ORE since 1966
OCEAN AND RESOURCES ENGINEERING
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

HANA O KE KAI "Work of the Ocean"

NEWSLETTER OF THE OCEAN AND RESOURCES ENGINEERING DEPARTMENT, Fall 2022, Volume 25, Issue 2

Chair's Message

Zhenhua Huang, Chair

Welcome to the 2022 Fall issue of ORE Newsletter. ORE has seen a lot of changes in the past several months. Thanks to the effort of all ORE faculty members, the department secured a record amount in extramural grants awarded to ORE in the Summer and Fall semesters. The department also saw a rapid increase in student enrollment, with 15 new students enrolled in our Masters and PhD programs in the Fall semester. To accommodate the increase of our student body, Holmes Hall 407 and 408 were converted into cubicles. This is not an ideal solution, but it temporarily provides enough desks for our students while we work on a long term solution with the School. I would like thank Dr. Mike Krieg for taking the lead in renovating ORE's new lab HIG151 and getting a new wave flume and other key equipment for the lab. The new lab now has two 3D printers that can satisfy our teaching and research needs. I would like also thank Dr. Deniz Gedikli for compiling a list of essential software packages for ORE's computer room, which is now temporally located in HIG151.

ORE's DA, Dustin Lee, left us for a job at the State Capitol recently. We're grateful for the contributions that Dustin Lee made during his time at ORE. Our request for an exception to fill Dustin's position has been approved by the President, and we thank all of ORE for your patience and understanding while we recruit a new DA for ORE.

In this issue

Editor's Corner

Guilherme Silva, ORE TA &
Eva-Marie Nosal, ORE Associate Professor

I would like to thank the department for the opportunity to be the TA for this semester. It's been a great experience to be back in Hawaii and dive into Ocean Engineering with ORE. I hope you enjoy this newsletter and I see you all soon! -GS

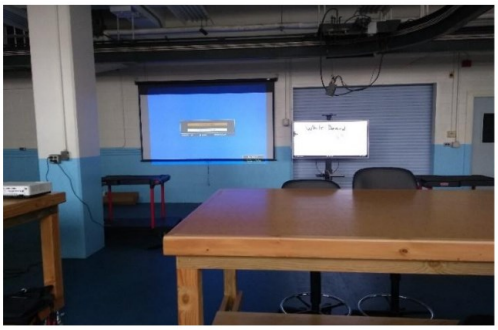
It has been a pleasure to work with Guilherme to prepare this edition of the newsletter. This is an active and exciting time in ORE, and we are glad to be able to share some faces, projects, and updates with you.—EMN

Inside ORE

Mike Krieg,
ORE Assistant Professor

ORE Research/Teaching Lab Updates

As introduced in the Spring 2022 volume of Hana O Ke Kai, the ORE department is in the process of developing a new state-of-the-art combined research and teaching laboratory. This facility will have a 12m long wave flume complete with model positioning (gantry) system, as well as general use work stations with data acquisition capabilities suitable for a wide variety of experiments. Some setbacks have delayed the full implementation of the facility. The wave flume was delayed due to semiconductor shortage and supply chain issues; however, it has now been completed and is undergoing testing before being shipped out mid to late December. In the interim, we have brought the facility to a state in which it can be used for class instruction and limited research. We have finished assembling the general use workstations and acquired the data acquisition hardware for them. We have installed two new 3D printers (a Markforged Mark II for composite fiber-reinforced parts and an Ender 5+ for larger parts). The facility has also been used to assemble seafloor instrumentation equipment for HNEI future research operations.



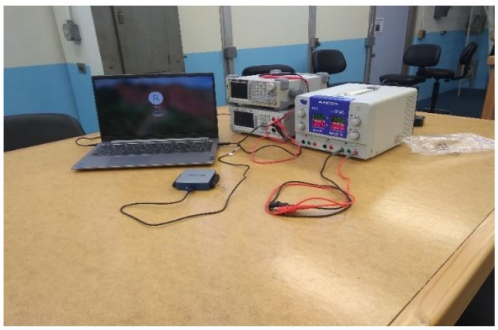
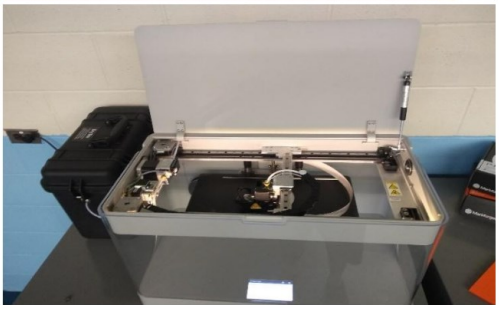


Figure 1: (left) A view of the projector screen and mobile digital white board from one of the workstations. (right) The measurement and data acquisition hardware suite for each laboratory workstation.



