Chair’s Message

ORE is 50 years old this year. We will be having a gala anniversary dinner event at the Waikiki Aquarium on Saturday 12 November. See more details below. All alumni – come and get reacquainted!

An MOA was signed in January inaugurating a 3+2 program with Ocean College, Zhejiang University (ZJU). We, along with College of Engineering, are looking forward to hosting ZJU students as they complete their undergraduate and masters degrees.

Dan Greeson will be retiring 1 July after 16 years of service to ORE. He is already working at the Pearl Harbor Shipyard on nuclear reactor quality assurance, based on his intimate knowledge from his days as a Navy submarine captain. After earning his PhD in ORE he was the chief engineer at the Hawaii Undersea Research Laboratory. We are still connected – Dan will continue as an affiliate graduate faculty. Thanks, Dan!

After six years of service as chair I will be passing the gavel to Prof. Eva-Marie Nosal. Please welcome her in that position!

Enjoy the summer!

Editor’s Corner

Thank you to all the contributors who made this issue possible. Working in the department this term has been a great opportunity to get to know a few of you better. I look forward to continuing to work with you in my remaining time in Hawaii, and hope you find this issue of Hana O Ke Kai to be an interesting view into some of the ongoing research and news in the Department of Ocean and Resources Engineering.

Department and Faculty News

- **The 50th anniversary celebration** of the Department of Ocean and Resources Engineering will be held at the Waikiki Aquarium on November 12, 2016 from 5:30-10pm. Please see the following website for more details: [http://www.soest.hawaii.edu/ore/ore50](http://www.soest.hawaii.edu/ore/ore50).

- **Professor Eva-Marie Nosal** will assume the role of ORE Department Chair on July 1, 2016.

- **Sea Engineering, Inc.** has been contracted to make mechanical repairs to the Kewalo Basin Observatory to allow data collection at the site to resume.
Some Recent ORE Publications


Upcoming Events


**Workshop:** Ocean observing infrastructure and sensing - Technical lessons learned and best practices. Monterey Bay Research Aquarium from September 23-25, 2016. Contact Bruce Howe (bhowe@hawaii.edu).


**Workshop:** SMART Cables for Earthquake and Tsunami Science and Early Warning. GFZ Potsdam (Germany) from November 3-4, 2016. Contact Frederik Tilmann (tilmann@gfz-potsdam.de).

**The Department of Ocean and Resources Engineering 50th Anniversary Celebration** will be held at the Waikiki Aquarium on Saturday, November 12, 2016 from 5:30-10pm.  [http://www.soest.hawaii.edu/ore/ore50](http://www.soest.hawaii.edu/ore/ore50)

**5th Joint Meeting of the Acoustical Society of America and the Acoustical Society of Japan** in Honolulu, Hawaii from November 28-December 2, 2016.  [http://www.acousticalsociety.org/content/5th-joint-meeting](http://www.acousticalsociety.org/content/5th-joint-meeting)

**American Geophysical Union (AGU) Fall Meeting** in San Francisco, California from December 12-16, 2016.  [https://fallmeeting.agu.org/2016/](https://fallmeeting.agu.org/2016/)


Joint Degree Program Between ORE/College of Engineering and Zhejiang University

On January 14 2016, Dean Ying Chen for Ocean College (Zhejiang University) and I signed a Memorandum of Agreement to implement a 3+2 program. Dean Peter Crouch (College of Engineering, CoE) and Krystyna Aune (Dean of the Office of Graduate Education) also signed on behalf of the University of Hawaii at Manoa. This culminated several years of effort of all involved, including Assistant Dean Song Choi (CoE, UH Manoa), John Wiltshire (ORE), Director Li Chen (Teaching Management, Ocean College, Zhejiang University) and Jiawang Chen (Professor, Ocean Engineering, Zhejiang University).

This agreement facilitates undergraduate ocean engineering students from Ocean College coming to the CoE and ORE to complete their fourth undergraduate year while starting their masters in either CoE or ORE and completing in five years. We look forward to this program growing and leading to substantive academic and research collaboration.

Figure 1. Main entrance to the Ocean College Campus on Zhoushan Island. Roughly twenty new buildings have been constructed to accommodate a student+faculty+staff population of 3000.

Figure 2. The Hydraulics Lab with wave tank on left and flumes on right (accommodating sediment and turns). A rotating tank is at the far end. A central computer control and data acquisition system in the center.
Figure 3. Large test tank with wave makers, sediment, and flow capabilities.

