Sea Grant College Program

The National Sea Grant College Program supports research, education, and outreach activities that address critical problems in human use of the sea. The MIT Sea Grant College Program focuses on developing scientific and technological systems that can provide ever-increasing accuracy and range in exploration, data gathering, analysis, and understanding of marine processes. Essential to this purpose is the transfer of knowledge to and within the program's broad constituency—industry, government agencies, public and private educational institutions, and the general public.

Sea Grant director Chryssostomos Chryssostomidis traveled to Washington, DC, several times this year for meetings of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. The group finalized operations on March 11, having uncovered numerous contributing factors to the blowout of the Macondo well, including a series of questionable decisions in the days preceding the blowout, emergency backup systems failures, poor design and materials, inadequate operation and maintenance protocols, and insufficient oversight and regulation.

The commission concluded that "Neither the actions, policies and procedures of the corporations involved, nor the oversight of the regulatory scheme, provided an effective systems safety approach commensurate with the risks of the Macondo well." The Commission's findings are now available: "Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling: Report to the President" (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Professor Chryssostomidis will continue assisting with revisions through late July 2011 to the section dealing with the rig.

MIT Sea Grant's research and outreach efforts fall under four general headings and are described below:

- autonomous underwater vehicle laboratory
- design laboratory
- funded research projects
- education and advisory services

Autonomous Underwater Vehicle Laboratory

MIT Sea Grant is historically credited with creating and developing autonomous underwater vehicles (AUVs)—small, inexpensive, artificially intelligent robotic submarines for undersea exploration.

Currently the lab is working with versions of the Reef Explorer (Rex) designed to maneuver in delicate underwater ecosystems without harm, and Odyssey IV, a deepwater AUV with hovering capability, rated to 6,000 m and designed for high-speed dives and ascents.

Reef Explorers

Rex II is a remotely controlled robot that combines the responsiveness and control of a remotely operated vehicle (ROV) with the versatility and range of an AUV. Rather than being tethered to shore or a boat like an ROV, Rex II is tethered to a surface buoy that sends and receives radio signals wirelessly via radio antenna. Rex II's small, compact design (110 lbs, 2 ¾ x 2 ¾ x 1 $^{2}/_{3}$ ft) means it can be transported, deployed, and controlled by a single scientist. Rex II is operated from a laptop using a standard PlayStation® II video game controller. A color video camera, a GPS compass, and a surface GPS unit allow for eye-in-the-sea monitoring of marine ecosystems.

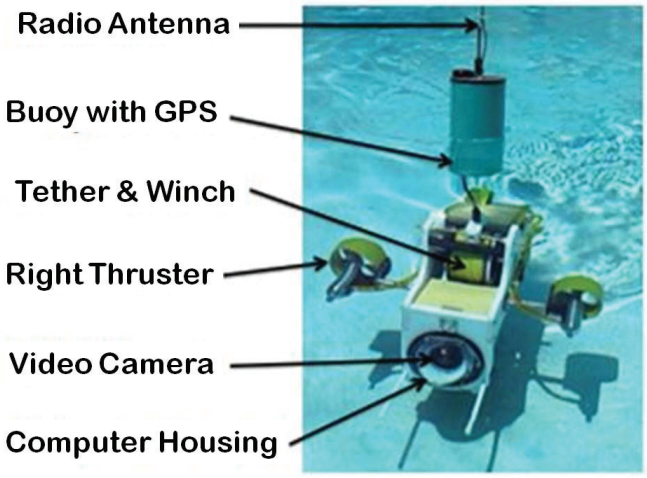

Figure 1: Major components of the Rex II AUV/ROV hybrid

Rex II proved especially adept at recording quality video of eelgrass, showing the contrast between scarred areas and healthy beds. As deployments required only one to two scientists, AUV/ROV monitoring proved more efficient in terms of man-hours than sending a dive team, the traditional method for gathering eelgrass data. Rex II was also deployed this year in the Mystic Lakes (in Massachusetts) to observe methane bubbles (for professor Harold Hemond of the Department of Civil and Environmental Engineering), and for sunken vessel telepresence viewing (in collaboration with Virginia Sea Grant).