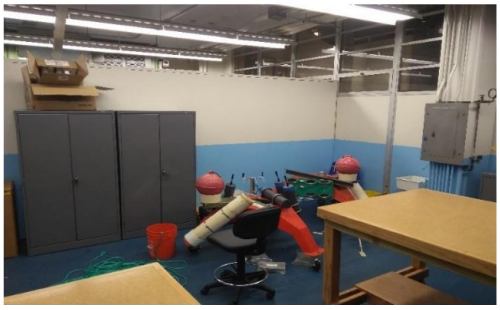


Figure 2: (left) Markforged Mark II 3D printer. (right) SeaSpiders being assembled for HNEI research.

Deniz Gedikli,
ORE Assistant Professor

New Software for ORE Computer Lab

The ORE computer lab has exciting updates to its software resources. ORE students and faculty now have access to the Altair software database, which includes more than 40 industry leading engineering softwares such as HyperMesh, OptiStruct, AcuSolve, and ShipMo3D, as well as OrcaFlex, a dynamic analysis software for offshore marine systems. Multiple ORE courses, such as ORE 609 Hydrodynamics of Fluid-Body Interaction, ORE 612 Dynamics of Ocean Structures, and ORE 677 Marine Renewable Energy, have already integrated OrcaFlex and Proteus DS. Students can use these software packages in the ORE computer lab for coursework and research. ORE graduates will gain skills in solving the most complex ocean engineering problems thanks to having access to and being able to use these industry-leading software, which will make them competitive in the marine industry in Hawaii, the United States, and around the world.

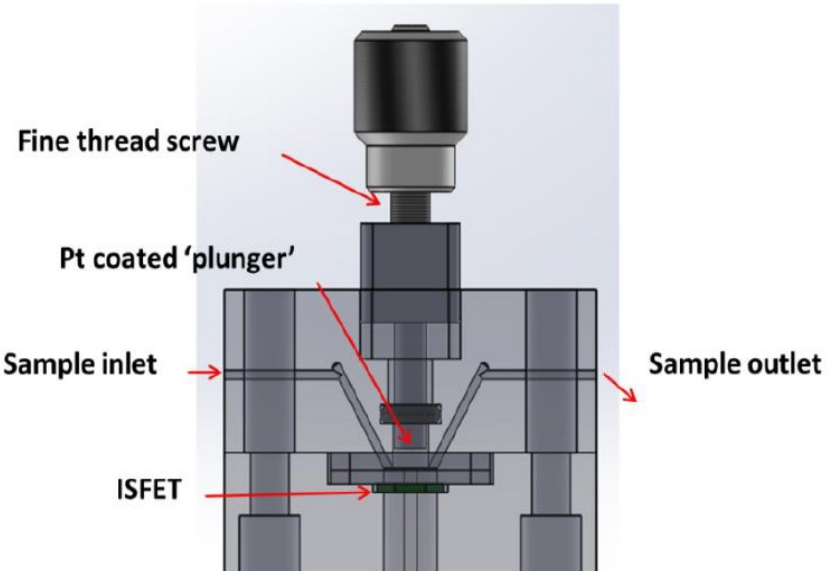
Inside ORE

Micro-pHAT: A re-envisioned sensor design for measuring seawater pH and Total Alkalinity in situ

Ellen Briggs,
ORE Assistant Professor

Dr. Briggs was recently awarded a new NSF grant (OCE award #2219930) titled, "Micro-pHA$_T$: A re-envisioned sensor design for measuring seawater pH and Total Alkalinity in situ." Briggs has recruited a new MS student, Guilherme daSilva to contribute to this project. One more MS student will be recruited by next fall as well as 3 undergraduate students over the summer months of the project.

The oceans play an integral role in the global carbon cycle and increased carbon dioxide emissions to the atmosphere have resulted in ocean warming and ocean acidification with cascading effects on marine ecosystems. Ocean-based carbon dioxide removal strategies are gaining a lot of attention and will require monitoring, reporting, and verification as well as evaluation of potential environmental impact. Traditionally, ship-based platforms have been used to collect seawater samples for benchtop analyses which has generated high quality snapshots of the ocean carbon chemistry. However, ship-based platforms are limited in their spatiotemporal resolution which has led to the development of a variety of autonomous platforms for filling in the gaps in both space and time. To date, there is no commercially available, single sensor for measuring the full seawater carbon dioxide system suitable for in situ, autonomous platforms. This project will focus on advancing the technology readiness level of a prototype sensor (Sea-pHA$_T$) for measuring both pH and Total Alkalinity. This two-parameter sensor does not require external reagents, is low power, is fast (about 60 seconds per measurement), has a small footprint, and is solid-state all of which lend it to be suitable and ideal for in situ, autonomous platforms. This sensor is unique because most other developing technologies for measuring the seawater carbon dioxide system require reagents, have complex moving parts, and cannot measure two parameters near simultaneously.



