Newsletter from the MIT Ocean Engineering Student Engineering Association

Making Waves

Volume 6, Issue 1 Winter 2007

Special points of interest:

- New Officers elected for 2007!
- Sailing Vessel Design class offered this semester!
- Tea Hour Returns!

Inside this issue:

RoBoat: Undergraduates Design Autonomous Surface Vessel

Nina Young ('07)

Last term six seniors from Courses 2 and 13, Seth Clark, Nathaniel Chan, Christina Gomez, Evan Karlik, James Sannino, and Nina Young, joined together to design RoBoat – an autonomous surface vessel with an acoustic tracking system.

2.019 Students at MIT's Towtank testing their surface vessel.

This project began in the spring of 2006, when the students of 2.017 were given an assignment to enable a new method of ocean observation by constructing a small, autonomous surface vessel capable of tracking a subsurface acoustic source. According to the design criteria, it must demonstrate acoustic homing to a subsurface beacon, navigation in a global frame (GPS and compass), and waypoint autopilot capability in Sea State 3 conditions. This project was an offshoot of the work the 2.017/2.019 class of 2005 had completed. This year's class was very thankful for previous year's work and the vast amount of information included in their report *Design of an Acoustic-Homing Autonomous Surface Vessel*. In 2.017, the students developed a vessel design starting with a Wilderness Systems Pungo 120 kayak with a system of outriggers attached. They also built and field-tested an acoustic tracking system and an autonomous control system. It was up to the class of 2.019 to integrate all of these sub-units, tweak the final design, and to perform tests to quantify its performance.

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Faculty Spotlight: Dr. Franz Hover (in his own words)

Interviewed by Ashley Cantieny ('08)

What projects are you working on currently?
Simulation and modeling of the Navy's new all-electric ship (AES) technologies, control of autonomous underwater vehicles using feature maps to operate in areas where traditional navigation is poor, deep-ocean underwater vehicle design, maneuvering of vessels, and vortex-induced vibrations in marine structures

If you had to pick a favorite of those projects, which would it be? Why?
I think they all are fun!

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Dr. Hover.

RoBoat: Acoustic Tracking Autonomous Surface Vessel

This year's 2.019 class has completed al the preliminary steps in reaching a final and cost efficient product. The team built an autonomous kayak that is capable of navigating using preprogrammed and real time motor commands, as well as navigating using GPS coordinates and compass bearings. In addition, a short baseline acoustic tracking system was designed and developed to track an acoustic beacon and to assure that the system could deliver accurate and usable positions for implementation in the motor controls. Testing in the Charles River proved the success of these systems.

The details of these systems can be found in the paper *RoBoat: Design and Field Testing of an Autonomous Surface Vessel and Acoustic Tracking System* that was recently presented at MIT 's SNAME Student Paper Presentation on February 8, 2007. Ultimately the team hopes to collaborate with the pervious year's class to improve and fully integrate this system as a useful product for ocean exploration.

2.019 Students staying warm while testing their kayak at the sailing pavilion.

Faculty Spotlight: Franz Hover

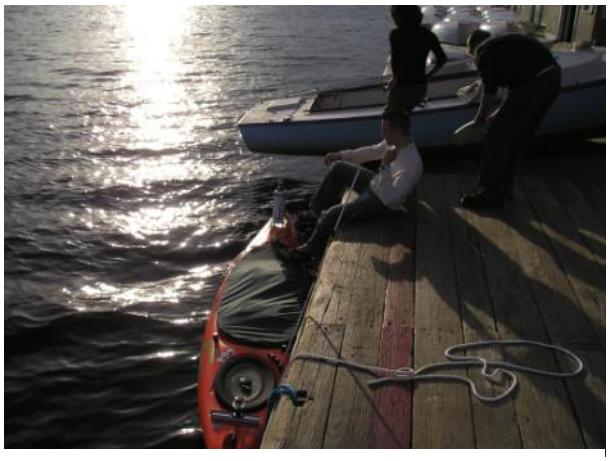
The simulation work is especially interesting because it is a broad new area for me. We try to understand the behavior of systems when there are uncertainties in their description, or in their environment. When the models are complex, we have to run costly simulations, and if there are many uncertainties, then we have to run many of them; the trick is to gain the most information for the absolute least computational expense. The long-term application is in design of complex systems. Today, such work usually amounts to a collection of independently chosen subsystems, operating safely within their specifications. Understanding of the whole system can improve performance and robustness, and probably save money as well.

Which part of the process do you like most? (ie. r&d, building, testing)

I get really excited by new data. If you have solid data, the world is at your feet. Processing the signals and seeing a new story unfold is very exciting.

