. The master's qualifying exam
2. Committee verification of undergraduate ABET requirements and assignment of remedial action
3. Capstone Design Class
4. Master's thesis defense and evaluation of thesis for outcome elements
5. Circulation and review of thesis proposals by all the faculty
6. Student employment placing, particularly repeat hires by employer

Indirect measures:

7. Local and International Advisory Panels
8. Employer Surveys
9. Student Exit Interviews
10. ABET course reviews done at the end of each course by both students and faculty
11. Alumni Surveys
12. Student advising meeting to determine fulfillment of undergrad requirements and progress



John Wiltshire serves as the Director of the Hawaii Undersea Research Laboratory, where his research concerns deep submergence systems and marine mineral resources Wiltshire's other projects concern deep-sea mineral resources, their economic contribution and examination of mineral processing schemes ad wastes (tailings) from the proposed develop-mint of seafloor manganese nodules, manganese crusts and polymetallic sulfides.

ABET has noted that these 12 rubrics are effective measures for the program and have been well applied.

8. Preparation

Please see the introduction to this section; the process of determining pre-program requirements is described there.

9. Faculty review of assessment

The faculty regularly reviews our rubrics and the preparation of the detailed department ABET study is a matter in which every member of the department is involved. The preparation of these documents and the data collections on which they are based is something discussed at almost every monthly faculty meeting.

Graduation Rates

10. Factors affection graduation

In general the times to graduation are reasonable for MS and PhD level students particularly given that students are generally switching fields coming into ORE. Well-prepared masters students average about 3 years and doctoral students about 6 years to graduation, see Table IV-1. In addition to this table showing graduation times, it shows where the students are working. We stress this is the critical metric of success – all graduates have productive jobs in the field.

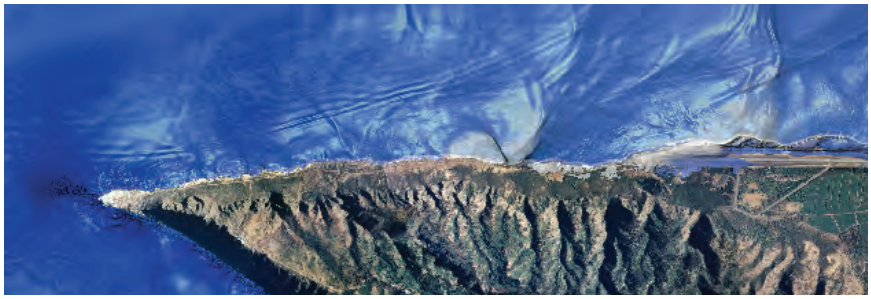
11. Ensuring timely graduation

The department monitors student progress closely. As we have a small department, regular meetings between students and their advisor and students and the department chair ensure timely progress is made. Students are rarely slowed by the lack of courses as the key required courses are taught every year. In the rare case that a course is not available the chairman and curricula committee will approve a substitute course from elsewhere in the university that is available.

12. Overall health of academic program.

Overall the program is extremely healthy. It is growing. The program received the highest available ABET accreditation and is on track to do this again. Graduates and employers are pleased with the results. All our students obtain good jobs in industry, government, and academia, Table IV-1.

5.4 Students



1. Satisfaction with quality

Overall the department is very pleased with the level and attainment of the students. One of the issues in comparing ORE students with other SOEST students is that essentially every student coming into ORE is switching fields. ORE is a graduate only department. There are only two undergraduate ocean engineering programs in the country (Table I-1). Most students join ORE with an undergraduate degree in either civil or mechanical engineering. Therefore on average it

takes them a semester or two longer to complete their degree as they have to learn the new ocean related material which was not part of their undergraduate program.

2. Enrollment trends

Enrollment trends in the Department are essentially level. If more assistantships were available we could probably recruit more students. On the other hand there is a limit to the number of students 8 faculty can mentor effectively at the graduate level.

