



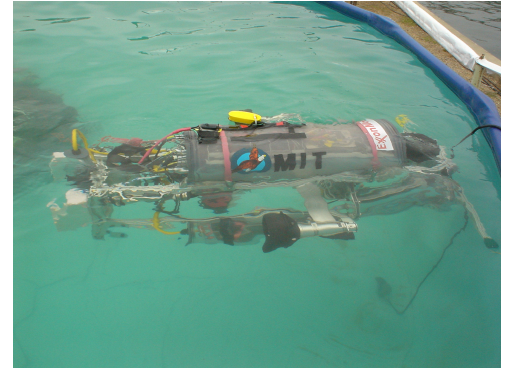
Making Waves

ORCA AUV Team

Contributed by Winnie Cheng

- **Volunteer for the Ocean Science Bowl 2005 in Feb! Email for more info: marcum@mit.edu**

Project ORCA is an MIT student group interested in Autonomous Underwater Vehicle (AUV) technology. The group was established in 1998 to design a vehicle to compete in the first International AUV competition organized by the Office of Naval Research (ONR) and the Association for Unmanned Vehicle Systems International (AUVSI). Since then, the group has attracted new members each year providing a fun hands-on experience in the design of new vehicles for this annual competition. The team consists of students at all levels, undergraduate and graduate, from a variety of engineering disciplines. In the past 8 years of the competition, ORCA has placed 1st five times and qualified into the final round every year.



The ORCA VIII

from a six-axis Inertial Measurement Unit (IMU) combined with appropriate data filtering assist in precise navigation control of the vehicle. A custom-built acoustic direction finder allows the vehicle to detect and drive towards acoustic pings. ORCA VIII is equipped with two Firewire cameras feeding live video streams to our machine vision algorithms and a line-scan camera with custom optics for efficient detection of modulated light.

ORCA VIII, the entry to this year's competition, follows the basic modular design philosophy of previous incarnations of ORCA. The mechanical frame and core systems are mostly unchanged from 2004's entry, allowing development efforts to be concentrated on adding sensing capabilities and redesigning some of the systems for increased performance and reliability.

This year's competition consisted of three tasks. One task was to rendezvous with a docking station represented by LED's blinking at specific frequency and color. Another task was to inspect a pipeline and mark a break in it by dropping markers into a bin. The third task was to home in on an acoustic beacon and surface within the zone. ORCA VIII has been designed to meet the goals of the competition. At the day of the competition, the vehicle was able to complete all three tasks individually. However, due to some calibration errors at the final competition run, ORCA VIII was only able to complete one of the three tasks, bringing home a third place finish. Nonetheless, the team had great fun coding and debugging under the California sun and we are all energized to build an even better vehicle for the coming year to recapture first place.

ORCA VIII is powered by four ROV thrusters. Two side-mounted thrusters provide thrust and yaw while a pair of vertically-mounted thrusters provide depth and pitch control. Measurements



The Team at SPAWAR.

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SNAME Maritime Technology Conference & Exposition

Contributed by Matthew Unger, (G)

For the past several years, SNAME's Annual Meeting (and more recently with its new name: SMTC&E), has featured a full program of events that include technical paper presentations, an exposition with industry vendors, and several social/networking events. But in addition to the "typical" conference agenda, the SMTC&E featured a full Student Program geared entirely towards the conference's student attendees. This year, the SMTC&E was attended by 128 students, which was over 20 percent of the conference's overall attendance!

The Student Program was organized and run by the SNAME Student Steering Committee, and this year's program was bigger and better than ever before. The following is a list and brief description of some of the student events:

- **Student Job Fair** – This event gave students the opportunity to talk with company representatives from most of the key sectors of the industry (offshore, commercial, government, and marine engineering to name a few)
- **Student Paper Presentations** – Two technical tracks offered seven student groups the opportunity to present their award winning papers and design competition entries. Among the presenters was MIT junior Evan Karlik who presented his paper entitled *Geometry and Performance of Stereolithographed Model Propellers 5449 and 5450 at the Naval Surface Warfare Center, Carderock Division*. Evan's paper won the first place award for the SNAME undergraduate paper competition.
- **Student Congress and Design Competition** – This has always been the highlight event of the



A "life boat" from the design competition.