The sensor suite and data-gathering capabilities of the Rex can be expanded, simplified, and tailored for different missions and sea states. The AUV Lab will be developing a Rex III and IV in the coming year. To create Rex III, Rex II will be streamlined and reengineered for higher speeds, more range, and greater depth. Mechanical simplification will make it smaller and cheaper to build, while software improvements will allow seamless transition between autonomous, supervisory, and remote control. Rex IV, based on Rex III, will be enhanced with a manipulator, to make possible tasks beyond survey and inspection.

Odyssey IV and Underwater Communications

With funding from the Chevron Corporation and the Office of Naval Research, MIT Sea Grant has developed the Odyssey IV, a vehicle designed for both ultra-deepwater

oil production and oceanographic research missions. Odyssey IV's energy storage and power management system can support payloads requiring up to 1.5 kW (peak power). It is stable in towed flight and also equipped with powerful vectored thrusters for hovering in place or precise maneuvering around objects on site. Navigation suitable for exploratory missions is via Doppler velocimeter-aided dead reckoning, which eliminates the need for reference beacons on the sea floor and increases operational flexibility

In this reporting year, the lab worked with Chevron's DeepStar, a joint industry technology project to develop AUV technology to explore, monitor, and intervene in deepwater oil field sites. The MIT Sea Grant AUV Lab has undertaken to provide image-based, supervisory control of an AUV using a wireless acoustic link to transfer video images and send control commands in real-time. This would make AUVs significantly cheaper to operate compared to the cumbersome, tethered ROV systems currently used in inspection and intervention procedures at oil field sites. We hope to demonstrate that AUV technology is reliable and efficient and will allow for easier and more efficient inspection of sensitive subsea equipment. The 2010 Horizon oil well blowout in the Gulf of Mexico emphasizes the value and importance of this work.

Underwater acoustic channel physics often dictate data rates that can be reliably achieved, and these are often very low. This year we developed and extensively tested a wavelet and MPEG-4 algorithm. Our simulation showed that MPEG-4 video compression, coupled with the OFDM algorithm, would enable us to transfer live video images wirelessly through the underwater acoustic channel and simultaneously allow sending supervisor control commands to an AUV. Later this year, a field demonstration of underwater wireless video transmission will be performed.

Design Laboratory

Under the general heading of the Design Laboratory, MIT Sea Grant carries out advanced work in naval architecture and systems. Designs of ship components, power and propulsion systems, and the hydrodynamics of various vessel hull shapes are modeled and tested using complex numerical simulations. The Numerics in Computational Engineering group, with its expertise in multi-scale mathematics and high-performance computing, complements and supports field experiments of physical models.

Electric Ship Research and Development Consortium

MIT Sea Grant director Chryssostomidis is active in the nationwide Electric Ship Research and Development Consortium (ESRDC), whose mission is to design an all-electric vessel for the US Navy. The group is managed by the federal Office of Naval Research, with participation from leading electric power research institutions and senior naval officers. The MIT ESRDC team is led by Professor Chryssostomidis and includes professor Michael Triantafyllou and assistant professor Franz Hover of the Department of Mechanical Engineering; professors Steve Leeb and James L. Kirtley of the Department of Electrical Engineering and Computer Science (EECS); professor George E. Karniadakis of Brown University; and associate professor Richard Kimball of Maine Maritime Academy. Karniadakis and Kimball hold research scientist and visiting scientist appointments, respectively, at MIT. They are assisted by research scientist Julie Chalfant and research engineer Mirjana Milosevic Marden.

The group has created an early-design, system-level engineering tool, the VisESRDC, which allows designers to visualize the thermal and electrical loads and equipment locations within a three-dimensional physical ship. They are now working to integrate VisESRDC with another such tool, Paramarine, a commercial product produced by Graphics Research Corporation. The objective is to combine the naval architecture functionality of Paramarine with the comprehensive visualization functionality of VisESRDC to display heat sources and power consumption under different operational scenarios.

Based on successes reported by designers in China, cloud computing is also being considered for supporting this collaborative design effort. The cloud environment reduces the cost of design and construction and improves the functionality of the final design. The ESRDC has developed key computer models and design architecture to be loaded to the cloud.