3. Student recruiting

The Department essentially works through professional engineering societies to increase awareness of its programs. Our newsletter is a very efficient tool in maintaining contact with our alumni and in helping them steer students toward the Department for graduate studies. Our web site has the entire text of our most recent comprehensive ABET study posted and is examined by most prospective students as there are so few ocean engineering programs to choose from. As the students normally apply to many schools and search for the best financial package available to them, we normally send initial acceptances to about half the students who apply with a view to getting about 60 percent of accepted applicants into the program. Typically for a Fall semester we might get on the order of 30 fully completed applications send out 15 acceptances and get 6-8 new students. Students may also start in the Spring semester for which only a fraction of the numbers for the Fall is received.

4. Financial support

The Department provides three kinds of financial support for students. These are teaching assistantships of which the department has two, internships of which the department has up to six and research assistantships that are funded by an individual professor's grants and are variable in number. All of these provide a tuition waiver (a significant UH advantage) as well as a monthly stipend.

Table IV-1. ORE Graduates in the last 5 years and current employment

Name	Entered	Grad	Years	Plan	Employment	Advisor
Goo	8/2005	12/2007	2.3	MS-A	US Army Corps of Engineers, Honolulu District	Cheung
Stopa	8/2005	12/2007	2.3	MS-A	ORE Graduate Student - PhD ADMITTED SPRING 2008	Cheung
Craw	8/2005	5/2008	2.8	MS-A	Trainee ORE - completed 11/11	Cheung
Namekar	8/2004	12/2008	4.3	MS-A	UHM Civil Engineering PhD student	Cheung
Wong	8/1999	12/2008	9.3	MS-A	Navatek, Ltd. Honolulu	Cheung
Yan	8/2006	12/2008	2.3	MS-A	China National Petroleum	Cheung
Bablinskas	8/2007	5/2009	1.8	MS-A	Alaska Dept of Environmental Conservation: engineer	Wiltshire
Quintero	8/2007	7/2009	1.9	MS-A	Naval Surface Warfare Center Carderock Div, West Bethesda, MD	Cheung
Shu	8/2007	7/2009	1.9	MS-A	Hunan Provincial Communication Plan. &	Cheung

Name	Entered	Grad	Years	Plan	Employment	Advisor
					Design Institute -engineer	
Chen	8/2007	12/2009	2.3	MS-A	Makai Engineering	Glazer
Heitman	8/2007	5/2010	2.8	MS-A	ORE Graduate Student - PhD	Cheung
Pisciotto	8/2008	5/2010	1.7	MS-A	Brown and Caldwell; Engineering firm; Honolulu	Cheung
Arinaga	8/2003	7/2010	6.9	MS-A	Substitute Teacher at various schools on Kauai	Cheung
Tyler	8/2007	7/2011	3.9	MS-A	ORE Graduate Student - PhD ADMITTED Fall 2011	Cheung
Tuthill	8/2009	5/2012	2.8	MS-A	AECOM, Honolulu; Environmental Engineer	Pawlak
Duarte Quiroga	1/2006	7/2012	6.5	MS-A	ESA-PWA, San Francisco	Cheung
Sites	8/2005	5/2008	2.8	MS-B	Global PCCI JV: senior engineer	Ertekin
Dempsey	8/2001	7/2008	6.9	MS-B	AECOM, Honolulu (Engineer)	Krock
Mohamed	8/2005	7/2008	2.9	MS-B	AECOM, Seattle (Engineer) /CEE-MANOA PhD.	Pawlak
Kubic	8/2007	12/2008	1.3	MS-B	Naval Facilities Engineering Command; Little Creek Virginia	Cheung
Wilkinson	8/2007	7/2009	1.9	MS-B	Naval Facilities Engineering Service Center, Port Hueneme, CA	Wiltshire
Vaganov	8/2007	5/2010	2.8	MS-B	PhD Student; Victoria University; Wellington, New Zealand	Malahoff
Eisen	8/2007	12/2010	3.3	MS-B	Oceanic Co. Inc. Honolulu; Project Engineer	Nosal
Keller	8/2009	12/2011	2.3	MS-B	Ocean Imaging Consultants; Project Engineer; Honolulu	Ertekin
Field	8/2010	5/2012	1.8	MS-B	Navatek, Ltd. Honolulu	Cheung
Canals	8/2005	12/2008	3.3	PhD	Asst. Prof; Univ. of Puerto Rice; Offshore/Coastal Engineering	Pawlak
Bandet	1/2001	5/2009	8.3	PhD	Visiting Fellow; Univ. of East Anglia; Norwich, UK	Pawlak
Ge	8/2004	7/2009	4.9	PhD	Oceanit: Coastal/Ocean Engineer; Honolulu	Cheung
Wu	8/2004	7/2009	4.9	PhD	Aker Solutions; Off-Shore Engineering; Houston, TX	Cheung
Rajagopalan	8/2002	7/2010	7.9	PhD	Post Doc - ORE	Pawlak
Yamazaki	8/2004	7/2010	5.9	PhD	Post Doc - ORE (prev. MS-A)	Cheung
Roeber	8/2003	12/2010	7.3	PhD	Post Doc - ORE	Cheung
Das	8/2004	7/2011	6.9	PhD	Houston Offshore Engineering LLC, Houston (prev. MS-A)	Cheung
Bai	8/2005	5/2012	6.8	PhD	Post -doc -ORE	Cheung