Plus anything else you'd like to talk about

Teaching is also an important part of my work. I really believe students have to put their hands on the instruments and the machines to appreciate design; this has been our intent in the 2.017 and 2.019 courses, and their OE ancestors.



Dr. Hover assisting the 2.019 students with their autonomous kayak during testing at the sailing pavilion. Dr. Hover is one of the instructors for 2.019.

"I get really excited by new data. If you have solid data, the world is at your feet."

Conducting research in the field.

Student Spotlight: Stephen Licht, Mastermind of RoboTurtle

By Vicente Fernandez (WHOI)

Stephen Licht, a graduate student working with Prof. Triantafyllou, has taken a roundabout path to his current place in the Center for Ocean Engineering. Graduating from Yale in the class of 1998, he had only recently decided he was interested Ocean Engineering. Originally, Stephen had be planning on majoring in history, but switched to engineering in his second year when he found it more natural for him. His interest in ocean engineering was piqued his senior year by talk he attended by Dr. Louis Whitcomb (now a faculty member at Johns Hopkins). The pictures of Greek islands and idea of research cruises caught his attention.

Between graduating and coming to MIT, Stephen worked in a number of jobs, moving steadily closer to Ocean Engineering. He started working in a combustion research lab at Arthur D. Little, and then moved on to a coastal geology lab at Boston College. As he was preparing to go to sea in the Gulf of Mexico, he was accepted into the MIT-WHOI Joint Program, bringing him to where he is now. In between all this, he even managed to spend two months fulfilling a minor dream as a Boston bicycle messenger.

As a graduate student, Stephen works on the overlap between marine animal locomotion and control of underwater vehicles. While the most common form of marine locomotion may be to use a single caudal fin, another evolutionary path has led to the development of flapping foils for generating motion. Think of penguin wings, or turtle and sea lion flippers for examples. These high aspect ratio flapping foils are surprisingly efficient and able to generate large forces very rapidly, giving them advantages over any swimming machine. Stephen investigates the control needed to make an underwater vehicle swim with flapping foils as the sole form of propulsion.

Recently, his work has taken him to the New England Aquarium to study the 600 lb green turtle named Myrtle in the Giant Ocean Tank. While a diver (unfortunately not Stephen himself) lures Myrtle with a piece of lettuce, Stephen films the swimming behavior of the giant turtle from several angles. Using the video records, Stephen is reconstructing the precise motions of the turtle fins. With the detailed information Stephen will be able reproduce them with a single mechanical foil in the MIT Towtank, measuring the force they produce and visualizing the flow around them. The motions turtles use for swimming are not as simple as one might expect and hopefully this will go a long way to answering why they use such complex motions.

The lessons learned from Myrtle will also directly affect the other major aspect of his work: Finnegan the RoboTurtle. Finnegan is an underwater robot with four flapping foils built by Stephen, which he has been teaching to swim and make the most of its maneuverability. Learning to effectively control the non-linear actuators is the true focus of his research. The full tests of Finnegan have mostly been carried out in the alumni pool at the Stata Center, though a few were also in the Charles River. Working with a large 500 lb swimming robot can lead to some unexpected situations, and Stephen's had his share of those. The first time he got Finnegan swimming in the pool, he nearly dragged a friend into the deep end:

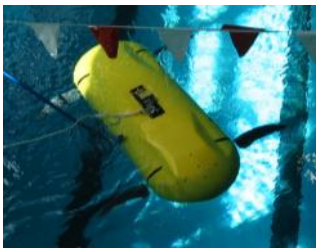
"I was using the joysticks to swim Finnegan towards the shallow end, when I suddenly lost communication with it and yelled to Jeff pull the vehicle up short before it hit the far wall. I looked up to see him sliding towards the water, leaning back with feet firmly planted in a tug of war stance. He slid about three feet before bracing himself against the ledge at the edge of the water. I think he lost track off how much mass was on the other end of the rope. I have to give him credit for superb balance ... and for not letting go!"

Despite this and other small mishaps, Stephen has had many fun experiences and successes with Finnegan. The result has been an exciting research project and a very interesting robot.

Later this term, 13SEAS will be hosting a demonstration of Stephen's Finnegan the RoboTurtle at the Alumni Pool in the Stata Center. Come see a 500 lb robotic turtle swim gracefully through the pool with four flapping foils. The date hasn't been set yet, but keep an eye out for announcements and posters.

Stephen's take home lesson from working with a large underwater robot?

"Don't invite everyone to come see the *first* test. You never know if you will actually be able to get the thing off the cart and in to the water in the first place..."



Finnegan the RoboTurtle in the Alumni Pool during testing.

"I looked up to see him sliding towards the water, leaning back with feet firmly planted in a tug of war stance."