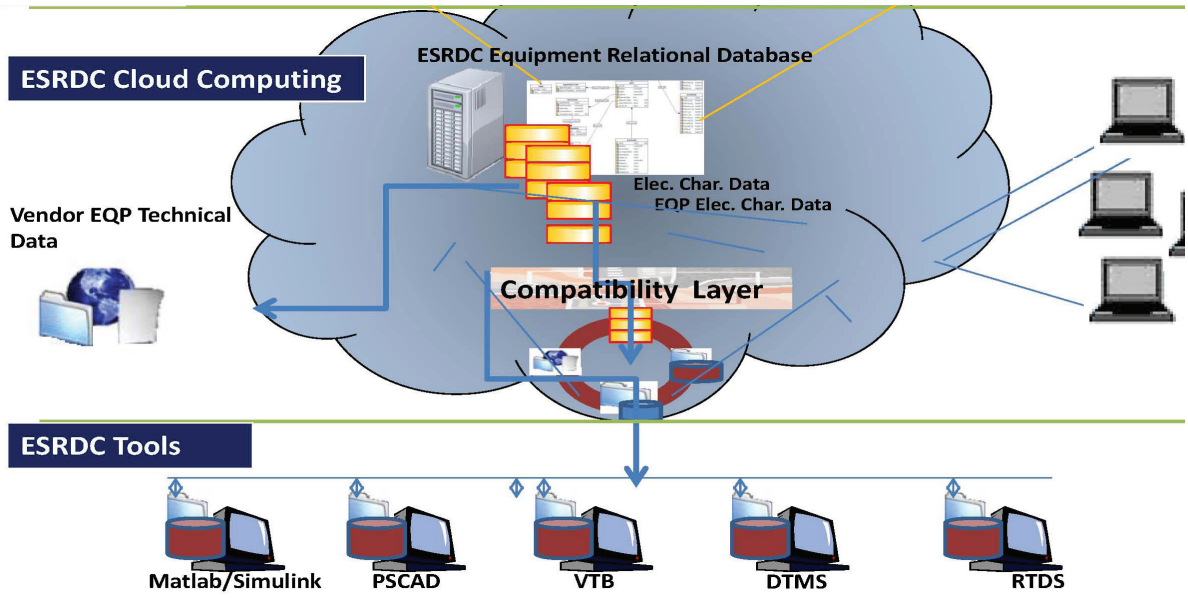

Figure 2: Concept drawing of the ESRDC cloud computing environment

This work will help the Navy, which funds the ESRDC, establish its own cloud-based ship design system in the future. However, the ESRDC's work has broader implications for energy management and conservation. The US Department of Energy has identified sensing and measurement as one of the five fundamental technologies essential for the creation of a Smart Grid. The ESRDC has devised a new way to collect electrical usage data with a greatly reduced investment in sensors, using a non-intrusive load monitor. This technology has great potential for helping consumers and managers balance and conserve energy demands and costs.

The ESRDC's project has resulted in a substantive body of publications and conference papers, of which this is a partial list:

"Simulation of a DC to DC Power Conversion Module for the All-electric Ship"

W. L. Gray, J. L. Kirtley, J. Chalfant, C. Chryssostomidis

"ESRDC Ship Notional Baseline Medium Voltage Direct Current (MVDC) Architecture Thermal Simulation and Visualization"

J. V. C. Vargas, J. A. Souza, R. Hovsapian, J. C. Ordonez, T. Chiocchio, J. Chalfant, C. Chryssostomidis

"Cooling System Early-stage Design Tool for Naval Applications"

E. R. Fiedel, J. Chalfant, C. Chryssostomidis

"Analysis of Various All-electric-ship Electrical Distribution System Topologies"

J. Chalfant, C. Chryssostomidis

"Presentation of Analysis of Various All-electric-ship Electrical Distribution System Topologies"

J. Chalfant, C. Chryssostomidis

"Comparison of Turbulence Models for Simulating Flow in Waterjets"