5. Research-oriented culture

ORE is a small tightly knit graduate department of about 25 students and eight professors. About a third of the students are at a PhD level and two thirds at a MS level. There are no undergraduate students and no undergraduate advising. As every student is working on a thesis or research project of some sort, it is not hard to inculcate a research-oriented culture.

The Department goes to great length to encourage students to take advantage of the many opportunities offered by the university as well as the broader engineering community. The Department encourages students to get sea-going experience through SOEST and HURL. It will pay for first year membership in the Marine Technology Society (MTS) and the Society of Naval Architects and Marine Engineers (SNAME). The Department has sponsored many students to attend the annual meetings of SNAME, the Oceanic Engineering Society and the Offshore Mechanics and Arctic Engineering conference (OMAE). In addition between ORE's sponsored student chapters of MTS and SNAME as well as its local advisory board, there is much opportunity for students to become aware of the needs and interests of the broader engineering community.

Advising and Mentoring

6. Faculty

Given the size of the Department and the close interaction of faculty (instructional, research, and specialist) and students because of this size, advising and mentoring of students has been very effective. In fact, the close links between students and the engineering profession fostered by the faculty, was one of the departments notable strengths, as noted by the ABET review.

7. Practical engagement

Students are actively engaged in the ocean engineering laboratory, the capstone design classes, in hands-on research, internships at local companies, and attending and presenting at conferences.

8. Effective advising

Because of the high degree of involvement of the students in the program and the low student/faculty ratio, there is more than an adequate amount of contact time between students and faculty for effective advising.

Governance

9. Student involvement

Students have a key role in governance both at a university wide level and through the Department. The Department's students are very active in the Graduate Student Organization that deals with graduate student issues in general. On a department level there is a student advisory committee that provides formal input to the faculty at a regular interval (several times in this study period). Several times a year the student body meets and discusses problems and forwards suggestions to the faculty for potential action. The faculty take all student suggestions seriously and discuss then at length during faculty meetings and report the conclusions back to the students. Faculty meetings themselves are closed to students as there are only 6-8 faculty meetings per year and these often discuss individual students as well as personnel issues.

10. Grievance procedures

As the Department is small, student grievance issues are handled by the department chair or associate chair depending on whom the student wishes to go to. If the issue is of a more serious nature the student may go to the SOEST associate dean for Academic affairs or to the University Ombudsman or Dean of Students. All of these university officials will begin an investigation and move it to a higher level if the situation warrants. Students are made aware of their rights and the various options they have through the ORE student handbook and the initial briefing they receive when they join the department. The Graduate Student Organization (GSO) also provides resources to students and keeps them informed of university–wide resources. As active participants in the GSO our students are well connected to these resources. The Department has no unresolved student grievances.

