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Kerri Hickenbottom Joins ERE Faculty

by
Kerri Hickenbottom, Ph.D.
ERE Assistant Professor

I am very excited to have joined HSU and the ERE department this fall. I recently finished my Ph.D. in Environmental Science and Engineering at the Colorado School of Mines in Golden, CO. My research is centered around the development of novel membrane processes for resource recovery from waste streams. At Mines, my Ph.D. research focused on investigating a hybrid, membrane-based process for energy generation from low-grade heat. My research has also extended to advanced treatment processes for recovery of hydraulic fracturing flowback water and management of concentrate streams.

Kerri sightseeing at Chanh Tao Church in Nha Trang, Vietnam.

My enthusiasm for science and engineering unfolded as an undergraduate in the Civil and Environmental Engineering program at the University of Nevada, Reno. There, I was involved in several student organizations including the Society of Women Engineers and Engineers Without Borders, where I participated in community outreach events, and worked alongside professors and professional engineers to create a sustainable design for composting toilets in Itaparica, Brazil. My involvement in these organizations exposed me to local and global environmental problems and the vulnerability of water quality and resources. However, it was my undergraduate research in advanced processes for wastewater treatment that launched my interest in seeking new alternatives and technologies for supplying sustainable potable water sources to populations in arid regions around the globe, and in

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FROM THE EDITORS

Hello from the Messenger staff! We hope you enjoy this Fall 2015 edition.

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"What's the use of having developed a science well enough to make predictions if, in the end, all we're willing to do is stand around and wait for them to come true?"

F. Sherwood Rowland
(1927-2012)
Nobel laureate

(Regarding chlorofluorocarbons and the dwindling ozone layer)

Alumni Profiles

Luke Armbruster

BS ERE 2013
Water and Energy Technical Associate
ESA Associates, San Francisco, CA

Growing up in rural southeast Missouri, I developed a strong appreciation for the streams and forests that split and dotted the landscape. I spent a lot of time there playing in nature and seeing the value in preserving it.

Just before my senior year of high school I moved to a boarding school in southern California. Two of my teachers there, both HSU alumni, encouraged me to peek behind the "redwood curtain" and look into programs at HSU. After checking out the school, I was drawn to environmental engineering because of my fervid desire to solve environmental problems. The ERE Program proved to be the right program for me because of the strong science education, highly knowledgeable faculty, and collaborative atmosphere among students. In addition, I was fortunate to have the mentorship of Dr. Beth Eschenbach, who encourages her students to make big dreams and follow them.

During my first two years at HSU I directed the on-campus compost program through the Waste-Reduction & Resource Awareness Program (WRRAP). There I was able to work with students from many different majors and help organize workshops and campaigns, as well as maintain the compost demonstration site. After my sophomore and junior years I obtained summer fellowships at the Department of Energy Lawrence Berkeley Lab. I also acquired a basic level of understanding of methods to model greenhouse gas emissions, learned the Statistical Programming Language R, and had the opportunity to network with other people who were passionate about studying climate change. It was a phenomenal experience.

I strongly encourage current ERE students to work during summer breaks and/or part-time during the semester, even if it means graduating a semester or two later than originally planned. There are many great opportunities to apply what you learn from the working world to class projects and ERE club activities. For example, my Comp Methods 3 project was focused in part on the work I started at Lawrence Berkeley. Even more, depending of course on the type of work, there will likely be many opportunities to apply what you learn in your ERE courses to the work you do at your job.

Soon after graduating I was hired by Environmental Science Associates in San Francisco, and I've been at the firm now for a year and half. One of my first projects was to assist in writing the initial study, and later, draft environmental impact report, for a 2-MGD recycled water project, which was to serve various large irrigation customers in the western part of San Francisco. I have also assisted with CEQA compliance on several projects, and worked on some engineering projects, including estimating stormwater reuse in Southern California, setting up and running hydraulic models of various stream systems, and assisting with the drafting of stream bank restoration plans.

Alumni Profiles

I can't thank the ERE program enough for giving me the tools to pursue meaningful work. I'll always remember it as a unique and extraordinary program, and I hope you will too. Best of luck in your future! Be sure to use your ERE alumni network when graduation time comes and you are ready to enter the workforce.

Lorrie (Morrison) Bundy, PE
BS ERE and BA Applied Math 1999
Field Office Engineer
USDA Natural Resources
Conservation Service, Yreka, CA

Dropping out of high school was one of the best decisions I have ever made. Attending HSU was number one. Growing up in southern California, I expected to be a secretary and took typing and shorthand classes in high school. No one in my family had attended college; in fact none of my three siblings finished high school. I always did well in math and other subjects, but there was no guidance to encourage me to pursue education and develop a plan. It was easy to drop out at 16. Just stop going and get a job. Lesson 1 – know when to quit.

A friend encouraged me to join the California Conservation Corps (CCC) as a way to gain the experience needed to become a fire fighter. I liked the physical challenges and was able to complete their Backcountry Trails program in the Klamath National Forest. Our crew of 15 people worked trails in the wilderness for five months under direction of Forest Service staff. "Hard work, low pay, miserable conditions." It was wonderful and I loved it! Lesson 2 – know when to gut it out.

I received a small scholarship after two years of service with the CCC. This incentive was all I needed to begin classes at College of the Siskiyous (COS). I still didn't know what to study, so I took the Eureka exam to determine what careers would best suit me. The exam results showed that I should be a YMCA director, an electrician, a military officer, or an engineer. I picked engineering because it seemed to be the most challenging. I decided I would consider the other options only if I failed at engineering. Lesson 3 – listen to others but follow your own instincts.

Well, I didn't fail. After completing basic coursework at COS, I transferred to HSU to attempt the ERE program. Not only did I complete the ERE program with honors, but I also passed the EIT exam and later the PE exam. I also completed a BA in Applied Math, thanks to the encouragement of an ERE colleague, Steven Romero, who believed that we can often get big rewards with a just little more effort. Lesson 4 – work hard and work smart.