X. Luo, B. Epps, C. Chryssostomidis, G. E. Karniadakis

"A Design for the Interface Between a Battery Storage and Charging Unit, and a Medium Voltage DC (MVDC) Bus, as Part of an Integrated Propulsion System (IPS) in the All-electric Ship (AES)"

T. Trapp, P. Prempraneerach, C. Chryssostomidis, J. L. Kirtley, G. E. Karniadakis

"Dual-operating-point Blade Optimization for High-speed Propellers"

B. Epps, O. Viquez, C. Chryssostomidis

"Presentation of Integration of the ESRDC Notional All-electric Ship Visualization with Paramarine"

J. Chalfant, J. Souza, S. Motiwalla, C. Chryssostomidis, R. Hovsapian, J. V.C. Vargas, J. C. Ordonez

"Presentation of a Design for the Interface Between a Battery Storage and Charging Unit, and a Medium Voltage DC (MVDC) Bus, as Part of an Integrated Propulsion System (IPS) in the All Electric Ship (AES)"

T. Trapp, C. Chryssostomidis, G. E. Karniadakis, P. Prempraneerach, J. L. Kirtley

"Presentation of 'All-electric Ship' Model Power Conversion Module (PCM)"

W. L. Gray, J. L. Kirtley, J. Chalfant, C. Chryssostomidis

"Spectral Element/Smoothed Profile Method for Turbulent Flow Simulations of Waterjet Propulsion Systems"

X. Luo, C. Chryssostomidis, G. E. Karniadakis

T-Craft

Early in 2008, the US Navy approached the ESRDC team about evaluating a new vessel, the Sea Base Connector Transformable-Craft, code-named T-Craft. Professor Chryssostomidis serves as a member of the evaluation team for overall design and development. In addition, Professor Chryssostomidis was awarded a separate grant to study the hydrodynamics and seakeeping behavior of the craft and its waterjets, particularly their performance in rough seas. The numerical modeling work for this is ongoing and final results will be presented in the future.

OpenProp

This work, originally funded by Google, has matured to the stage where it is now in active use by advanced ship designers. The Center for Tankship Excellence has used OpenProp to study the effects of new regulatory requirements on the fuel efficiency of large container ships. The electric ship consortium has adopted the program for the task of calculating how much power (electricity) it takes to propel a ship using various propeller designs. Brenden Epps (MIT postdoctoral associate), OpenProp's creator, will present a paper titled "Dual-operating-point Blade Optimization for High-speed Propellers" at the 11th International Conference on Fast Sea Transportation in September 2011 on this project.

Funded Research Projects

As mandated by the National Oceanic and Atmospheric Administration, MIT Sea Grant conducts a yearly funding competition through the National Sea Grant office. Grants are available to researchers throughout the Commonwealth of Massachusetts. Selected proposals support the goals outlined in our strategic plan, and we are required to match every $2 from our federal grant money with $1 from nonfederal sources.

This year we selected six new core research projects for funding. We continued support for the six, two-year projects initiated in February of 2010, as well as several larger, ongoing, six-year focused research projects.

New Projects, Begun February 2011

Investigators submitted proposals for comments by in-state stakeholders, peer review by reviewers recruited from outside of Massachusetts, and finally, by a panel of technical experts chosen by the director. Six projects, described below, were approved for funding.

Don Anderson of Woods Hole Oceanographic Institution (WHOI) for his project: Development of Real-time Instrumentation for the Robotic Detection of Paralytic Shellfish Poisoning (PSP) Toxins in Massachusetts Coastal Waters. This proposal received top scores from peer reviewers and technical review panelists. It is also an excellent fit with one of MIT Sea Grant's long-term, strategic objectives of developing "advanced, efficient, field-tested instrumentation, sensors and platforms to assess and mitigate…threats to coastal water quality."

Professor Triantafyllou of the Department of Mechanical Engineering for his project: Energy Efficient AUV Using a Lateral Line Sensor. The panel and committees felt that increasing the energy supply in AUVs is a key issue in the field of ocean engineering. A panel member wrote, "This project offers important contributions for both near- and long-term impacts…. It is this near-term impact that ties the effort well to MIT Sea Grant program plans. A case study is the recent use of an AUV by MBARI (Monterey Bay Aquarium Research Institute) to collect water samples in the aftermath of the Macondo oil spill in the Gulf of Mexico. The work was of high value but the endurance limitations of the AUV were a genuine limitation. The project proposed here will yield algorithms, based on an existing sensor concept, that should improve performance of AUVs such as that recently employed in spill response."