Evan Karlik (OE '07) with Prof. Tom Lamb, Chairman of the Education Committee

student program, and this year was no different. Students were tasked with building their own version of a modern lifeboat, capable of being launched by way of a ramp into a test pool. The boats were tested for their self-righting capabilities and crashworthiness, as determined by whether any of their passengers (eleven Grade-A large eggs) had cracked from the impact. All the teams should be commended for a job well done. The winners, Team Breakfast Club and their lifeboat named "The Descrambler" received a \$500 prize.

- **Student Summit** – Faced with low student retention and few young members, this new event was a first step for SNAME to learn first hand what our younger members expect from SNAME. With over 60 students and 18 SNAME leaders in attendance, an extremely lively brainstorming session took place and has given SNAME and the Student Steering Committee an overwhelming number of ideas and input for improving the value of a SNAME membership. Be sure to look for the formal report from the SSC that outlines the findings from this event. The Student Summit was an extremely exciting event right up to the end, when President Compton promised to visit each of SNAME's Student Sections during the upcoming year. Thank you President Compton for showing how much SNAME cares about its students!

Other events of note included the MIT Alumni cocktail social, and the SNAME Annual Banquet. Thanks to the ConocoPhillips, the SMTC&E Student Program Sponsor, all students attended the Banquet for free.

All totaled, this year's program can be considered a great success. The number of students showing interest in SNAME was extremely promising. Be prepared for another great program at the next SMTC&E in Fort Lauderdale, where we hope even more students will attend.

Discover Ocean Engineering

Contributed by Timothy Villabona



Tim with his Sea Perch

I came to MIT as I'm sure most of the entering freshman class does--nervous and disoriented at the prospect of beginning my college career at a world-renowned technical institution. Discover Ocean Engineering provided me a perfect opportunity to slide comfortably into my new lifestyle, and acquainted me with a firsthand look at what ocean engineering encompasses. Much of the stress of adjusting to a new locale was diminished because I was kept busy with the program. I quickly got to know my group, and became friends with my ROV-building partner and upperclassmen mentors.

We spent the first couple of days building a Sea Perch ROV (Remotely Operated Vehicle). These instruments can be fully submerged in water with various devices attached for gathering data, taking pictures, etc. The body is constructed out of lightweight PVC pipe and the entire apparatus is propelled by three small propellers driven by electric motors. By the fourth day, we were able to test our ROVs in the Zesiger Center Pool.

Fortunately, our DOE experience was not constrained to the MIT pool, and we explored and were exposed to many real-world applications of ocean engineering. We were able to visit the Mystic Aquarium and Seaport, tour MIT ocean engineering laboratories, and finally, test our ROVs at Woods Hole. The trip to Mystic Aquarium gave a glimpse of the amazing animals of the ocean, while the afternoon exploring Mystic Seaport served as an opportunity to discover the roots of nautical transport and the history of a maritime town. Touring OE labs at MIT, brought the curious student face-to-face with some examples of engineering practice, such as an Odyssey AUV or the swimming "turtle" robot.

On the last day of DOE, we brought our Sea Perches to Woods Hole to test them in the harbor. After exploring the labs around Woods Hole, my partner and I played with the ROVs for a while. We were able to get a clear view of several ships' hulls, complete with algae and barnacles. We wrapped the day up by returning to MIT and enjoying a slideshow of all the pictures taken during our field trips.

What Did You Do Last Summer?

Seth Clark, OE '07

I worked for Island Packet Yachts this summer in Largo, FL. I spent the beginning of the summer working in the tooling department helping to build their newest hull plug. Later on I moved into their mill and used AutoCAD and Rhinoceros to model and document all of their cabinetry; including dimensioning and building notes. I learned a great deal about naval architecture and yacht construction in general.

Lauren Cooney, 2-OE, '06

Over the summer, I worked on the San Diego/Southern California Coastal Ocean Observing System at the Scripps Institute of Oceanography. I was looking at internal waves near and offshore, using a REMUS AUV and an optical sensor carriage.

Bridget Downey, OE '06 and OSM '07

This past summer I worked for Parsons in their Transportation Group (Irvine, CA). My project was to work on the Rail Master Plan for the Port of Long Beach. My specific role was to improve the schedule and finish the Rail Map for the Port. I learned to use AutoCAD, got to go on a couple of site visits to the San Pedro Ports, and had an awesome time at the beach on the weekends.