Figure 4. A high speed ship test tank, still under construction. A ship model is attached to a rotating radial arm.
Changes at the Hawaii Undersea Research Lab

The Hawaii Undersea Research Lab (HURL) was set up at the University of Hawaii, in 1980, by former ORE faculty member Dr. John Craven. Its current Director is Dr. John Wiltshire. The lab runs two deep diving submersibles which go to depths of 2000 m. In addition, through cooperation with the UH Marine Center lab personnel operate an ROV capable of 6000 m. Together this combination gives a very powerful set of tools to investigate the deep ocean. Through 2014, HURL was funded by the National Oceanic and Atmospheric Administration (NOAA). By 2015, with a change in NOAA funding priorities, only contract funds were available to support the two submersibles and staff of 20. Several staff members retired or were laid off and strenuous efforts were made to secure outside funding. A major five-month expedition was planned for the East Coast of China in March, 2016 with funding from the Chinese Academy of Sciences. Some of the dives on this mission were to look at methane hydrate deposits in the South China Sea. Unfortunately, from the time this work was initiated until the present the political situation in the South China Sea has deteriorated. Rather than be potentially part of a political situation, the University of Hawaii, with encouragement from Washington, decided to put the dive operation on hold pending an improved political landscape. For HURL, this has left the lab scrambling for replacement dives for the 2016 season. Some fisheries work, pipe inspections, and other dives are planned as well as a project training Navy divers in the use of our submersible launch, recovery and transport submersible platform. HURL is also actively developing the Makai Pier as an ‘in ocean’ instrument test site. For HURL, it is both a time of change and new opportunity.

Figure 1. Launch, Recovery and Transport Submersible Platform. This innovative design is being used in June 2016 for US Navy Diver Training in Conjunction with HURL.
Houston is the home to the world’s offshore oil industry. Each year during the first week of May it hosts the world’s largest offshore oil conference, the Offshore Technology Conference (OTC). In 2015, this conference had an attendance of 105,000 with 3,000 exhibits including full size drill rigs. Then the price of oil collapsed from $105/barrel to now $48/barrel. This has had a devastating impact on the offshore oil industry with 200,000 layoffs in the greater Houston area alone. The 2016 attendance at OTC was 68,000, a stunning 35% decline, after years of growth. The conference is looking to diversify and is considering other options such as marine minerals, methane hydrates, offshore wind, alternative offshore power and geo-technology. It is a time of change for ocean engineers. ORE’s John Wiltshire has been part of the OTC program committee for the past ten years, going to Houston 5 times a year to help orchestrate this massive event. As a significant number of ORE’s graduates work in the oil industry in Houston, this is an excellent chance for a close up discussion of the industry. Offshore oil provides approximately 25% of total oil production worldwide but unfortunately is the expensive part of the industry. While at one point the oil industry was controlled by the Middle East oil magnates, the swing producer is now the US shale oil industry, having brought massive new resources on line through its development of hydraulic fracturing. The offshore oil industry is certainly not fading away any time soon but it will take at least $80/barrel oil to restart the growth in the large offshore projects we have seen over the last decade. If the sentiment at this year’s OTC is any indication, we are at least a few years away from seeing this again.

**Figure 1.** Typical Large Offshore Floating Rig—Aker’s Spitsbergen
The severity of coastal inundation, resulting from tsunami runup and storm surge events, continues to threaten coastal communities throughout the world. Researchers continue to develop and improve numerical models capable of refining our knowledge and improving our understanding of the underlying physics. The ever increasing availability of computational resources has further permitted the use of high fidelity phase-resolving models for practical applications. Boussinesq-type models, for example, serve as an indispensable tool in the study of wave dynamics affiliated with inundation studies.

Numerical challenges arising from the discretization of Boussinesq-type equations are most apparent in resolving surf zone processes, where wave breaking and runup processes are depicted as discontinuous. Numerical methods used to overcome discontinuous obstacles are often dissipative and/or dispersive in order to preserve numerical stability. Recently, the application of shock capturing conservative numerical methods to these processes has led to robust and accurate solutions. Beyond the surf zone, theoretical advances in Boussinesq-type equations continue to push computational boundaries further offshore to better resolve both linear and nonlinear transformation throughout intermediate depths. However, if the same numerical methods utilized in a discontinuous region are applied over an extensive computational area, wave propagation characteristics are hindered, leading to false positive assessments of the wave dynamics at the surf zone boundary.