Di Jin of WHOI for his project: Development of a Scientific Management Framework to Support the Ecosystem-based Management of Coastal Resources. The principal investigators proposed to develop a regional economic model based on computable general equilibrium principles and link it to an existing food web model to produce a model to allow for better management of fisheries on Georges Bank.

Seth Tuler, research fellow at the Social and Environmental Research Institute, Greenfield, MA, for his project: Improving Understandings of Consequences, Vulnerabilities, and Adaptation Strategies to Climate Change Related Hazards. Both the principal investigator and his institution are new to MIT Sea Grant funding. The proposal is a good match with our programmatic goals and the principal investigator was responsive to our request to modify the project to include a comparison of the different assessment tools to determine their efficacy.

Professor Hemond of the Department of Civil and Environmental Engineering for his project: Combating Nitrogen-driven Coastal Eutrophication: An Artificial Neural Network (ANN)-based Instrumentation Approach. The proposal was ranked fifth of eight by peer reviewers, but the committee considered it good fit with our strategic plan. The technical panel suggested that the principal investigator cut the project down by concentrating on the viability of the ion-selective electrodes, discarding the neural network piece, and including tests to prove that the sensors do not foul but remain functional under diverse field conditions. The investigator agreed to these conditions and rewrote the proposal and budget, cutting it from the $99,999 originally requested to $50,000.

Continuing Projects, Begun February 2010

Bob Chen of the University of Massachusetts (UMass) Boston for his project: Consortium for Ocean Sensing in the Nearshore Environment

John Stegeman and Jared Goldstone of WHOI for their project: Active Samplers: Development of Biomarkers for Coastal Pollution in the Blue Mussel, *Mytilus edulis*

Rodney Rountree, Francis Juanes, and Stephen Frasier of UMass Amherst for their project: DeepFSL—A Low Cost Bimodal Observation System for Deep Sea Ecosystem Research

Scott Gallager, Mary Carman, and Amber York of WHOI for their project: Assessing the Distribution, Spreading Rate, and In Situ Growth of *Didemnum vexillum* and Other Invasive Species along the Northeast Continental Shelf

Changsheng Chen of UMass Dartmouth for his project: Development and Validation of the Water Quality Model System for Massachusetts Coastal Waters

Alexandra Techet of the Department of Mechanical Engineering for her project: Three-dimensional Imaging System for In Situ Biological Sensing and Flow Velocimetry

Continuing Six-Year Focused Research Projects

Jeffrey Lang of EECS (started 2006) for his project: Touch-at-a-Distance, Pressure Microsensor Arrays for AUV Navigation

Milica Stojanovic of MIT Sea Grant (started 2007) for her project: Acoustic Communication Networks for Distributed Autonomous Underwater Platforms

Franz Hover of the Department of Mechanical Engineering (started 2008) for his project: Autonomous Vehicle Exploration and Sampling of Deepwater Corals

Advisory and Outreach Program

MIT Sea Grant has an active advisory, education, and outreach program designed to address issues important to local, state, and regional government agencies, coastal municipalities, businesses, and citizens' organizations. Our staff members have strong links to the community and serve as conduits for the transfer and exchange of marine science information and technological developments with our constituents. They are an active link between marine scientists and our constituents.

Marine Invasive Species

Tracking and mapping of invasive marine species is a key advisory initiative. Advisory leader Dr. Judith Pederson led the fifth Rapid Assessment Survey of Marine Invasive Species in collaboration with the Massachusetts Office of Coastal Zone Management from July 24 to July 31. An international team of investigators, mostly volunteers, identified five new invasive species, recorded the spread of previously observed invasives, and compared the biomass of non-native to native species. In some areas non-native species dominate the ecosystem and are spreading northward as ocean temperatures rise.