Evan Karlik, OE '07

I completed a month of Navy ROTC training in June, which entailed a "tour" of the different Navy communities and enabled me to spend a night aboard a fast-attack submarine and a few days aboard a destroyer, fly helicopter and F/A-18 flight simulators, and shoot an M16, M249 automatic, and M203 grenade launcher. The other two months I worked at the university in Bremen, Germany on a soil mechanics project, studying water transport and channeling through saturated sand, and traveled the country on weekends.

Jordan Stanway, OE '06

I built an asset management database and designed a draft measurement system for Shell's offshore platforms.

Thaddeus Stefanov-Wagner, ME '06

I worked for Shell in Houston Tx, evaluating navigational technology for a HUUV (Hybrid Underwater Unmanned Vehicle). The HUUV would be used to provide maintenance and support for seabed operations during the winter when sea ice prevents ship access. My job was to determine the feasibility of making a vehicle with both long range and short range positioning capabilities, as well as a collision avoidance system suitable for use in arctic conditions.

David Tobias, ME '06

I worked for Systems Planning and Analysis Inc., on technology assessments for the U.S. Navy's CVN-21 and large displacement UUV programs.

Nina Young, OE '07

I worked at Lamont Doherty Earth Observatory in the Geo-Chem Department under William Smithie doing CFC/Oceanography research which included a UC Scripps cruise in the Santa Barbara Basin to test the properties of a new tracer element SF5.

Research Spotlight: Prof. Paul Sclavounos

As told to Lauren Cooney, 2-OE '06

Professor Paul Sclavounos has been an active member of the MIT Ocean Engineering community since 1977, earning his Ph.D. in Marine Hydrodynamics in 1981, and has been teaching here since 1981. Research topics which Prof. Sclavounos and his students are currently studying are the motion control and optimal ship navigation as well as offshore wind energy, exciting fields which deal with surprisingly similar problems and have the potential to be very valuable in generating electricity from the wind and reducing the fuel consumption of ships.



The “ship navigation and control in a stochastic environment” is a very important research subject, allowing for the “optimization of fuel efficiency in marine navigation,” said Prof. Sclavounos. There are several elements of the control problem which his group is studying. For example, one of his graduate students is investigating the motion control of high speed vessels in random waves. By coupling this theory to the resistance, propulsion and seakeeping problems, Prof. Sclavounos hopes to better understand operational and environmental uncertainties, leading to more fuel efficient marine systems, resulting in an “impact on the maritime community which can be very substantial.”



Offshore wind energy has been another topic attracting strong interest from both scientific and political groups, including various sectors of the Oil industry, General Electric Company, and the Massachusetts Technology Collaborative, just to name a few. Prof. Sclavounos envisions a 500 MW offshore power plant, made up of 100 or more 5 MW floating wind turbines. There are a range of shapes and sizes for possible turbine designs, but a current estimate is somewhere around a tower height of 100m, blade radius of about 65m, buoy diameter around 35m, and a draft around 10m.

Prof. Sclavounos describes many of the fundamental disciplines and complexities involved in the development of an offshore wind turbine, including “marine hydrodynamics, wave-body interactions, responses in stochastic wind and wave environments, and minimization of the amount of steel and other materials needed to put together such a structure”. His group has been researching the design of turbines in waters up to depths of 300 m (a “good upper bound for the North-Eastern coastline”), as well as the real time regulation of pitch angle of wind turbine blades, a problem similar to that of the control of ship navigation.

Professor Spotlight: Captain Patrick Keenan

Contributed by *Bridget Downey (OE '06)*



While a new member of MIT's faculty, Captain Patrick Keenan, USN is not new to the Center for Ocean Engineering. A graduate of the US Navy's Construction and Engineering program here at MIT in 1993, Capt. Keenan is now welcomed back as a Professor of the Practice for the program. Capt. Keenan was offered the position after his predecessor Capt. David Herbein, USN retired last year.

