

## 2008 Annual Report: Applied Ocean Physics & Engineering

Many years ago, as a 14 year old, I routinely took the bus and subway to the 1964 World's Fair in Flushing Meadows, New York. At that amazing fair, science and technology were spotlighted as keys to the future. The Bell Telephone System featured the history and future of communications, DuPont Chemicals produced "The Wonderful World of Chemistry" (the first time I saw artificial bioluminescence), General Electric sponsored "Progressland", and General Motors, in a happier day, produced the spectacular "Futurama" ride that 26 million people eventually took.

It is now 45 years later. What has happened to fulfill the technology dreams glowingly described by these corporate giants many years ago?

Looking just at the technical aspects, I have to say: Yes, they got it right! What I live and work with in the AOP&E Department — the science and technology being used daily to study the ocean, a half century after that brilliant fair— is absolutely the "science fiction" described there. Let me show you some comparisons.

The DuPont exhibit highlighted chemistry: We do chemistry within AOP&E, and have strong links to the WHOI Marine Chemistry and Geochemistry Department. Senior Scientist Jim Ledwell has carried out numerous cruises in his "DIMES" project, including some in 2008—during which he releases custom-made chemical tracers into the sea to study how water masses mix in the deep ocean. Also in 2008, Assistant Scientist Rich Camilli finished developing a miniaturized mass spectrometer (a huge room full of equipment in 1964) that measures chemicals in the ocean. It will soon be deployed on small AUVs and gliders to travel the seas detecting oil leaks, unexploded ordinance, telltale chemicals released by seafloor spreading, and other things researchers can discover with a "bloodhound nose" for chemicals.

Bell Systems' exhibit anticipated future communications: In 1964, Dick Tracy's "two way wrist radio" was a science fiction gadget in that comic strip, but now we live in the cell phone era. What about the ocean? Well, we've kept up with the above-water developments. AOP&E's Associate Scientist Jim Preisig and Senior Engineer Lee Freitag are leaders in the art of underwater acoustic communications from moorings, vehicles, and whatever we put in the sea. Sound travels much further than light in water, which helps us communicate over respectable ranges underwater. However, if you need high bandwidth (for sending a LOT of information), then you need to use light. AOP&E is also leading the way in underwater optical transmissions, with Senior Engineer Norm Farr and others building an advanced optical modem. All told, we've met and passed the 1964 predictions for communications.

General Electric's Progressland featured robotics: The "audio-animatronic" Abe Lincoln robot at the '64 Fair astonished everyone with the realism of its words and movements. Half a century later, robotics is not just an amusing novelty, but a transformational technology, on land and in the sea. Robotic vehicles such as the REMUS AUV, the SENTRY AUV, the NEREUS ROV/AUV hybrid, and others developed in the AOP&E Department carry scientific and applications payloads all over the world's oceans. NEREUS was in advanced development in 2008, and in 2009 dove to the deepest part of the world's oceans, the Mariana Trench (10,902 m). Also in 2008, a customized REMUS vehicle built by AOP&E engineers again examined the water tunnels for the City of New York. Robots are now important research tools, and in the future they may become perhaps our primary tool.

General Motors presented the "City of Tomorrow": In terms of the ocean, next to which the majority of humanity resides, AOP&E is helping to create the technology and science for that City. Our acoustics research helps provide for its defense from enemies from the sea. Our coastal oceanographers study factors that affect the City's water quality, both salt and fresh. Our biologists examine threats from "red tides" (toxic algal blooms), with an eye to understanding and predicting them. The list goes on.

Our science and technology really *is* as modern as the futuristic displays of 45 years ago, and AOP&E operates at the border of that visionary realm. Forty-five years from now, I hope that scientists and engineers in our Department have the same feeling of "gosh, we DID fulfill those old dreams" that I feel today, looking back at promises made by a World's Fair, most of a career ago.

—[James F. Lynch](#), Department Chair



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AOP&E Department's Ocean Systems Laboratory members Amy Kukulya and Greg Packard deploy a REMUS 100 vehicle in calm but cold winter waters. (Woods Hole Oceanographic Institution)

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## Life in the Aqarius Lab

WHOI Assistant Scientist Rich Camilli studies sponges near Aquarius, an undersea laboratory 63 feet below the ocean surface in the Florida Keys National Marine Sanctuary. Camilli recently spent 10 days in the submerged lab, which is operated by the National Oceanic and Atmospheric Administration.

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