Data collected for the survey was entered into our Marine Invader Tracking Information System, the oldest and most robust of our tracking systems. As our work with marine bioinvasions has increased over time, with multiple projects and partners, we have moved from "shoebox" data kept in various software packages, to an integrated server-based application. This past year our database was accepted into an oceanographic data system, the Ocean Biogeographic Information System, that is part of the Intergovernmental Oceanographic Commission of UNESCO.

Figure 3: Rocky shore species sampling at Nahant

Climate Change

Research engineer Dr. Juliet Simpson, our coastal ecologist, surveyed salt marshes in Duxbury and Kingston, MA, measuring indicators of ecosystem health and resilience to both rising sea levels and severe and damaging storm surges. Salt marshes are a buffer against the effects of climate change, protecting coastal properties, infrastructure, and ecosystems. Survey results were provided to managers and municipal officials through a Google map and other documentation, supporting more effective land use planning in those towns.

Coastal Use Conflict Resolution

Space-use conflicts are common between renewable energy advocates, commercial and recreational fishermen, and boat operators along our coast, and offshore energy projects are thwarted or delayed by such conflicts. Madeleine Hall-Arber, MIT Sea Grant anthropologist, is conducting ethnographic research in the Northeast, mid-Atlantic, southeast Florida, northern California, Oregon, and Washington to provide some factual foundations to this ongoing debate. As part of this project, funded by the Bureau of Ocean Energy Management, Regulation and Enforcement, a geospatial database is being created to determine how best to mandate multiple-use areas offshore.

Communications

This was an extraordinarily active year in communications. Our newly hired communicator specialist Nancy Adams completed a dramatic overhaul of MIT Sea Grant's website, incorporating social media tools such as Facebook and YouTube. RSS feeds and podcasts are in the works. She is also publishing a well-received and popular e-newsletter. This period has seen the production of over 60 publications, dozens of media releases, and public relations pieces that effectively highlight MIT Sea Grant projects and programs. The website runs on Sea Grant's content management system, electronic Sea Grant (eSG), providing information on 900+ MIT Sea Grant projects, 1,400+ publications; pages for staff, students, and interns; program news and announcements; image and video galleries; a calendar of events; and numerous other features.

Education

A key component of outreach is a comprehensive and varied educational program, mostly directed at K–12 students. The most effective tool in our educational toolkit is the Sea Perch, a simple ROV young people can build out of inexpensive, easily available materials. Launched in 2003, the Sea Perch program has trained scores of educators to build the Sea Perch, and to use it on missions to observe underwater environments and collect near-shore water quality data. Having trained teachers in over 200 schools (including in Cyprus and France) the program has ignited schoolchildren's enthusiasm for science, technology, and engineering on several continents.

Sea Perch teacher trainings have evolved into a suite of programs and activities to exploit the outstanding success of this ongoing effort.

Sensor Suite for Sea Perch

In January, MIT Sea Grant engineering educator Kathryn Shroyer began work on version 3.1 of the Sea Perch Sensor Suite. The suite is a student-built, water quality sensor kit. The process of building the suite introduces students to the basics of marine science and engineering while learning hands-on engineering skills such as soldering, computer programming (including BASIC), and circuits and electronics. In deploying the suite, students learn to measure time, temperature, depth, and light, and then upload the data to the MIT Sea Grant Digital Ocean water quality database. Digital Ocean stores and displays data collected by students around the world, showing trends in the state and condition of the ocean over time.

The sensor suite is currently undergoing testing and revision by Sea Grant staff, as well as beginning beta testing with educators in the field. The sensors we have chosen for the suite measure selected variables (e.g., time, temperature, transparency, and depth) that are key to the productivity and health of marine ecosystems. Students who build the Sea Perch ROV and then build and deploy the sensor suite will have a complete introduction to oceanographic engineering, data collection, and the marine sciences.

Sea Perch Institute 2011

The Sea Perch Institute is a multi-year program that works with veteran Sea Perch schools to build on the basic Sea Perch course with a more advanced and multidisciplinary curriculum. Schools are selected based on demonstrated support from school administration and the involvement of multiple teachers and classrooms: four were accepted in 2010, and five in 2011. Professional development workshops are held for teachers during the year, focusing on new technology, current research, and field sessions.