Drawing of an early concept-stage Micro-pHA$_T$ device.

The Sea-pHA$_T$ is an ISFET-based (ion sensitive field effect transistor) pH sensor that has been modified through the addition of a coulometric actuator device to additionally perform an alkalinity titration on the chip. In its current configuration, the actuator electrode (anode) is deposited directly on the surface of the ISFET chip. We will design a microfluidic-type housing that will instead suspend the anode above the ion sensing region of the chip (gate) with adjustable vertical positioning. This has several benefits including on the fly adjustment of the anode-gate distance. A rigorous characterization of the anode-gate distance will be performed side-by-side with the tunable Micro-pHA$_T$ and modified ISFETs of the Sea-pHA$_T$ sensor. The optimal anode-gate distance will be determined over various ranges of AT and sensitivity of the measurement to temperature and salinity will be assessed. Signal conditioning routines will be explored to optimize the sensor output and will be integrated in the sensor software. The results from all the configurations tested will be synthesized in a user manual to aid future users in selecting optimal operating parameters and understanding system options. All of this will result in bringing us several steps closer to having a commercially available, user friendly, single dip probe for measuring the full aqueous carbon dioxide system that can be integrated on a variety of platforms.

Inside ORE

The SMART Atlantic CAM cable system

Bruce Howe,
ORE Researcher,
Chair JTF SMART Subsea Cables

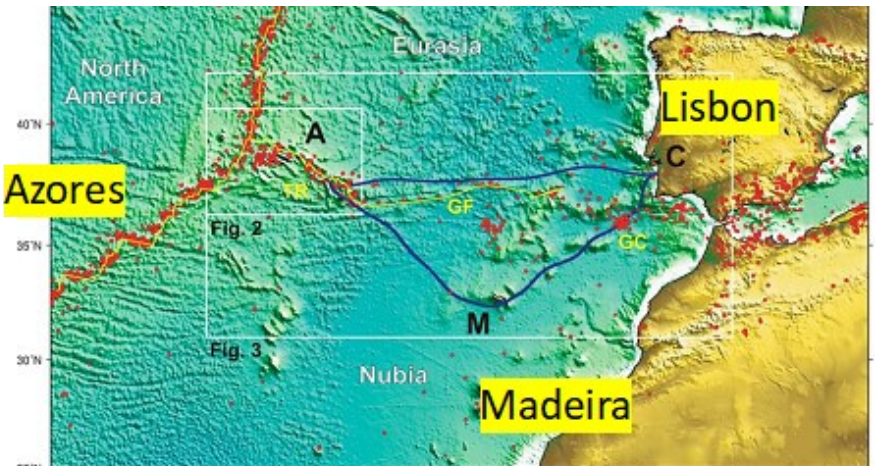
The Joint Task Force SMART Cables – Science Monitoring And Reliable Telecommunications – is working to integrate environmental sensors for ocean and climate monitoring and disaster warning into submarine telecommunications cables. We are sponsored by the International Telecommunication Union, the World Meteorological Organization, and the UNESCO Intergovernmental Oceanographic Commission. We are proud to say SMART has been endorsed as a UN Decade of Ocean Science Project, and we now have a significant award from the Moore Foundation.

Over the years I have provided ORE with updates on the on-going SMART Cable project. Here I focus on the SMART Atlantic CAM system (see map). The Portuguese Government has just approved this project with a budget of €154M; the SMART portion is roughly 10 percent. This is the first SMART system.

The regulatory agency, ANACOM has played a crucial role. It is a given now that no citizen can be left behind when considering Internet connectivity, and that it is essential for territorial cohesion both for the nation and for the European Union. ANACOM was tasked from the beginning to include "seismic and environmental detection" for disaster risk reduction as it planned the replacement of the present 25-year-old system. CAM is largely motivated by the 1755 disastrous earthquake/tsunami that destroyed Lisbon and much of the coastlines of North Africa, Portugal, and Spain. The value of lives saved in a 1755 event in the 25-year life of the system will more than compensate for the entire capital cost, based just on earthquakes, not yet including tsunami effects.