I worked as a math and science tutor during the school year and spent my summers working trails. I highly recommend tutoring others as a way to reinforce coursework. Getting paid for it is just a very nice bonus. To explore career options, I also worked as an intern for NOAA River Forecast Center and Klamath National Forest.

My husband wanted to stay in a small community near his hometown, Sawyers Bar, so there were not many job opportunities for me after graduation. However, the local Resource Conservation District (RCD) office needed an engineer to design fish screens and fish passage structures, and I had a job. But, there were no engineering mentors for me. Fortunately, the ERE courses I had taken at HSU provided a solid foundation for solving both technical and social problems. I can still hear Mike Anderson asking me if I believed the premise for a dynamics problem. And Robert Willis encouraging the competitive comradery between modeling teams solving groundwater problems. And Margaret Lang patiently deriving the governing equations for transport models. And Susan Firor really explaining the meaning of a null hypothesis.

As an RCD employee, I worked with local agencies and private landowners to help develop a fish screening program that accelerated fisheries protection on agricultural property. One partner, the USDA Natural Resources Conservation Service, liked the work and offered me a position in Weaverville. After 3 years there, I accepted a new position in Yreka. I am lucky to work for an agency with the inspiring mission: Helping People Help The Land. I am also grateful that private landowners trust me to work with them.

The ERE program and professors followed a robust process with social consciousness for learning that is still engrained in me. I like to tell others that at HSU I was not only EDUCATED, but also TRAINED.

"Always laugh when you can – it is cheap medicine."

Lord Byron
(1788-1824)

Alumni Profiles

Avram Pearlman
BS ERE 2005
Senior Test Engineer
Cumulus Energy Storage
Oakland, CA
www.cumulusenergystorage.com/

It was 2006 and I had completed my work at HSU. I had been part of a team of ERE students in the Renewable Energy Student Union (RESU) that won the Grand Prize at the 2005 Hydrogen Student Design Contest offered by the National Hydrogen Association, and sponsored by the U.S. Department of Energy and other partners.

Working with HSU's Schatz Energy Research Center (SERC), and using funding provided by Chevron, we formed an LLC to see if we could actually implement our design. We were able to get paid for this activity. It turned out that the project wasn't feasible at the time, but partly as a result of our efforts and the relationships we had built in the private and public sectors, HSU now has a hydrogen vehicle fueling station located on campus!

Before leaving Arcata I had a chance to work briefly with Cypress Grove Chevre as a volunteer cheese engineer. They needed help designing new packaging to provide convective airflow through the boxes of cheese during shipment. This was one of my favorite projects because I was able to work independently, designing experiments and solving problems. Not only did I get all the cheese I could ever want, but I left the job knowing that the problem solving and critical thinking skills I had gained at HSU had been put to good use.

My first "real" job as an engineer was working for kW Engineering in Oakland, California. It was a small consulting firm at the time, and I was one of only 17 employees. Over seven years the firm grew to more than 50 employees, with several offices throughout the US. During this time I learned that engineering consulting was not for me.

While at kW I managed the rising solar rebate contract (SGIP and CSI) we had with PG&E, often billing more than $100,000 per month for my team. Under my watch, the average number of inspections went from 12 per month to 120 per month, shaving down time from 10 hours to 3.25 hours per project, keeping our clients very happy. I also helped coordinate database integration for project tracking and monthly reporting.

I learned a lot designing the inspection documentation used throughout California, and as the program expanded I worked closely with utilities to include solar hot water and energy storage. We saw all sorts of technologies, from solar stickers that fit onto sheet metal roofs to solar roofing tiles, and from home solar systems to large Megawatt-scale two-axis tracking systems.

However, I was struggling to maintain a balance between my work and private life. I regularly billed 50, 60 and even more hours per week, and was not able to spend much time with friends and family or pursue some of my hobbies. I did, however, earn my PE license (Mechanical), and I learned a lot about working harder, faster and cheaper. Looking back on it, I am grateful that I qualified for the PE exam, and encourage every engineer to pursue their PE if given the opportunity.

Being a bit jaded from the industry, I decided to take a break and teach yoga and fitness classes, very challenging and rewarding in its own way. It was also at this time that I moved onto a sailboat with my future wife to cut the cost of living in the bay area. After about a year, I decided to apply for an MS at San Jose State, and I was accepted into their first-of-a-kind engineering program focused entirely on battery technology. It was through this program that I was introduced to Cumulus Energy Storage.

One of my classmates asked for my help working at Cumulus Energy Storage, a startup in Oakland developing a new battery technology. The difference between working at a consulting firm and a startup was like night and day. Instead of harder, faster, cheaper, it is a constant stream of problem solving, creative solutions and on-the-fly decisions. Often, I have an idea that fails on implementation, but I learn so much and have many other success and wins along the way. The startup environment is much more what I had envisioned while still a student at HSU.

Now, as a Senior Test Engineer at Cumulus, I am looking at how ion exchange membranes change size when introduced to different electrolyte solutions; designing, sourcing and building the wiring harness for our battery; testing designs for functionality; creating and modifying CAD drawings for bids; working with vendors; building and maintaining lab equipment; and much more. Each day is full of critical thinking and discussions on how to scale up to mass production. A big thanks to HSU and ERE for giving me a solid foundation to get me to where I am today! Ω

FROM ERE TO PhD:
Taking the High (er Education) Road

by
Ryan Ziels (BS ERE 2011) Graduate Student
University of Washington, Seattle, Washington

As students approach the end of the ERE program, many new career paths call their names. Because the ERE program provides such a diverse engineering tool belt, there are many possible avenues for graduates—private industry, government, and even academia. For some ERE seniors, the thought of more university coursework is enough to cause an upset stomach. Yet, for others, the idea of tackling unsolved engineering problems and potentially making the world a better place is motivating enough for them to go back to the classroom. In reality, most engineering graduate school experiences involve much less time spent in the classroom relative to time spent gaining hands-on experience in a field or laboratory setting. ERE graduates are well suited for such a demanding intellectual endeavor, due to the high level of independent thinking and motivation that is required in the ERE program.