The exciting finale to the institute year was the Sea Perch Institute Challenge held on May 6 at MIT's Zesiger Sports and Fitness Center pool. Over 300 middle and high school students worked in teams to analyze and remediate a simulated deepwater oil spill resulting from a blowout, using remotely operated underwater vehicles they had built and equipped themselves.

The 14th Blue Lobster Bowl

This event, organized by MIT Sea Grant in collaboration with the Center for Ocean Engineering, is one of the 25 academic tournaments that comprise the National Ocean Sciences Bowl. The February 2011 Blue Lobster Bowl featured 130 students from 15 Massachusetts high schools. First place went to the team from Lexington High School; second and third place were taken by teams from Lincoln-Sudbury Regional High School. Lexington went on to take second place at the National Ocean Sciences Bowl in late April at Texas A&M University in Galveston.

In addition to the opportunity to travel to the national finals, teams vie for a variety of prizes, including scholarships, internships, and educational trips. All participating students are also eligible to apply for the Coastal and Ocean Science Training internship program funded by the National Oceanic and Atmospheric Administration, and the National Ocean Sciences Bowl's National Ocean Scholar Program, a two-year, $6,000 scholarship award for students studying marine and coastal sciences. In addition, Blue Lobster Bowl participants are eligible to apply for two six-week paid summer internships at MIT Sea Grant, described in the Students Supported section.

The Ocean Engineering Experience

In July, MIT Sea Grant hosted its first Ocean Engineering Experience (OEX), a residential summer camp aimed at recruiting students to the field of ocean engineering. Participants chosen in a competitive application process came from Georgia, Washington, Maryland, and Massachusetts. The program is jointly sponsored by the MIT Sea Grant Program and the Center for Ocean Engineering. Tuition was $1,200 per student, with some scholarships coming from Blue Lobster Bowl funds.

Instruction was provided by graduate and undergraduate students, research staff, and faculty with experience in robotics and ocean and mechanical engineering. The student team had access to state-of-the-art laboratories at the Center for Ocean Engineering, and program size was limited to approximately 28 participants.

The mission for OEX students was to design and build a fully functional, floating wind turbine and an ROV. The turbine was moored on the Charles River and the ROV had to be guided to dock at the turbine platform to simulate data transfer or battery charging. The students successfully demonstrated their project on July 30 at the MIT Sailing Pavilion.

Figure 4: OEX students bringing the turbine platform to the river

Students Supported by MIT Sea Grant

MIT Sea Grant promotes and administers a number of programs and awards that directly support aspiring scholars who are pursuing studies and careers in marine research.

The 2010 Dean A. Horn Award for Undergraduate Study in Marine Research was awarded to Adam Doroski, a senior in the Department of Mechanical Engineering, for his research and written report, "Precision Stationkeeping with Azimuthing Thrusters."

The Dean John A. Knauss Marine Policy Fellowship places graduate students with host organizations in legislative or executive branches of government. Caitlin Frame, a graduate of the MIT/WHOI Joint Program, is currently serving as a science specialist in the US Department of Energy's Wind and Water Power Program.

Undergraduate Research Opportunities Program

During this reporting period, the following students conducted Undergraduate Research Opportunities Program projects, supervised by Sea Grant staff in the lab or in the field:

Owusu Ansah Agyeman Badu, senior (Mechanical Engineering): Assessment of Salt Marsh Vulnerability to Climate Change (summer 2010)

Matthew L. Gildner, senior (Mechanical Engineering): Development of an Inductive Charging System for an Autonomous Underwater Vehicle (summer 2010)

Jessica Lin, senior (Mechanical Engineering): Development of Academic Quiz Game (fall 2010) and Creating an Online Ocean Science Bowl (spring 2011)

Joann Lin, junior (Civil and Environmental Engineering): Space-use Conflict in the Development of Offshore Alternative Energy Sites (summer 2010) and Source Tracking of Pollutants in the Boston Harbor and Beyond (fall 2010)

Caine L. Jette, senior (EECS): Continued Development of Electronic Ocean Sciences Bowl (summer 2010)