The LEA group (Listening to the Earth under the Atlantic) is providing science advice to the implementing entity IP Telecom. ANACOM, making use of the SMART data, will provide cable protection and supervision services. It will give future SMART cables priority in the permitting process. CAM will be part of the larger Digital Hub, and European Atlantic Digital Gateway. The SMART cable has already catalyzed research in combining telecom+ sensing, including optical fiber sensing. The data will be made available to the larger community, including the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (NEAMTWS).

One last point. The European Union Directorate General for Digital Connectivity just issued a €100M request for proposals for submarine cable connectivity, emphasizing outermost regions and overseas countries and territories which are geographically very distant from the European continent (e.g., New Caledonia, Greenland, the Caribbean, and others). Importantly, it specifically states it will support associated environmental sensing and gives SMART cables as the example. Portugal expects to apply as the Azores and Maderia are considered outermost regions.



SMART Cables are firmly underway!

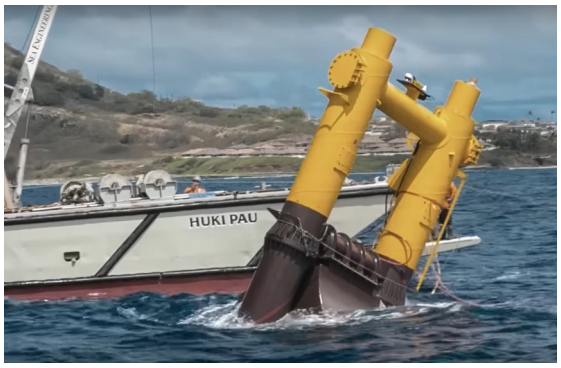
The SMART Atlantic CAM cable system will be 3,700 km long with 50 SMART repeaters with ocean bottom temperature, pressure, and seismic acceleration sensors.

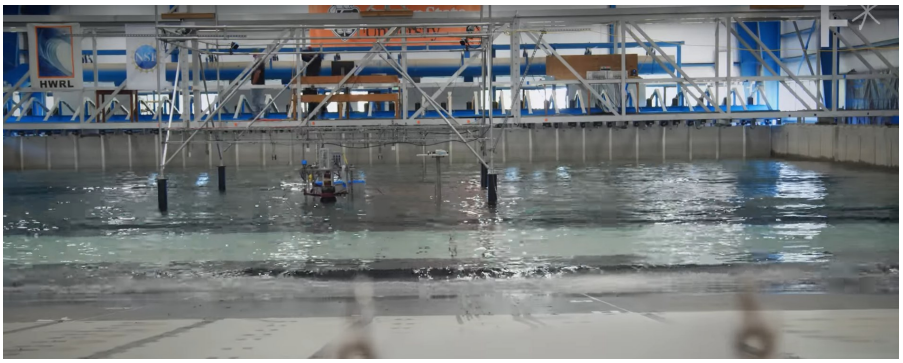
Inside ORE

Freethink Wave Energy Documentary

Patrick Cross
HNEI Specialist (Marine/Ocean Energy Program Manager)
and ORE Cooperating Graduate Faculty

The Marine Energy group at UH, which now supports 6 ORE graduate students working on various aspects of wave energy, was recently featured in a video released by Freethink online. The video was facilitated by the Navy sponsors of the Wave Energy Test Site (WETS) and emphasizes the role of WETS in developing wave energy for the Navy, the nation, and the world. But it also features work by the group under a DOE-funded project in which they are developing a flap-type wave energy converter (WEC), called HAWSEC. Though not ultimately included in the video, interviews also centered around the work of ORE PhD student Nic Ulm, whose work focuses on the development of a floating WEC called Halona – aimed at providing power at sea for the recharge of AUVs. Check it out at: https://www.youtube.com/watch?v=xrQBQ2m2blk



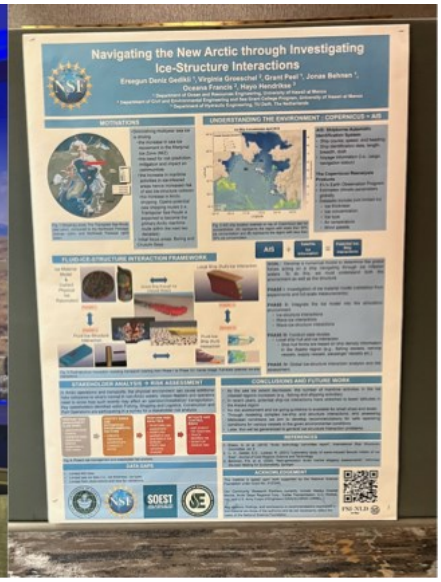


The Freethink Wave Energy Documentary features some of the WEC devices deployed at WETS, and Cross with ORE students testing at the Hinsdale Wave Research Laboratory at Oregon State University.