Capt. Keenan's primary responsibilities are to advise the students that are part of the Construction and Engineering program (students hail from the US Navy, US Coast Guard, and foreign navys), and to teach courses in the program's new place in the Mechanical Engineering Department. He is currently a lecturer in various courses, including Introduction to Naval Architecture (2.701), Computer-Aided Design and Systems Engineering of Naval Ships (2.702), , Projects in Naval Ship Conversion Design (2.704), Projects in New Concept Naval Ship Design (2.705). This is the first opportunity that Capt. Keenan has had to teach in an academic setting, and he is thrilled to have the

opportunity. From his perspective as a Professor here at MIT, he mentioned that he must always be "on his toes" when lecturing. It is likely that he shares these sentiments with his former Professors that include Prof. Yue, Prof. Wierzbicki, and Prof. Carmichael to name a few. Captain Keenan enjoys the intellectual environment at MIT, and feels "privileged to be part of a world class education and research institution."

Prior to coming to MIT this year, Capt. Keenan's role with the Navy included doing diving, salvage, ship repair, and dry docking work. He was based in Singapore as a Salvage Officer, in Florida working on aircraft carrier repair, in Bahrain as a Salvage Officer, and finally back to Florida as Commanding Officer Navy Experimental Diving Unit, before he joined us up here in New England.

Salvage, marine heavy lift transport and dry docking are Capt. Keenan's primary work interests. Outside of work, his interests are his family (wife and two boys), working on his home (200 years old) in CT, and skin diving for lobsters.

Alumnus Spotlight in Her Own Words: Ann M. Polsenberg

I graduated in 2001 with my SB in Ocean Engineering and a minor in Music. Shortly after graduation, I spent a few weeks in Greece on an underwater archaeology mission with Professors Chryssostomidis, Triantafyllou, Mindell, and many of the AUV lab and DeepArch folks. After that it was off to Pasadena, California, where I have been a graduate student in Mechanical Engineering ever since.

This spring I will be defending my doctoral thesis at Caltech in the research groups of Professors Joel Burdick and John Dabiri. The topic is "Cephalopod Inspired Pulsatile Jet Propulsion for Small Underwater Robots," also known as "can a robot swim like a jellyfish or squid?" I think the answer is yes. I've been fortunate to have a wonderful team of undergraduate students working with me (whom I still think of as UROPs) and we hope to launch the prototype vehicle shortly before I graduate.

Another role I have at Caltech is founder and leader of the Caltech Robotics Outreach Group, which runs robotics programs and lectures at schools, museums, and on campus. We are about to hold our second annual conference on robotics for middle schoolers and their teachers. The topic? Underwater Robotics! (No one was surprised to hear that I had picked this topic.) I am also very active with Caltech's Engineers for a Sustainable World. Through a speaker series, classes, trips and projects, we are attempting to bring an awareness of environmental and societal issues to Caltech engineers.

In addition to my affiliation with Caltech, I have been a faculty member at the Art Center College of Design for over a year. At Art Center, I teach classes on "Nature's Designs" (A survey of biology, biomimicry, and bio-inspired design) and "Introduction to Robotics and Artificial Intelligence." It's a bit odd being a "student by day, faculty member by night," but it is also incredibly rewarding. Prior to joining the faculty, I had been a night student there in product and graphic design. 2004 marked my first gallery exhibition, a robotics/geology/music



AnnMarie during her honeymoon on the Isle of Man.

installation entitled "ear(th)" in collaboration with artist Steve Roden and professor Mark Simons.

Obviously my graduate work on underwater robotics uses my OE knowledge every day. Things I learned in all of my classes, particularly 13.017/8, 13.012 and 13.015, have been incredibly helpful.

Also important are the contacts I made in the OE department. I still keep in touch with many of my professors and bump into fellow OE alums at conferences (such as this year's UUST and OCEANS conferences.)

MIT still influences my life outside of work as I am married to a fellow MIT alum, Chris Thomas (Chemistry '99). We originally met while we were both living in East Campus, and re-met at Caltech. In my free time I have been taken sewing lessons from a seamstress and reading lots of books.

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Highlights in the next Making Waves...

- Lunch Talks
- Student Research
- 2.019/13.018 Design of Ocean Systems II
- And as always... spotlights on Ocean Engineering professors, students, and alums!

Look for the next Making Waves in Winter/Spring '06!