Bertucci's and Science: OE Lecture Series Recap

Seth Clark ('07)

This past term 13seas was fortunate enough to have two excellent speakers talk about their experiences in the realm of ocean engineering. Our first speaker was John Gullotti ('78), the principle Welding Engineer at Electric Boat Company. Mr. Gullotti is the EB representative to the Navy Joining Center as well the vice-chairman of the American Welding Society A3.0 committee on welding. Mr. Gullotti spent the hour discussing progress on the new Virginia Class of attack submarines that EB has been commissioned to build. Mr. Gullotti also shared with us the importance of project management and a few of the new techniques that EB has used to increase its speed and efficiency in producing submarines.

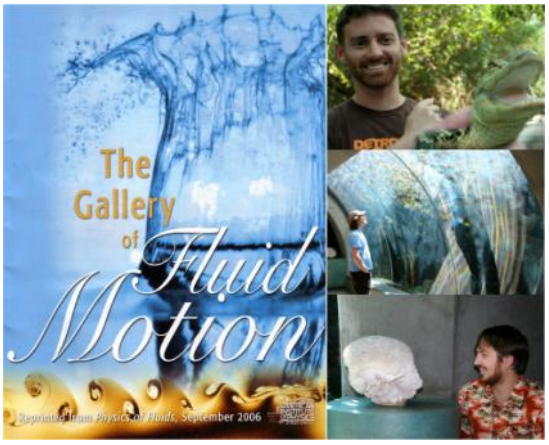
Our second speaker was Justin Manley ('96), a Senior Research Scientist at Battelle. He has been consulting for NOAA since 2002 and currently serves as overall technology program lead for the Ocean Exploration program. Mr. Manley shared with us his experiences with the NOAA Ocean Exploration Program, which is dedicated to exploring and understanding the 95% of our oceans that are yet unexplored. He presented a very interesting slide show on many of the research voyages that he has been apart of, as well as much of the new technology that is being developed to aid in ocean research. Both of these lectures were very informative and interesting and we thank our two speakers for sharing their time and their experiences with us.

Be sure to check out this semester's upcoming talks, and if you have ideas for topics or speakers, email 13seas-officers@mit.edu.

Epps, Truscott and Stanway Represent MIT at APS Conference

Tadd Truscott (PhD '08)

This year's American Physical Society's (APS) Division of Fluid Dynamics (DFD) conference was held in Tampa Bay, Florida. Three MIT Center for Ocean Engineering students attended the conference and presented reports about their respective research. Jordan Stanway (SM 05') presented his work on humpback whale flipper tubercles. He introduced PIV (particle image velocimetry) data and force measurements related to his flipper mock-ups that were tested in the Marine Hydrodynamics Laboratory (MIT) water tunnel. His presentation was original, informative and entertaining. Brenden Epps (PhD 09') also presented PIV data, but on a smaller aqueous creature (Giant Danio). He studied the impulse related to turning and was able to successfully match the momentum imparted to the fluid with the momentum of the fish by using a large resolution high-speed camera to visualize the flow field. The high-speed PIV videos he presented were amazing to watch. Tadd Truscott (PhD 08') also presented his impact of spinning spheres research at the conference. His images gathered a lot of interest, there was even a moment when the audience blurted out "oh, wow". He was especially delighted when his advisor Alexandra Techet (PhD 01') showed him this year's Gallery of Fluid Motion magazine since one of his images from last year's poster contest was on the cover (see figure on right). This year's conference was an exciting event for everyone involved. The weather was pleasant and the people at the conference were so friendly and wanted to collaborate so willingly we sometimes wondered if we had entered an altered reality. We all got to spend some time in the Tampa Bay Aquarium and were able to "ooh" and "aah" over all the wildlife and fluid phenomenon we witnessed (see figure). Our advisor Alex Techet graciously helped us all attend the conference and advised us on our presentations. We now understand why this is her favorite conference of the year. Everyone in the Experimental Hydrodynamics Lab (EHL) would like to thank those at MIT that helped us with our research and getting us to the conference.



Tadd's photograph on left; (top to bottom) Brenden, Tadd, and Jordan at the Tampa Bay Aquarium.

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We're on the Web !

web.mit.edu/13seas

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13Seas is the ocean engineering student organization. We are a group of students, faculty, and alumni who work to build and maintain the vitality of the ocean engineering community at MIT.

Check us out on the web at: web.mit.edu/13seas

Email any questions or comments to 13seas-officers@mit.edu.

OFFICERS:

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SNAME Advisor: Dr. Dave Burke
Webmaster: Harish Mukundan

Upcoming Events:

Cinco De Mayo Mixer

End of Year BBQ at Sailing Pavilion

Tea Hours!!

Lunch Talk with CAPT. Patrick Keenan, USN

More Ocean Science and Technology Talks!

Ocean ENGINEERING