Inside ORE

Navigating the New Arctic Community Meeting

Deniz Gedikli,
ORE Assistant Professor



Left: Closing ceremony of the NNA Community meeting. Heartbeat of Mother Earth drum group, Kenaitze Indian Tribe. Right: NNA poster presented by Dr. Gedikli and Virginia Groeschel.

ORE Assistant Professor Dr. Gedikli and Virginia Groeschel (PhD student in CEE, UH-Manoa) attended the third annual National Science Foundation's Navigating the New Arctic (NNA) Community Meeting, which was held in Anchorage, Alaska, on November 15-17, 2022.

The NNA Community Meeting was organized by the NNA Community Office to raise awareness, partnerships, opportunities, and resources for collaboration and equitable knowledge generation within, between, and beyond the NNA-funded research projects. The NNA meeting also provided an excellent opportunity for ORE students to interact with Arctic communities and learn about recent developments in Arctic maritime activities. Dr. Gedikli met with research and community partners and gave two flash talks about his NNA research, in which he and his colleagues, Dr. Oceana Francis from CEE and Dr. Hayo Hendrikse from TU-Delft, The Netherlands, are developing an observational and modeling framework for safe maritime operations in the Arctic and Sub-Arctic regions. Their project aims to understand the impact of melting sea ice and rapidly changing sea ice environment on natural, social, and built systems (i.e., shipping and offshore engineering). This is extremely important, because Arctic sea ice is thinning due to rapid climate change, potentially increasing access to Arctic waters for economic activities including shipping, exploration, and resource exploitation. The increase in maritime operations in the region generates concerns regarding their environmental impact (e.g., oil spills, structural damage on ships and marine structures, etc.).

Student News

Jacob Foster presented his MS PlanB project "Direction of Arrival Estimation of Acoustic Signals from a 2-Element Hydrophone Array" in July 2022

John Melve presented his MS PlanB project "A Wave-Flume Study of the Dispersion of Tsunami-Induced Debris: Freight Containers on a Moored Container Ship" in July 2022

Jonathan Chapman, PE, presented his MS PlanB project "Estimating Marine Atmospheric Boundary Layer Stratification with Synthetic Aperture Radar Data" in November 2022

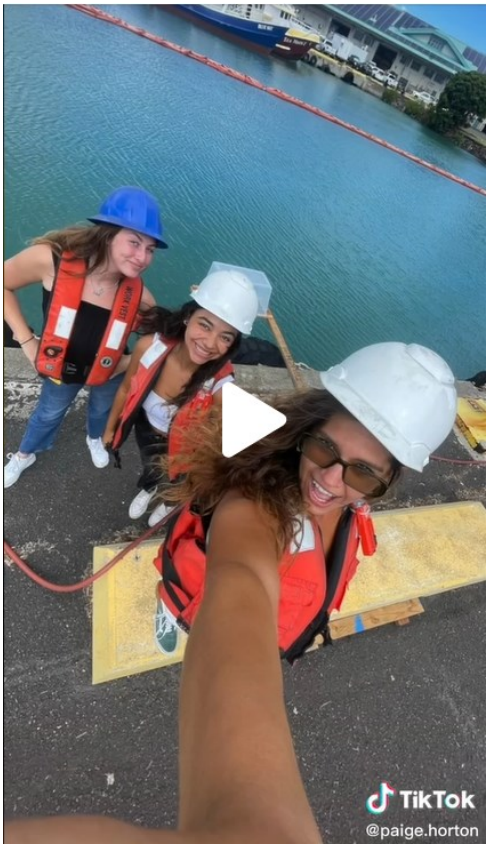
Brendan P Rideout defended his PhD Dissertation "Of RATs and Men: Underwater Passive Acoustic Localization Investigations using Relative Arrival Times and Blind Channel Estimation" in December 2022