High order spectral-like schemes emphasize wave propagation in the discretization of the governing equations by minimizing the error associated with numerical dispersion over a given range of frequencies and wavenumbers, such that the phase is accurately represented in the solution. Its implementation in water wave models represents an important advancement in coastal engineering research. My research focus is on the development of a numerical model that implements this discretization scheme into a Boussinesq-type numerical model with shock capturing. As a net result, both linear and nonlinear processes are resolved with improved accuracy leading to an enhanced understanding of coastal processes.

Figure 1. South swell refracting into Mamala Bay. Left to right: Wave height, wave setup, wave driven current.
Part of my research work is about using tsunami data to resolve earthquake sources. It has been recognized that land-based geodetic and seismic observations provide poor resolution for far-offshore coseismic slip distributions. Underthrusting events in subduction zones often have significant coseismic slip offshore, which results in strong tsunami excitation. The low speed of tsunami waves enhances their sensitivity to the spatial extent of earthquake-induced seafloor deformation. The expanded availability of high-quality tsunami recordings from seafloor pressure sensors of the Deep-ocean Assessment and Reporting of Tsunami (DART) network and tide gauges allows the incorporation of tsunami data into the techniques and procedures for resolving earthquake sources.

Generally there are two approaches for utilizing tsunami data to constrain the slip distribution. One is by doing joint inversion and another one is through iterative modeling. In joint inversions, tsunami Green's functions are built for the discretized finite faults along with the Green's functions from teleseismic and geodetic datasets. The slip model is resolved based on the underlying assumption of linearity. For iterative modeling, a preliminary source model is obtained by inversion of teleseismic and geodetic data only and provides predicted tsunami waves. By comparing the predictions with observations, the inversion parameters are modified. The process is repeated until an optimal source model is achieved which gives a satisfying match for the computed tsunami waves with recordings.

Figure 1. An example of joint inversion approach to the 2010 Mentawai Mw7.8 earthquake. (a) and (b) show the computational domains with locations of four tsunami observations and the source discretization. (c) shows the tsunami Green's functions generated from one subfault. (d) shows the slip patch (upper) and the waveform fits (lower) from the final preferred model.
The aim of my research is to investigate the sea state of Hawaii during the passage of intense extratropical storms. I am analyzing the swell trend as affected by North Pacific generated extratropical cyclones.

Sea level fluctuations and incoming wave conditions are among the primary factors affecting coastal shorelines and infrastructure. Extratropical storms are an important weather element that affect ocean circulation in the mid-latitudes. In order to prepare the ecosystem and the community of coastal shorelines for the uncertainties and inundation caused by these swells, wave hindcast analysis is performed to guide the implementation of proper adaptation strategies.

This research includes categorization of the cyclones, selection and storm tracking of effective storms, hindcasting the swells, and mapping the vulnerability caused by the swells on Northshore Oahu. The hindcast is conducted using WAVEWATCH III and SWAN models with surface forcing data provided by the 10-m-above sea level wind field of the NCEP-NCAR reanalysis. The significant wave height hindcast is compared with the buoy and altimeter data acquired from the NOAA National Data Buoy Center and in-situ measurements.

The in-situ measurements include the current vector velocity of the water column, full wave spectrum of the surface wave directions, and velocity vectors of the waves. The deployment of a Sentinel V Acoustic Doppler Current Profiler (ADCP) took place at 40-feet and 60 feet depth in Sunset Beach Shore, Oahu during summer 2015 and winter 2016 respectively.

I will be analyzing the correlation of the vertical and horizontal profiling of ocean swells on the variability of time scale events with extratropical cyclones and its effect on coastal vulnerability at the end of this research. The sensitivity of the analysis will depend on the intensity of the near surface wind data from the reanalysis and spatial resolution. Funding availability and ocean and weather conditions limit the number of in situ deployments.
My doctoral research lies at the intersection of marine bioacoustics and electrical engineering, and aims to improve the reliability of tracking underwater marine mammals. Specifically, I’m trying to expand the usefulness of high performance tracking approaches to a wider range of species than is currently possible. This is an important problem to address because estimating marine mammal population sizes and reducing the risk to marine animals posed by human oceanic noise sources relies on knowing where the animals are in the ocean. Expanding high performance localization techniques to a wider variety of species will allow us to better identify critical habitats for marine sanctuaries and more responsibly conduct sound-producing oceanic activities, including scientific, industrial, and military endeavors.