I caught the research bug during my third year of the ERE program. For the final course of the Computational Methods series, I decided to model microbial dynamics in an anaerobic digestion process converting food waste into renewable methane. After spending the semester immersed in the term project, I realized that there were many knowledge gaps remaining within the topic area, and that I very much enjoyed contemplating those unknowns. It was at that point that I realized a path of research could enable me to explore such questions pertinent to biological waste treatment processes, and would potentially allow me to improve the current state of understanding. Fortunately, the U.S. National Science Foundation (NSF) facilitates a program—Research Experience for Undergraduates (REU)—that enabled me to participate in a research project on anaerobic digestion at Clarkson University during my summer break. That experience confirmed that research was the right path for me, and I began preparing applications to graduate programs that supported research in my area of interest.

Going from the ERE program into graduate school has many advantages—an important one being that ERE grads are trained to think critically and write clearly, and this goes a long way

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Ryan touring the centralized biogas plant in Linköping, Sweden. The plant utilizes compostable waste from residential homes to generate renewable methane to power public transportation vehicles.

Radical Sabbaticals

by Brad Finney, ERE Professor
Margaret Lang, ERE Professor

Introduction by
Heidi Otten, ERE Senior and ERE Messenger Student Editor

ERE Professors Brad Finney and Margaret Lang recently spent time away from school on sabbaticals. Every seven years HSU faculty have the opportunity to request a sabbatical. One of the requirements is that the work done during that time be beneficial in some way to the HSU community. Faculty are given the opportunity to focus on research, advance the knowledge in their field, and revitalize their classes by bringing experiences back into the classroom. As you will read below, Professors Finney and Lang spent their sabbaticals in interesting places, doing exciting work.

BRAD FINNEY

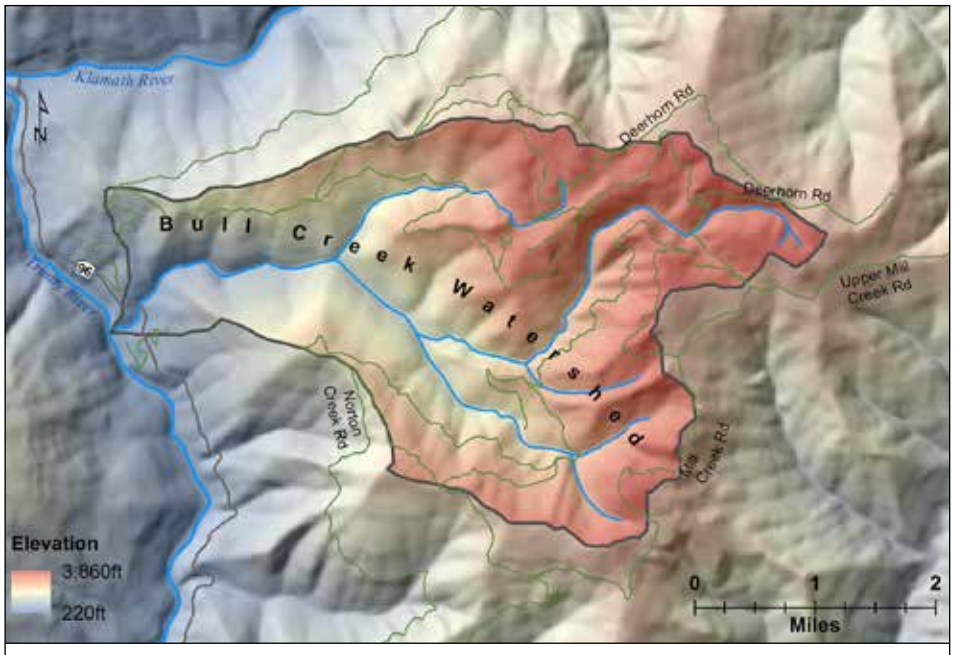
In the last few years, ERE faculty members have spent their sabbatical leaves in such exotic places as Australia, Brazil, and France. For my sabbatical leave during the Fall 2014 term, I traveled to the less exotic but still beautiful Hoopa Valley.

The Hoopa Valley is located in Humboldt County, CA. The valley, which is bisected by the Trinity River, is the traditional home to the Hupa people. Hoopa Valley is encompassed by the Hoopa Valley Indian Reservation, which was established by a Federal Executive Order in 1876. The Reservation has an area of approximately 140 square miles, and is governed by the sovereign Hoopa Valley Tribe. This rural and mountainous area is sparsely populated, with approximately 2,500 Hupa people living within the reservation boundaries, and the only formal community being the unincorporated town of Hoopa.

The Hoopa Valley Tribal Government manages the natural resources in the valley for direct use by tribal members, providing jobs and export products (primarily lumber) for income. One natural resource that has not yet been developed, but could provide additional income for the tribe, is hydropower. The objective of my sabbatical research was to examine the viability of run-of-river hydropower development on Beaver Creek and Bull Creek. These creeks are tributaries of the Trinity River on the Hoopa Valley Indian Reservation. Following a preliminary site analysis, it was determined that there were cultural and logistical constraints that would prohibit or limit the likelihood a hydropower facility could be successfully implemented on Beaver Creek, and this creek was not considered further.

A hydrological evaluation was conducted to determine the physical characteristics of the Bull Creek watershed. Since there is no recorded flow data for Bull Creek, a data collection program was initiated to provide information on the relationship between rainfall and runoff in the watershed. With two partial years of streamflow data, a rainfall-runoff model was developed to extend the observed streamflow record based on long-term precipitation data. Ultimately, 55 years of daily flow data for Bull Creek were estimated using daily rainfall from Hoopa Valley.

The components of a hydropower system appropriate for the streamflow characteristics of Bull Creek were then determined. Three different alternative systems were considered, differing by the working head of water and the type of turbine used to convert the energy in the diverted streamflow to mechanical power. In addition, four different penstock materials were considered, including PVC, ductile iron, glass reinforced polymer, and steel. The three types of turbines considered were crossflow, Francis, and Turgo. The crossflow and Francis turbines were recommended for the "lower head" setting with approximately 150 feet of head, and the Turgo turbine was recommended for the "higher head" setting with 460 feet of head. An economic analysis of the



Bull Creek Watershed on the Hoopa Valley Indian Reservation.

hydropower alternatives showed they are all viable, but the Turgo turbine alternative has an internal rate of return (IRR) of 8.7 percent, twice that of the other two alternatives. Depending on the level of grant support available to assist the Tribe in financing the capital equipment costs, the IRR for all alternatives could be much higher.