Inside ORE

ORE 203L Surf Science and Culture Lab

Ellen Briggs
ORE Assistant Professor

As part of ORE 203L, Surf Science and Culture Lab, Dr. Briggs has developed a laboratory exercise where undergraduate students, mostly non-science majors, build and deploy a 'do it yourself' (DIY) tide gauge. The design of the tide gauge sensor was part of a collaboration with Phil Bresnahan from University of North Carolina, Wilmington and others which led to a publication in the DIY Oceanography journal (Bresnahan et al., 2022). The tide gauge is a low-cost (~$100), DIY ultrasonic water level sensor/datalogger that has been designed, constructed, and tested for use in education, citizen/community science, and research settings. The sensor package comprises an ultrasonic distance sensor, a microcontroller running Arduino firmware, a micro-SD card for datalogging, a real-time clock for timekeeping and sleep functions, and an OLED screen for real-time display. Electronics are housed in low-cost custom containers using either upcycled plastic containers (we use ice cream jars) or laser-cut acrylic. Reported ultrasonic sensor accuracy is 5 cm across a range of 15–645 cm, with an estimated power budget of 76 days of operation on a rechargeable 10 amp-hr battery. The DIY sensor has been field tested alongside two commercial sensors for 18 days in Wilmington, North Carolina, including during Tropical Storm Colin, with all sensor measurements in close agreement (e.g., root mean squared error of 1.5 cm between the DIY sensor and a proven commercial unit). In Briggs' class, the tide gauges have been deployed each semester at the UH Marine Center and this activity is quite a hit! Students this semester even documented their experience in a TikTok video.



Check out the full video at: https://www.tiktok.com/@paige.horton/video/7151153479774440750

ORE 783 Hilo Field Trip

Lauren Heslop
ORE MS Student

The ORE 783 Capstone class had the opportunity to travel to Hilo for a field trip on November 4, 2022. Students were accompanied by Dr. Cheung and Dr. Stopa. The purpose of the trip was to conduct a site visit of Hilo Harbor and the breakwater at Hilo Bay. The class has been hard at work all semester on a Hilo Bay Improvement Project. The purpose of the project is twofold: (1) to investigate the feasibility of adding an engineered breach or a wave energy converter into the Hilo breakwater to improve water quality issues in Hilo Bay and (2) to investigate a breakwater head redesign to dissipate wave energy coming into Hilo Harbor and reduce coastal erosion in the surrounding area.

Continued on the following page

ORE 783 Hilo Field Trip, continued

Students had the opportunity to talk with a Hilo Harbor official to discuss the implications of adding a breach to the current breakwater. The discussion offered valuable insight on how the Hilo maritime community feels about this project. Students also were able to walk along a portion of the breakwater where many useful observations were made. They examined their proposed breach location, observed the wave conditions, and assessed the current status of the breakwater. The field visit also included a severely eroded section of Bayfront Beach and sites along the Wailuku River, which is a primary source of pollution in Hilo Bay. All in all, it was a fun and educational trip

Flights from Honolulu to Hilo were comped by Southwest Airlines and expenses covered by the ORE Student Enrichment Fund.

Hilo Breakwater

ORE 793 students Grant Peel, Lauren Heslop, Kyle Pappas, Jesse Gray, Jon Chase, and Wyatt Burkley walk along the Hilo breakwater

Hilo Bayfront Beach

Wailuku River State Park Waterfall

Company profile

Makai Ocean Engineering Inc.

Makai Ocean Engineering, Inc. is an innovative ocean technology and engineering firm based in Hawaii, providing engineering products and services locally and worldwide since 1973. Makai is considered a world leader in several technology areas including submarine cables, ocean energy and marine pipelines, and subsea robotics. Makai is certified under ISO 9001:2015, an internationally recognized standard for quality management. Makai's 38-person staff includes physicists, oceanographers, and mechanical, ocean, chemical, and software engineers, many of whom hold master's degrees or Ph.Ds.

Makai's headquarters, for nearly 50 years, are located at the Makai Research Pier on the southeast coast of Oahu, Hawaii. The site is 30 minutes from Honolulu provides access to coastal testing areas for our ocean research and development projects.

This facility and the surrounding waters have ideal conditions for rapid prototyping of underwater vehicles and other subsea hardware systems. Makai performs research & development for a wide range of clients, including the U.S. Departments of Defense and Energy, and provides related engineering services for many of world's leading technology firms.

Makai Ocean Energy Research Center.

Makai has additional offices and research facilities in Kailua-Kona, on the Big Island of Hawai`i and in Ventura, California. Kailua-Kona is home to Makai's Ocean Energy Research Center (OERC), including an advanced manufacturing lab for next-generation marine heat exchangers and site of the largest U.S. grid connected ocean thermal energy conversion (OTEC) plant, commissioned in 2015. Out of Ventura the Makai team provides critical engineering and subsea installation support for the US Navy.

Social Media

Makai Engineer on site for a desalination pipeline project in Saudi Arabia.