A sound that is heard underwater is a function of both the sound made by the source and the environment the sound moves through in traveling from source to receiver. For example, ocean wave conditions, ocean bottom sediment properties, and relative source and receiver locations all influence the way a sound is heard underwater. Quantitatively, we refer to the net effect of all these environmental influences as the impulse response for the acoustic channel between the source and receiver. Knowledge of this impulse response allows us to estimate the source location in many cases, and may also allow us to estimate properties of the ocean environment. To measure this impulse response, we employ an approach called Blind Channel Estimation (or BCE), where blind refers to us not knowing anything about the source in advance. BCE was originally conceived as a technique to improve cell phone communication as a person travels through a complicated environment such as between tall buildings.

For example, consider the simulation depicted in Figure 1. In (A), we see a single source (e.g., a humpback whale) 30 m below the surface and 30 m in horizontal range from two underwater acoustic receivers (at 7 m and 15 m below the surface, respectively). This source produces a frequency sweep signal, which is observed by the simulated receivers as shown in (B) and (C). The estimated, and true, impulse responses for each of the two channels are shown in (D) and (E). The good match between true and estimated channels suggests that blind channel estimation can reveal enough about the impulse response to allow the sound source to then be located, but our work predicts that some environmental conditions and source characteristics are better suited for estimating the underlying impulse responses than others; as the ocean surface and bottom become rougher and the source bandwidth decreases, the estimated impulse responses tend to be less informative.

Figure 1. Blind channel estimation simulation experiment.
My research aims at developing, understanding, and improving a coastal energy and shore protection concept which combines an OWC (oscillating water column) array for power generation and a slotted barrier breakwater for shore protection. I am investigating the effectiveness of this concept both in terms of power generation efficiency (as compared to incoming wave energy and other similar wave energy devices), transmission coefficient (amount of wave energy that travels past the structure) and sediment scouring characteristics of this device using laboratory, theoretical, and numerical techniques. The main academic aims are to understand the effect of vortex shedding on OWC power conversion efficiency, and how the addition of power extraction via OWC can help mitigate wave transmission and sediment scouring in protected areas as well as the foundation of the structure.

An OWC device usually contains a semi-enclosed structure bottom-resting or moored floating in water, with an air chamber inside connected to a turbine via an air duct. When waves reach the device, the pressure fluctuation outside the semi-enclosed structure creates a pressure fluctuation in the air chamber. Air is then driven by the pressure fluctuation through a duct into and out of a power-generating turbine, converting wave energy into electricity. OWC is one of the most widely studied and tested wave energy conversion devices.

As a new source of renewable energy, development of wave energy harvesting has suffered from its relatively high cost per watt-hour. This is mainly due to the fact that even though the device must be optimized for local prevailing wave conditions (including tidal range, significant wave height, and significant wavelength), it must withstand local extreme events such as storm surge, which are usually much larger than prevailing conditions. This increased structural cost, together with a relatively low-efficiency turbine system (usually a Wells Turbine, or an ordinary turbine combined with flow control valves), have been hurdles for the development of the wave energy harvesting industry. One solution to these problems is to incorporate wave energy harvesting into shore protection devices, since shore protection devices are built to withstand extreme events and thus can share the structural cost with the wave energy device. As is shown in the conceptual art figure, the device of interest is an array of cylindrical OWC cylinders acting as a slotted barrier breakwater. When waves reach the structure a partial standing wave is formed in front of the structure (behaving like a breakwater), increasing the capture efficiency of the OWC device. At the same time, the OWC device converts part of the wave energy into electricity, hence reducing wave transmission and giving the structure better protection performance than a traditional slotted barrier breakwater. Furthermore, because a larger portion of reflected wave energy is now extracted, scouring at the foundation of the structure may also be mitigated due to a less energetic reflection.

Figure 1. Combined wave energy harvesting and shore protection
The Department of Ocean and Resources Engineering would not have accomplished such great success in its first 50 years without the financial support of our alumni and friends. Would you take a moment today to consider donating to the ORE Enrichment Fund? Gifts are tax-deductible and allow us to respond immediately to new opportunities and unforeseen needs.

To donate online, please visit the ORE Enrichment Fund website:

https://giving.uhfoundation.org/funds/12373104

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If you have any questions about your donation, or about how ORE is using donor support to move into its next 50 years of excellence, please contact Jana Light at 808-956-9172 or jana.light@uhfoundation.org.

Mahalo for your support!

Sunset from the ORE Lanai, looking west toward Punchbowl.