11. Student recognitions

There have been several notable student recognitions over the last five years:

- MS student Jerica Nolte was awarded two scholarships:
    - Society Graduate Scholarship of SNAME to study hydrodynamic forces of a WEC buoy tethered to a sea anchor. $5,000; 2012-2013, and
    - IEEE Oceanic Engineering Society scholarship for having demonstrated excellence in academics and the ability to perform independent research, through professional and/or academic recognition programs. $2,000. 2013-2014. Advisor Prof. C. Ertekin
- PhD student Masoud Hayatdavoodi won the very prestigious Link Foundation Ocean Engineering Fellowship. This $25,000 award is the largest student prize in ocean engineering in the world. 2011-2012. Advisor Prof. C. Ertekin.
- Former MS student Dominique Roddier won the Excellence in Renewable Energy Award in Innovation for the design of a three-legged semisubmersible floating wind turbine, a first by a US company. He received his PhD. from Berkeley in 2000. ORE advisor Prof. C. Ertekin.

The Outstanding ORE Graduate Student Award was initiated in the 1993-1994 academic year. It was awarded to Yoshiki Yamazaki in 2010 (advisor Cheung) and to Masoud Hayatdavoodi in 2011 (advisor Ertekin).

5.5 Staff Support and Facilities

1. Adequacy of physical and staff resources

The Ocean and Resources Engineering Department has one full-time secretary and a part-time student helper and no other department paid staff. This is inadequate for the number of students, the number of grants to be processed, the amount of travel undertaken by faculty, or the extent of purchases made on these grants. While the ratio of support staff to faculty is

reasonable by UH standards for academic departments, particularly undergraduate departments, it ignores the fact that ORE graduates a large number of students per faculty member, all of whom are graduate students requiring more paperwork for theses and committees than undergrads. Also underserved by this staffing level is the large number of ORE cooperating faculty (or said another way, the low number of formally assigned faculty) and large number of grants to be processed for these faculty. While not an uncommon staffing level by UH standards, the ORE department secretary and part-time student helper (actual ratio: 8 faculty/1.3 FTE support = 6.1, not 4.75 as noted in UH official records) are barely able to handle the academic demands of the department and cannot begin to address such research needs. Several large grant programs, such as the ALOHA Cabled Observatory and the Hawaii Undersea Research Lab employ one or more administrative staff to look after their own purchases, travel, personnel issues, etc. While this option works for these programs, it is not ideal from the overall perspective of maximizing research productivity and it is inconsistent with the fact that indirect costs are meant to provide for adequate research support. To make matters worse, the department has an increasing number of high profile projects in the areas of tsunamis, deep ocean observing, and offshore renewable energy for which the PIs will be forced to hire part-time administrative support staff. The department itself employs no technicians or engineering support staff. Technician support staff are individually employed on each project, for example glider technicians or deep-sea observatory engineers. This level of ad hoc technical support, while cost effective from a UH perspective, is far from ideal from the point of view of supporting a strong and diverse body of skilled technicians.

The assignment of physical resources, in terms of lab space and equipment for the department, has been a problem since the loss of the Look Ocean Engineering Lab in the late 1990's. While some lab space is available, it could be better. This is an ongoing low-level issue, which we hope will be ameliorated over time.

2. Staff development

The Department encourages the development of its APT and Civil Service staff through the participation in seminars and other career building activities. Many of the staff have greatly assisted the department through the participation in national and international conferences.

3. Ratio of staff: faculty support

The number of full-time administrative staff paid for and directly assigned to ORE is one (the ORE secretary). As an official ratio, UH gives this as 4.75:1 (UH provided data) or 4.75 BOR appointees to one assigned support person. While as a strict ratio this appears reasonable and is one of the highest in the school, in absolute terms for assigned workload, it is barely manageable.

5.6 Extension and Outreach

1. Relationship to community organizations

The ORE Department is highly research oriented. There are very strong ties to a number of professional societies.

These societies include the Marine Technology Society, the Society of Naval Architects and Marine Engineers, the Oceanic Engineering Society and the International Marine Minerals Society. The Department hosts the student sections of SNAME and MTS. In September of 2011 the department was the prime academic sponsors of the Oceans '11 meeting that brought 1500 marine scientists and engineers to Hawaii. This meeting was noted as one of the largest and technically most sophisticated Oceans meeting in the 30-year history of the conference. It also pumped $5 million of outside income into the Kona area at a time when tourism and hotel revenues were down, a fact for which the local mayor and government were most grateful. In fact the mayor served as conference honorary co-chair.