It was also determined that a 30-inch penstock was appropriate for all three hydropower alternatives. Based on preliminary budget quotes for the penstock materials, PVC was the least cost material, although the price of a penstock using the other material was not significantly higher than PVC given the long lifetime of the alternative materials. A final decision on the optimal material will need to consider engineering and construction characteristics of the materials, in addition to price.

Based on the analysis performed during this project, developing a hydropower facility on Bull Creek would be a sound financial investment. The Hoopa Valley Tribe is encouraged to proceed with the next few steps in planning and implementing a hydropower facility. These next steps include completing a geological site investigation of both the proposed powerhouse location and the higher head diversion point, and refining cost estimates. The geological site investigation should be conducted to verify that there are no hazards preventing placement of a structure at the proposed locations. A geological and engineering investigation for the access road should also be completed to suggest a route and refine construction cost estimates. When these investigations are completed, a refined estimate of the power that could be produced can be computed, and negotiations with PG&E over a power purchase agreement can be started.

MARGARET LANG

One of the most enjoyable job benefits for professors is sabbatical leaves that allow us to pursue research interests and learn new things. For Spring 2015, I enjoyed my first foreign sabbatical. I conducted cooperative research at the Institut National de la Recherche Agronomique-Ecologie Comportementale et Biologie des Populations de Poissons (INRA-ECOBIOP) research laboratory in St. Pée sur Nivelle, France. The lab is in the far southwestern corner of France near the Atlantic Ocean, and is within a few kilometers of Spain. The climate has much in common with Humboldt County's climate, and the Nivelle River watershed is very similar in size, elevation relief, and average rainfall to the Little River near Trinidad, California. The Nivelle River also has anadromous fish species, including Atlantic Salmon, Sea Trout (sea-run brown trout similar to Steelhead), lamprey, and shad.

While visiting INRA-ECOBIOP from January through June 2015, my primary research collaboration was a project to assess the impacts of extreme hydrologic events, floods and droughts, on emergent juvenile trout and salmon. This research was conducted in cooperation with the laboratory director, Dr. Agnès Bardonnet; a PhD student, Elorri Arevalo; and a faculty member from the University of the Basque Country in Bilbao, Spain, Dr. Aitor Larrañaga. The research is Elorri's PhD project and includes both laboratory and field experiments. My contributions were the design and analysis of hydraulic conditions in the laboratory and field station experimental channels. INRA-ECOBIOP has a large laboratory facility with indoor flume channels and an outside field station with experimental channels that are side channels to the Nivelle River. These channels can be manipulated to simulate a variety of natural hydraulic conditions. The fish and aquatic invertebrate populations can be isolated to study their movement and survival under these different channel conditions.

I also developed a sediment transport model for the Nivelle River

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Margaret with landlord Teixa Faliere in front of Teixa's traditional Basque house.

Renewable Energy Student Union

Real Hands-on Projects that Support the Community

by Douglas Saucedo (BS ERE 2005) ERE Lecturer and RESU Founding Member
Kristen Radescsky (MS ES-EES 2009) SERC Research Engineer and RESU Past Vice President
Julian Quick, ERE Senior and RESU Past President
Lori Jones, ERE Senior and RESU President

RESU's Genesis

by Douglas Saucedo

RESU was started in the spirit that motivated people with the right opportunities can do extraordinary things. The club was formed in the 2003-2004 academic year by several ERE students and colleagues interested in expanding the intellectual and hands-on learning resources related to renewable energy, energy storage, and power systems. At the time, the ERE department did not offer advanced energy courses due to a lack of faculty with the necessary expertise and available time. Students were facing potential missed opportunities due to this lack of faculty, and RESU's first "project" was to lobby the administration to hire a new faculty member with energy expertise. These efforts contributed to the hiring of Professor Arne Jacobsen in Spring 2005. RESU was now on its way, and within its first few years achieved impressive results in student competitions and basic research related to renewable energy.

RESU was formed to seek out and facilitate hands-on learning activities related to renewable power systems. We accomplished this task by collaborating with the Schatz Energy Research Center (SERC), participating in student competitions, and engaging the community. We worked with SERC to expand their docent program and find ways to support hands-on RESU projects. As SERC docents, students engaged the community by providing information relating to energy efficiency, renewable energy, and energy storage. Through competitions, we won the grand prize in the 2005 National Hydrogen Association student design competition with support from SERC and ERE staff. The impact of the 2005 competition brought SERC to the attention of Chevron Energy Solutions and ultimately resulted in construction of a hydrogen vehicle fueling station on HSU's campus.

RESU Gets Hands On

by Kristen Radescsky

RESU first got its hands dirty in a myriad of renewable energy projects and fish fries between 2006 and 2008. The Solar Radiation Monitoring Station (SoRMS) was launched in 2006 and continues to be maintained by RESU. SoRMS consists of two Eppley PSP pyranometers that collect solar radiation data on the HSU library roof. Live and historic data are available on the National Renewable Energy Laboratory (NREL) website for use by solar installers and researchers to use when working on projects in Arcata.

This is the third in a series of articles about the five student clubs associated with ERE.

Up next: ERESA

As RESU members, we had the great opportunity to build relationships with local partners such as solar installer Ben Scurfield and Rock Creek Ranch, both introduced to RESU by our ERE mentor Arne Jacobson. Ben Scurfield volunteered his time to teach the club via three projects: re-installing the CCAT solar electric and hot water system, installing a solar electric (aka photovoltaic) system on Ben's home in Eureka, and installing the hybrid micro-hydro and photovoltaic system at Rock Creek Ranch. The Rock Creek Ranch hybrid energy system project was initiated in Arne's Renewable Energy Technology class as a design project, and carried out by RESU in 2007. The as-built system consists of a 1.15 kW photovoltaic pole-mount system and a 600 W culvert-diverted micro-hydro system. The water runs down from the road through the penstock and into the pelton wheel, and no fish are harmed in the process. The installed pelton wheel was the final unit custom built by the famous Don Harris.