Oscar A. Viquez Rojas, sophomore (Mechanical Engineering): Development of Numerical Codes for Design and Analysis of Marine Propellers and Wind Turbines (summer 2010) and Development of Propeller Chord Optimization Model for Both Cruise Speed and Max Speed (spring 2011)

Xin Qi Li, junior (Biological Engineering): Environmental Pollution by PPCPs (spring 2011)

Jessica Lin and Oscar Viquez Rojas will continue work on their undergraduate research projects with Sea Grant for the 2010 summer term, and Jeffrey Carothers (freshman, Mechanical Engineering) will act as an undergraduate research project student mentor for the OEX program.

Internships

Two high school students will work alongside marine scientists from MIT Sea Grant this summer: Susanna Elledge, a senior at Brookline High School, and David Matthews,

a graduate of Bedford High School. The two will be part of a team monitoring invasive species in the intertidal zones of the Boston Harbor Islands National Park.

Administrative Initiatives

The electronic project management and website content management system, eSG, was essentially completed during this reporting year. The system has been installed at four other Sea Grant Programs in Washington, Virginia, North Carolina, and Georgia. It will be installed in Texas and California this summer. This system handles the entire proposal and reporting cycle, including peer review and rebuttal, all subsequent required reporting, and submission and distribution of technical papers.

2011 MIT Sea Grant Lecture

Each year MIT Sea Grant presents a lecture or symposium on an ocean-related topic. On April 20, we hosted Professor Wallace Broecker, the Newberry Professor of Geology at Columbia University's Earth Institute and a scientist at the Lamont-Doherty Earth Observatory. As one of the first climate scientists to understand the thermohaline circulation of the global ocean and its moderating effects on our climate, Professor Broecker has been described as one of the world's greatest living geoscientists, "a genius and a pioneer" and "the grandfather of climate science." His visionary work has earned many awards, including the National Medal of Science and the Tyler Prize for Environmental Achievement.

The lecture, "Climate and the Oceans: Where We've Been and What's Ahead," was delivered at the MIT Tang Center's Wong Auditorium. The well-attended event featured a lively question-and-answer period and was followed by a reception.

Staffing and Oversight

MIT Sea Grant is overseen by a Joint Advisory Committee consisting of MIT faculty members and leaders in Massachusetts' marine-related industry, colleges and universities, state government, and key non-governmental organizations.

The program's management team consists of a director (Professor Chryssostomidis) and an associate director for research utilization (Dr. E. Eric Adams). Professor Chryssostomidis is responsible for overall program management; Dr. Adams's research portfolio is in coastal processes. Our former associate director, Milica Stojanovic, has taken a faculty appointment at Northeastern University but retains a part-time position with MIT Sea Grant to work on underwater communications. The management team is jointly responsible for planning the program's research directions.

Dr. Pederson leads the program's advisory group. MIT Sea Grant's administrative staff consists of assistant director Timothy Downes and program coordinator Katharine de Zengotita. The advisory, education, and outreach program now has seven professional staff members, including Dr. Pederson. Their expertise covers climate change mitigation, coastal ecosystems, invasive species, educational programming, anthropological research in fisheries, and data and communications. In addition to the advisory staff,

MIT Sea Grant employed eight research engineers in the AUV Laboratory, and in support of our externally funded research in the Design Lab.

Changes this year include the hiring of Nancy Adams as communications specialist and Joanne McHugh as assistant to the director. Kathryn Shroyer, an MIT graduate, has joined the education section of the advisory group, along with Rachel VanCott, an MIT graduate with a SM in Science. Together, Shroyer and VanCott manage the Sea Perch outreach program, which includes the summer OEX event.

Special Awards and Funding

Each year MIT Sea Grant awards the Doherty Career Development Chair for Ocean Utilization, a two-year appointment at $25,000 per year for a young professor working on marine research. The 2011 winner is assistant professor Kripa Varanasi of the Department of Mechanical Engineering for his project, Nanoengineered Surfaces for Hydrate Mitigation in Subsea Oil and Gas Operations.

Chryssostomos Chryssostomidis
Director
Henry L. and Grace Doherty Professor in Ocean Science and Engineering