New in ORE

Jonas Behnen, ORE PhD Student

PhD student with Prof. Gedikli (FSI Lab). Ice-structure interactions, numerical simulation, machine learning.

Surfing, hiking, traveling

William Robert, ORE PhD Student

PhD student with Prof. Cheung. Tsunami, seismology, ocean acoustics

Hiking, traveling

Bethany Stafford, ORE MS Student

MS student. Coastal engineering

Endurance sports (running, trail running, triathlon), adventure (skiing, rock climbing), art

Catharine Creadick, ORE MS Student

MS student Coastal morphology, beach erosion, nature-based engineering

Outrigger paddling, diving, traveling

Charlotte White, ORE MS Student

MS student with Prof. Huang. Nearshore/coastal engineering

Cooking, hiking, traveling

Clara Encke , ORE MS Student

MS student. Renewable energy

Hiking, sailing, traveling, art

New in ORE

Jomphol (Jom) Lamoonkit, ORE MS Student

MS student with Prof. Briggs. Autonomous sensors, OceanCDR

Surfing, scuba diving, trekking

Elizabeth Hauschild, ORE MS Student

MS student with Prof. Huang. Wave energy conversion, nearshore processes

Sailing, surfing, reading

Merritt Shephard, ORE MS Student

MS student. Coastal engineering

Surfing, hiking, diving

Steven Wilhelm, ORE MS Student

MS student. Ocean Engineering

Diving, reading

Tyler Inkley, ORE PhD Student

PhD student with Prof. Krieg. Biomimetics, robotics, underwater vehicles

Diving, music, rugby

Zach Niezgodki, ORE MS Student

MS student. Waterfront structures, port construction

Lifting weights, scuba diving, kayaking

New in ORE

Brady Halvorson, ORE PhD Student

PhD student with Prof. Huang. Water modeling in coastal environments and wave energy conversion

Bouldering, weightlifting, snorkeling

Meysam Rajabi, ORE PhD Student

PhD student with Prof. Gedikli. Fluid-structure, data science and machine learning

Cooking, snorkeling

Guilherme Silva, ORE MS Student

MS student with Prof. Briggs. Sensors, ocean structures

Diving, sailing, cooking

Edward Samson, ORE PhD Student

PhD student with Prof. Francis. Sustainability, bio-inspired engineering, robust control, system identification, estimation and filtering, fourier analysis

Ayrton Medina, ARL Postdoctoral Re-

Aloha! My name is Ayrton Medina and am from Mexico City. I obtained my PhD in Civil Engineering at the National Autonomous University of Mexico and, in parallel with my PhD, I got my second master's degree in Renewable Energy in the Marine Environment from three different universities in Europe (Scotland, France and Spain). I have always been attracted to fluid dynamics and mathematics and would like to be able to contribute to society with research and application of these research areas. Now, as an ARL Postdoctoral Researcher, I work on developing numerical models to simulate water wave-interaction with perforated structures using the Boundary Element Method. In my free time I like running, travelling and spending time with my family.

New in ORE

Mert Gokdepe , Ocean Engineer

Mert Gokdepe is an Applied Research Laboratory (ARL) coastal/ ocean engineer. He joined the team in September of 2022. He is a naval and ocean engineer, a former career Turkish naval officer with 6+ years of experience in project management of high-end naval ship manufacturing, starting from steel cutting through delivery to the navy. In his current position, he is conducting OPENFOAM simulations to analyze wave-structure interaction of the perforated structures. He is a proponent of lifelong learning and enthusiastic about working in multidimensional and broad-scope projects. He holds two master's degrees, one in Naval Architecture and Marine Engineering, one in Mechanical Engineering from the Massachusetts Institute of Technology. He continues his Ph.D. studies in shipbuilding and ocean engineering in Istanbul Technical University. He is conducting research on point absorber type wave energy converters.

Recent graduate profile
Jonathan Chapman, ORE MS graduate

Raised in Wilmington, North Carolina, Jonathan Chapman spent several years working in power system design prior to being accepted into the Ocean and Resources Engineering Department. While at the University of Hawai'i, he focused in oceanographic engineering and worked under the auspices of Dr. Stopa. His research work was funded by NASA and utilized machine learning techniques to estimate air temperature, humidity, and atmospheric boundary layer stratification from SAR sea surface roughness images.

Jonathan's final semester in ORE was defined by an internship performed at PacMar Technologies. At PacMar he performed seakeeping analyses, analyzed ADCP data, and designed electrical schematics for a very large AUV. Jonathan graduated with his Master of Science in December and is excited to start full-time with PacMar as an Ocean Engineer II.