The project was partially funded by RESU's annual fish fry located outside Science D. Hundreds of students received a healthy meal of fresh-caught local rock fish tacos with beans, rice, and horchata for a good price.

Upon the close of this era, RESU discovered P3, the People, Prosperity and the Planet Student Design Competition for Sustainability. RESU participated, won $10,000, and installed a 30 m-tall wind monitoring station in Kneeland in 2008. The installation consisted of anchoring the guide wires in the ground with cement, raising the tower with a winch, and setting up the data acquisition system to record wind speed and temperature at multiple locations up the tower. In addition, we developed a novel software tool to predict long-term wind data for a potential site by correlating

RESU Quick Facts

The Renewable Energy Student Union was formed during the 2003-2004 academic year as an independent student club.

RESU currently has 15 active members.

Goals

Seek out and facilitate hands-on learning activities related to renewable energy power systems, emphasizing real projects that have positive impacts in the community.

RESU members and supporters in front of wind monitoring station in Kneeland, California. Front row: Colin Sheppard, Arne Jacobson (faculty advisor), and Juliette Bohn. Back row: Jim Zoellick, Doug Saucedo, Ranjit Deshmukh, James Apple, and Kristen Radecsky.

short-term data from that site with long-term data of nearby sites, which reduces the time and costs required for monitoring.

RESU Matures and Grows

by Julian Quick

During the period 2011-2015, RESU engaged in several small community renewable energy projects and two Renewable Energy competitions. These small projects included: helping build a solar powered hot tub for a friend in McKinleyville, building a tandem bicycle-powered kitchen blender, and installing the major components of CCAT's Mobile Operations Energy Wagon and 3-D printing pelton wheels as part of a pico-hydro energy demonstration device for the California Student Sustainability Alliance.

We continued to work with Rock Creek Ranch, where we collected solar resource data and for the roof of a building and performed a comprehensive energy audit that was summarized in a memo. We began a new relationship with Jefferson Elementary School when we tested the pressure capacity of their solar thermal panels and submitted a memo recommending the sizing of general system components based on an energy audit we performed.

In 2014, we formed a team of 12 students to compete in the hydrogen fueling station competition. We were awarded honorable mention, and presented our design in a Department of Energy webinar. Last semester, we formed a team of 16 students to compete in NREL's Race to Zero student design competition, in which students design homes with net zero energy consumption. The ERE Department and Department of Natural Resources funded a trip to NREL in Colorado, where we presented our design, attended net zero technology presentations, and networked with some of the biggest names in building across the country.

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Think Outside the Cubicle:
Combining ERE and MBA

by
James Robinson IV (BS ERE 2011), Registered Representative
Starlight Investments, LLC, Berkeley, CA

The process of becoming an engineer is not limited to developing proficiency in mathematics, physics, chemistry and programming. It is a state of being, an approach, and a lifestyle. Engineers are needed in many fields outside of engineering because of their excellent problem-solving skills.

I came to HSU initially to study botany. I was good at memorizatio (plant names, parts, processes, etc) but I quickly realized that I needed more than this to impact the world, I needed to *apply* knowledge. So I changed focus to the technologies that adversely affect plants. This meant I had to learn mathematics, almost from the ground up, and that was only the start. It was very difficult for me, when school had always come easy, and I had to reprogram my finely-tuned 'hard-drive brain' into 'RAM.' But with determination it became easier and incredibly fun. Energy resource technology became my greatest passion.

During the Christmas vacation before my final year of ERE, I dedicated time to reflecting on my life plan. I felt that to have the greatest positive impact globally, I needed to be involved in law, politics, or business. Having started my first business in high school, and running a business to pay my college tuition, I decided to stay in that field. I wanted to collaborate in the international arena, and the internationally recognized Master of Business Administration (MBA) would allow me to do that. So, in my last year of undergraduate studies I took all the prerequisites necessary for the MBA at HSU.

Once in the MBA program, I focused on increasing my business knowledge, learning everything I could about sustainable business, and I wrote a thesis on triple-bottom-line accounting (Profit + People + Planet).

Despite my excellent education, relatively good grades, good experience, good attitude, and all the extracurricular activities I participated in at HSU, such as HEIF and RESU, I spent many unfruitful months applying for jobs without a nibble on my resume. Eventually, I decided to approach the problem from a different angle; what I needed was face-time with the business community. Being a member of professional organizations such as ASCE and Rotary made all the difference for me (trade shows and conferences are also good options). Within a week, I had a job in San Francisco as a business development consultant for a Costa-Rican hydroelectric start-up. I enjoyed the work, and I was very successful. I approached their business shortfalls as an engineer, and suggested some strategy changes that helped get them 'out of the red' and 'into the black.'

Last year, and again using my contacts made through the Berkeley Rotary Club, I moved on to a new position with an investment bank, Starlight Investments, LLC, located in Oakland, California. Our firm specializes in advising renewable energy-focused businesses to make them attractive to investors, so they can raise growth capital for their projects. I now live in Sweden with my wonderful wife, an Austrian Ph.D. engineer with expertise in aluminum alloy materials science. I work via the internet, mostly through email and Skype, and I travel globally to as many trade shows and conferences as possible to stay active with client-businesses seeking to raise capital.

Based on my experience, here are my recommendations for ERE students:

Persevere as an engineer if at all possible. The difficult technical sciences and computer algorithms don't have to be your career, but through them you will learn to think critically and effectively. This methodology can apply not only to engineering, but to all aspects of your life. You will have the abilities to accomplish everything that engineers do, and more.

Get a master's degree if it makes sense for your interests, or go to work first to figure out what kind of additional degree may help. Many of the most 'successful' people I've met don't have advanced degrees, but they have a few things in common: perseverance, diligence, and will-power. A meticulous ability to stay organized is also a big help, so make organization a habit. It takes work, but is well worth that work as the layers of life pile up.