The Hawaii student chapters of both the MTS and SNAME are housed in the Department. The Department does outreach to student groups through active participation in the SOEST open house. The Department also has three active advisory boards. These are a student advisory board, a board of local engineers and a national/international advisory board. It is through these boards that the department keeps close contact on what is happening in the ocean engineering profession and is in a better position to more wisely guide students.

Through its close association with the local engineering community the Department has established 6 internships with local companies. The internships allow the students to work 20 hours per week for the local companies often gaining material for their theses as well as gaining income in the form of a graduate assistantship and having their tuition paid. The Department would like to see more internships as the lack of student assistantships is one of the major factors limiting enrollment.

In reaching out to the general public, the faculty often make presentations in local community settings, for instance at the Sigma Xi sponsored Science Café and on Hawaii Public Radio.

2. Newsletters

Another of the major outreach tools of the department is the newsletter (available on the Department web site, www.ore.hawaii.edu). This newsletter is written twice a year and covers the major research, new students awards and directions of the Department. It is sent to all alumni and former faculty who were part of the department since it's founding in 1966. It is one of the major tools used to keep in touch with alumni who number just under 300 for the entire period. The ORE secretary keeps up the email database for the newsletter that is sent out electronically. As part of the newsletter we request news and comments from alumni as well as soliciting donations. Over the years this newsletter has perhaps been our most successful outreach tool.

5.7 Concluding Statement

1. Overall assessment

The Department of Ocean and Resources Engineering provides a critical component of engineering education to provide the needed workforce in Hawaii. It fills a clear educational mandate of the State of Hawaii in the area of marine technical training. ORE is among the highest ranked ocean engineering department in the country. In 2010, ORE prepared a 250 page self study and was evaluated along with five other UH engineering departments by the Accreditation Board for Engineering and Technology (ABET). ORE was fully accredited for the maximum possible time of accreditation, 6 years and had the highest rating of all five UH departments reviewed. ORE had no deficiencies or weaknesses and only two very minor concerns. This is a stellar performance and a great improvement from past ABET cycles.

To help highlight ORE's situation, we performed a SWOT analysis. This simple technique identifies strengths, weaknesses, opportunities, and threats as seen from a broad outside perspective but with clear inside vision. It has been presented in the Overview sidebar.

In conclusion, the more recent success of ORE has been due to several factors. Perhaps the most important of these is the commitment of funds and positions from the Dean of SOEST to allow an expansion of ORE from four to eight faculty (including two HURL staff members). Second, ORE has very strong local and national and international advisory boards that provide insightful advice that ORE tries closely to follow. Third, ORE has developed an evaluation and assessment regime with 12 criteria to greatly help assess the progress and results achieved. Fourth and finally, ORE has focused on some of its new strengths such as tsunami research and wave modeling, offshore renewable energy, and acoustics where the department has excellent internationally known expertise. Taken together these four factors are carrying ORE forward in a well-defined manner poised for continued success.

2. Relationship with SOEST

The Department has excellent relations with the other academic and research units of SOEST. A definite attraction is the ease of collaboration across units and the relative lack of "stove pipes." The physical proximity of all the units helps in this respect. From our perspective, SOEST is a closely-knit research enterprise, one that values and understands the "T" in SOEST. We take this opportunity to also reiterate our good two-way relations with the faculty and Dean of the College of Engineering.

3. People for the Review Board to meet

- Peter Crouch, Dean of the College of Engineering
- Brian Bingham, Assistant Professor of Mechanical Engineering, Coop Faculty ORE
- Rhett Butler, Affiliate Researcher, HIGP

4. Facilities to visit

- Engineering Support Facility, HIG 153
- SOEST Ocean Glider Facility, HIG 155
- Ocean Engineering Lab, HIG 133
- The SOEST Video Wall
- HURL, Makai Pier (we are very willing to host an early evening dinner there!)
- UH Marine Center – Snug Harbor