Some ORE Publications

Bresnahan P, **E Briggs E**, B Davis, AR Rodriguez, L Edwards, C Peach, N Renner, H Helling, M Merrifield (2022). A low-cost, DIY ultrasonic water level sensor for education, citizen science, and research. Oceanography, https://doi.org/10.5670/oceanog.2023.101.

Bai Y, C Liu C, T Lay, **KF Cheung**, L Ye (2022). Optimizing a model of coseismic rupture for the 22 July 2020 MW 7.8 Simeonof earthquake by exploiting acute sensitivity of tsunami excitation across the shelf break. Journal of Geophysical Research: Solid Earth, 127(7), e2022JB024484.

Ye L, Y Bai, D Si, T Lay, **KF Cheung**, H Kanamori (2022). Rupture model for the 29 July 2021 MW 8.2 Chignik, Alaska earthquake constrained by seismic, geodetic, and tsunami observations. Journal of Geophysical Research: Solid Earth, 127(7), e2022JB023676.

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Liu H, R Yuan, Y Lv, H Li, **ED Gedikli**, G Song (2022). Remaining Useful Life Prediction of Rolling Bearings Based on Segmented Relative Phase Space Warping and Particle Filter. IEEE Transactions on Instrumentation and Measurement, vol. 71, pp. 1-15, 2022, Art no. 3527415, doi: 10.1109/TIM.2022.3214623.

Peel G, **ED Gedikli** (2022). Investigating the dominant force distributions in ice-induced vibrations using multivariate analysis. 26th IAHR International Symposium on Ice, Montreal, Canada.

Rowe CA, **BM Howe**, MJ Fouch, M Angove, J Aucan, CR Barnes, N Bayliff, NC Becker, F Carrilho, B Fry, HA Janiszewski, A Jamelot, LSL Kong, ST Lentz, DS Luther, G Marinaro, L Matias, A Salaree, AE Sakya, T Thiele, F Tilmann, C von Hildebrandt-Andrade, LM Wallace, S Weinstein, WSD Wilcock, J Barros (2022). SMART Cables Observing the Oceans and Earth, Marine Technology Society Journal, Vol.56 (5), p.13-25

Graupe C, LJ Van Uffelen, PF Worcester, MA Dzieciuch, **BM Howe** (2022). An Automated Framework for Long-Range Acoustic Positioning of Autonomous Underwater Vehicles, J. Acous. Soc. Am, 152,3, pp 1615-1626, https://doi.org/10.1121/10.0013830.

Ma BB, BD Dushaw, **BM Howe** (2022). Rainfall at Sea: Using the Underwater Sounds of Raindrops as a Rain Gauge for Weather and Climate, Acoustics Today, Vol. 18, issue 2, pp 62-71, 2022.

Howe BM et al. (2022). SMART Subsea Cables for Observing the Earth and Ocean, Mitigating Environmental Hazards, and supporting the Blue Economy. Front. Earth Sci. doi: 10.3389/feart.2021.775544.

Salaree A, **BM Howe**, Y Huang, S Weinstein, AE Sakya (2022). A numerical study of SMART Cables potential in marine hazard early warning for the Sumatra and Java regions, Pure Appl. Geophys. https://doi.org/10.1007/s00024-022-03004-0. 2022.

Smith LM, L Cimoli L, D LaScala-Gruenewald, M Pachiadaki, B Brennan, H Pillar, **JE Stopa**, S Baumann-Pickering, SE Beaulieu, KLC Bell, H Harden-Davies, KM Gjerde, P Heimbach, **B Howe**, F Janssen, LA Levin, HA Ruhl, A Soule, K Stocks, MF Vardaro, DJ Wright (2022). The Deep Ocean Observing Strategy: Addressing Global Challenges in the Deep Sea Through Collaboration. Marine Tech. Soc. J., pp. 50-66, https://doi.org/10.4031/MTSJ.56.3.11

Lee CH, PHY Lo, H Shi, **Z Huang** (2022). Numerical Modeling of Generation of Landslide Tsunamis: A Review. Journal of Earthquake and Tsunami Vol. 16, No. 06, 2241001 (2022)

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Publications continued

Stopa JE, C Wang, D Vandemark, D Foster, A Mouche, B Chapron (2022). Automated Global Classification of Surface Layer Stratification Using High-Resolution Sea Surface Roughness Measurements by Satellite Synthetic Aperture Radar. Geophysical Research Letters, 49.12 (2022) https://doi.org/10.1029/2022GL098686

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