An MBA is valuable not only because of the required coursework, but also because the three letters (MBA) are so widely and internationally recognized.

Nokero Solar Light

The following are suggestions for those who read my story and consider following a similar path:

The world of finance needs determined individuals who can objectively evaluate efficacy and successfully determine which projects and businesses are worth investing in. Many independent contracting jobs are available to be an entrepreneur, and you can be your own boss under the umbrella of a firm, such as Edward Jones, or an investment bank or business development company similar to the bank I work for now.

To begin such a path, regardless of your educational background, you'll need to prepare for the "Series Exams." Series 7 (the exam mentioned in "The Wolf of Wall Street") will give you a very good head start. Then, you need to find a financial institution willing to sponsor you for the exam. The test is 7.5 hours of multiple choice questions, similar in structure to the Fundamentals of Engineering Exam.

You can also directly approach companies that have in-house engineering teams. There are many such companies that develop products or provide infrastructure services. There is no need to limit yourself to applying to engineering firms. For instance, one of the clients my bank serves is growing rapidly in the international arena, selling low-voltage solar products, and it is planning to hire a new electrical engineer soon. As an aside, this company was previously listed under ERE Professor Arne Jacobson's Lighting Global standard. I assume the company will be listed again, as its products have become *the* industry standard.

ERE students: it may be possible for my bank to hire a recent graduate with the right attitude, motivation, and professionalism. If you are interested, send me a resume.

Let me know if there are any questions. I'm happy to talk individually as well. Email me at: james.riv1021@gmail.com

All the best to each of you! Ω

Children in Ko Mpisi (near Victoria Falls), Zimbabwe, posing at night with their Nokero (No Kerosene) lights. These lights, charged by the sun during the day for use at night, help people in emerging markets, predominantly in Africa and Asia, avoid hazardous exposure to kerosene, the fuel source for historically available lights.

Hickenbottom
Continued from page 1

pursuing a graduate degree and continuing research in managing the global water crisis.

As a graduate student at Mines, I continued to explore applications of membrane processes for managing difficult-to-treat wastewaters. I investigated forward osmosis (FO), an osmotically driven membrane process, as an effective method for the treatment of drilling wastewater from oil and gas (O&G) exploration and production. This research was part of a collaborative study, where I worked with a team of professionals from the O&G industry and a leading membrane manufacturing company. The study concluded that FO can reduce the volume of the O&G waste stream and supply a sustainable water source as a replacement for consumption of local or transported freshwater. As a master's degree student, I also investigated the application of membrane distillation (MD) as an appropriate technology for water and mineral recovery from concentrate streams. In this study, I developed a novel operating technique to mitigate membrane fouling and reduce chemical demand, which resulted in a U.S. patent application.

My PhD research transitioned to the water-energy nexus, and to developing a novel membrane-based process for energy production from otherwise unused low-grade heat. For my PhD research, I developed a dynamic system model that integrates experimental results and established system models to predict process performance, economics, and environmental life-cycle impacts. Results from this study were impactful in establishing the osmotic heat engine as a potential renewable energy generation technology that can be effective in both increasing the energy efficiency of existing power plants and as a lower-emissions energy storage device to be used during peak electricity demands.

I have also enjoyed taking my research outside of the laboratory by presenting at local and national conferences and participating in K-12 outreach initiatives. I worked with the Minority Engineering Program at Mines to develop a Summer Engineering Education & Development (SEED) outreach program for underrepresented students entering grades seven through nine. I have also enjoyed working with local educators to develop lesson plans on advanced water and wastewater treatment processes. During Engineers Week we brought local middle school and high school students to the lab and presented our research through hands-on activities. I am eager to continue promoting environmental resources engineering to the broader community at HSU, and look forward to working with and supporting ERE clubs to promote STEM education and professional development.

My future research plan is to continue the development of sustainable waste-to-resource systems that protect receiving environments from waste streams as well as supply safe and reliable water and energy sources that are broadly accessible to developed and developing countries. I plan to continue my work investigating MD for resource recovery from reverse osmosis concentrate streams, FO for treatment and reuse of contaminated wastewater streams, and pressure retarded osmosis for renewable-based energy storage. These are all current or impending issues in California. I am particularly interested in expanding my research to include investigating social aspects related to water, especially water reuse. Water scarcity and the drive for sustainable technologies are motivating increased stimulating research and development of innovative treatment solutions. However, the broader community must accept these technologies for them to be implemented, and some community education will be needed.

Aside from my research and outreach activities, I enjoy experimenting in the kitchen, traveling and exploring new places, and spending time outdoors. Humboldt is an excellent backdrop to all these activities! On the weekends (when I am not grading papers! ☺), you can find me exploring new running trails, or riding with my husband, ERE Assistant Professor Andrea Achilli, on our tandem bicycle. Ω

ERE to Ph.D.
Continued from page 5

when preparing manuscripts and reports in an academic setting. Another important advantage that the ERE program provides is the amount of laboratory and field exposure students gain. I remember struggling with the amount of time I had to spend conducting lab exercises and preparing reports while being an ERE student—but I was instantly grateful once I began graduate school, as those experiential learning opportunities gave me an advantage in class and the laboratory.

Since beginning graduate school at the University of Washington in 2011, I have been involved in several research projects covering a broad array of topics, and I have conducted this research while living in several different countries. I was very fortunate to be awarded an NSF Graduate Research Fellowship at the start of graduate school, which has provided me with the flexibility to pursue the areas of research on which I am passionate. With such flexibility came numerous opportunities to branch outside the walls of my department and collaborate with other researchers worldwide. One example is an 8-month research exchange that I conducted at the Biogas Research Center in Linköping, Sweden. There, I collaborated with private industry and university research teams to advance the understanding of the microbial ecosystems in anaerobic digesters. Through my stay in Sweden, I also collaborated with other researchers across Europe. As a result, I will be returning as a visiting researcher to the Laboratory of Microbiology at Wageningen University in the Netherlands this

upcoming spring and summer. By keeping collaborative projects focused within my PhD topic area, I have been able to use the results as chapters of my doctoral dissertation.

As you can see from my experience, pursuing a graduate degree can be a great way to see the world while also exercising the valuable skills gained through the ERE program. That is not to say that a PhD is a walk in the park—it requires more independent motivation and dedication than the average job. But ERE graduates are well-trained candidates to take on graduate research projects in stride, thanks to the writing and critical thinking that is demanded throughout the ERE program. I highly recommend that any student in the ERE program who enjoys independent problem solving should give research a try. The NSF REU program is a great opportunity to 'test the waters' of research, and see if the path of academia is a good fit. In my experience, ERE faculty are more than helpful when it comes time to prepare applications for graduate programs. So, don't simply dismiss the idea of staying within the university after graduation—as you will most likely find that graduate school is a perfect compliment to the hands-on education that the ERE program provides! Ω

Sabbaticals
Continued from page 7

reach that includes the Lurberria flood control dam. INRA-ECOBIOP has been studying fish populations in the Nivelle River for many years, but has not conducted significant research related to the river's geomorphology and its possible impacts on fish populations. The flood control dam was constructed in 2008 and potential geomorphic impacts on salmonid habitats, particularly spawning habitats, are a concern. I developed a preliminary HEC-RAS sediment transport model for the Nivelle River in the dam region to assist the researchers in assessing the impacts of the dam. I also trained INRA scientists and technicians in conducting field measurements so they can continue monitoring possible impacts of the dam on fish habitat.

The other enjoyable part of my sabbatical was the cultural exchange and experience. The French Basque country shares many similarities to Humboldt County besides the weather! The people are interested in local products and foods; many are small-scale entrepreneurs; and the region is the center of France's surf culture (it's the home of Quiksilver). We lived in the country, renting a small apartment in a traditional Basque farmhouse that included apartments for the couple who owned the property, their grandmother, an Aunt, us, and occasional other renters. The farm produced Piment d'Espelette, a mild red pepper introduced to this region from Central America in the 16th century. The family also kept chickens and rabbits for food, and donkeys for working. The cycling culture was also impressive on both the French and Spanish side of the border. Our landlords introduced us to members of one of the numerous local cycling clubs, and we enjoyed many bike rides with the Saint Jean de Luz Olympique (SJLO) club. Ω

RESU
Continued from page 9

The Future of RESU

by Lori Jones

Continuing RESU's founding focus on hands-on projects, the start of the Fall 2015 semester saw us commit to competing in the Northern California Solar Regatta. For the Regatta we will design and build or retrofit an existing boat to run purely on solar power, and then race the boat at the end of the Spring 2016 semester. This project is seen as a wonderful opportunity in the traditional RESU style: to gain experience with a form of renewable energy while also joining a fun competition. This competition will be the only large project we focus on for the 2015-2016 academic year. This will allow us to produce a high quality product while also being able to stay focused on our course work.

This semester we are also making a big commitment to fundraising by selling smoothies made with our bike blender. In order to calibrate the pyrometers used for the SoRMS project, we must raise $500 per year. In the past few years, RESU has essentially raised no money, as we focused on doing smaller projects. Now, we will continue our commitment to maintaining SoRMS by not only continuing our daily maintenance of the station, but also by raising the needed money for the calibrations. As RESU continues to grow, the goal of offering students the opportunity to gain experience with renewable energy and staying committed to all of our projects will remain a central theme.

If you are interested in any aspect of renewable energy, please join us at RESU. We are excited to welcome new members. You will work on interesting and fun projects, participate in regional and national competitions, and connect with other students and professionals in the field. Ω

"A man is like a fraction whose numerator is what he is and whose denominator is what he thinks of himself. The larger the denominator, the smaller the fraction."

Leo Tolstoy (1828-1910)

GRE

Continued from page 16

Research Section:
1 section, time varies
Similar to the Experimental Section, this also does not count towards your score. However, it is clearly identified as the "Research Section" and always appears as the very last section. Some GRE's do not have the Research section.

WHERE and WHEN

Fortunately, the HSU library is an official GRE test center. The next-nearest test centers are in Medford, OR, Chico CA, and Santa Rosa, CA. In general, the HSU center has a few weekday time slots each week, when school is in session. If the available time slots do not work for you, you can request that they open up an additional slot for you.

WHY

Thousands of U.S. graduate and business programs require you to submit GRE scores with your application. According to ETS, the GRE test features question types that closely reflect the kind of thinking you'll do in graduate or business school.

HOW

You register for the exam online at www.ets.org/gre/. The base cost is $195. Rescheduling or changing your testing center both cost an additional $50. There are a lot of free study materials available online, both on the ETS website and through Google searches. Of course, there are many test prep services who promise you improved scores if you buy their study materials. Also, read the "On Test Day" tab on the ETS website for information about when to arrive, what you can and cannot bring to the testing center, etc. They have LOTS of rules and are very strict.

If you are in a time crunch and cannot commit hours to studying, you should AT LEAST learn the test format and what kind of questions you can expect. Be sure to get plenty of sleep the night before, have a good breakfast, maybe some caffeine. The test is timed, so be prepared to work fast. Good luck and godspeed! Ω

Figure 1: GRE Typical Sample Problem: Verbal Reasoning
http://www.ets.org/gre/revised_general/prepare/verbal_reasoning/sentence_equivalence/sample_questions

Select the best word to complete the unfinished sentence.

"It was her view that the country's problems had been _____ by foreign technocrats, so that to ask for such assisstance again would be counterproductive."

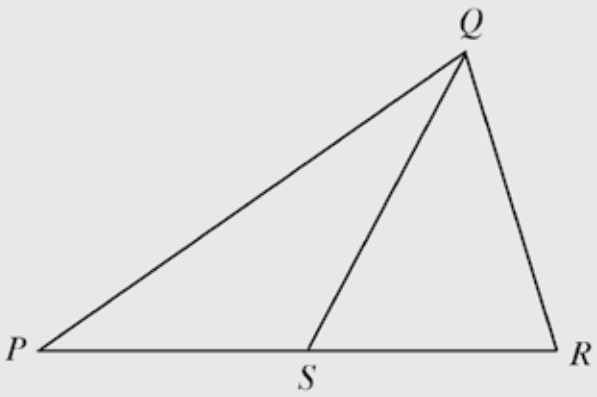
a. ameliorated
b. ascertained
c. diagnosed
d. exacerbated
e. overlooked
f. worsened

Figure 2. GRE Typical Sample Problem: Quantitative Reasoning
http://www.ets.org/gre/revised_general/prepare/quantitative_reasoning/comparison/sample_questions

Using only the information provided, determine the relationship between Quantity A and Quantity B.

Quantity A	Quantity B
PS	SR

a. Quantity A is greater.
b. Quantity B is greater.
c. The two are equal.
d. The relationship cannot be determined from the information given.



$PQ = PR$

ERE Clubs Information Board

Compiled by Heidi Otten, ERE Senior and ERE Messenger Student Editor

Organization	Fall 2015 Activities	Spring 2016 Planned Activities
ERE Student Association (ERESA) **Email:** *eresa.hsu@gmail.com* **Webpages:** *http://www.humboldt.edu/clubs/club_sites/eresa.1*	• ERE coffee table • Welcome back pizza • ASCE Pizza with Professionals • Fall Follies • Presentations by professionals • Tour engineering firms • Community outreach • Locker raffle • ASCE report card meetings	• ERE coffee table • ASCE Leadership Conference • ASCE Local Wastewater Treat Comp • ASCE Mid-Pac Wastewater Treat Comp • Mock interviews at local firms • ERE rafting trip • Ice Cream Social • ASCE ERE Awards Banquet • ASCE Order of the Ring Ceremony • ERE graduation reception • Locker raffle
Engineers Without Borders (EWB) **Email:** *humboldtewb@gmail.com* **Webpage:** *http://www.humboldt.edu/ewb/*	• Construct rainwater catchment system for tribal members in Salyer • Move forward with wastewater project in La Manzanilla, Mexico • Design project for engineering education at Hoopa School	• Present interactive demonstration at Sister City Project's I-Block Party
Renewable Energy Student Union (RESU) **Email:** *resu@humboldt.edu* **Webpage:** *http://www.humboldt.edu/resu/*	• Solar Regatta design and build • HSU Solar Radiation Monitoring Station • Smoothies with bike blender	• Solar Regatta competition • HSU Solar Radiation Monitoring Station • RESU Reunion at Redwood Park • Smoothies with bike blender
Society of Women Engineers (SWE) **Email:** *swe@humboldt.edu* **Webpage:** *hsu.swe.org*	• Resume building workshop • Internship panel • SWEshi • Societal Conference in Nashville • PaddleFest cardboard and duct tape kayak race • Direct contact membrane distillation project	• Girl Scout Day • SWE Social • 2016 SWE Regional Conference in Seattle • Direct contact membrane distillation project
Society of Hispanic Professional Engineers (SHPE) **Email:** *shpe@humboldt.edu* **Webpage:** *www.facebook.com/shpe.hsu*	• ERE drop-in tutoring sessions • Dia de Los Muertos event • SHPE National Conference in Baltimore, MD • REU / internship resumé workshop	• ERE drop-in tutoring sessions • Humboldt Math Festival • SHPE Conference

The GRE Test

The Graduate Record Examination
Who, What, When, Where, Why, and How?

by
Lianna Winkler-Prins (BS ERE 2014) Staff Engineer
SHN Consulting Engineers and Geologists, Eureka, CA

Are you an ERE student working toward your undergraduate degree? Perhaps an upperclassman, pondering life after Science D? If so, this is a huge fork in the road. What will you do? Take a vacation? Find a job? Move back to your hometown? Or, maybe a different state or country? And maybe, as if the ERE program isn't long and grueling enough, you consider graduate school.

Let's say you fall into the last category. Perhaps you are very passionate about a certain topic and want to do research for the next four (or five, or six…) years and earn a PhD. Or, perhaps you are interested in a Master's program, from which you can gain additional knowledge in a certain field but not commit to several years of intense research. Either way, you put together a list of schools and programs that interest you and begin to research each program's admissions process. It is likely that the checklists for these applications include Graduate Record Examination (GRE) scores. Your heart drops. *"ANOTHER exam?! Right NOW? How will I find time, with Capstone and all? What IS this GRE, anyway?"*

While a quick Google search will give you pages and pages of information about the GRE, this article is meant to give you a short and sweet overview.

WHO

The GRE is for individuals applying to graduate school (e.g. master's or doctoral programs) or business school. Note that some schools and programs require one or more GRE subject tests (e.g. Biology, Chemistry, Mathematics); however, engineering-related graduate programs usually require the general GRE Test.

WHAT

The GRE is a test administered by Educational Testing Services (ETS) and used by many universities as input to help them determine which graduate school applicants to accept. The exam is approximately 3 hours and 45 minutes long and includes analytical writing, verbal reasoning, and quantitative reasoning. It is good to know the general format before you take the test. The following describes the format of the computer-delivered test, the most common form:

Part I - Analytical Writing
2 essays, 30 minutes each

One essay is an "Issue Writing Task," where you present your perspective on a current issue. The other essay is an "Argument Writing Task," where you read a snippet of an argument and then critically analyze that argument. Trained readers will grade your essays, and they are looking for VERY SPECIFIC things. Take time to research what they are looking for, as this will improve your scores.

10 Minute Break

Part II - 6 Sections
Unspecified order, total time varies

Verbal Reasoning:
2 sections, 30 minutes each
This may be one of the rare times in life that knowing words like 'fusillade' and 'epaulet' will actually do you some good (Figure 1, page 14). Many test-prep services suggest learning long lists of vocabulary words before taking the exam.

Quantitative Reasoning:
2 sections, 35 minutes each
Covered topics include arithmetic, algebra, geometry, and data analysis. Even if your undergraduate studies are math-heavy, as is ERE, it is still worthwhile to research some example questions. They may not be the type of math questions you are accustomed to seeing (Figure 2, page 14).

Experimental Section (unscored):
1 section, time varies
Used by ETS to try out new questions, which may be either math or verbal. You are not told when you are on the Unscored Section, so it is in your interest to do your best on all sections.

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