HUMBOLDT STATE UNIVERSITY

ASCE
Student Chapter American Society of Civil Engineers

ERE MESSENGER

Environmental Resources Engineering

VOLUME 24, NUMBER 1 FALL 2014

The West African Water Crisis

by Chike Monwuba, Ph.D.
Research and Development Engineer, LiDAR USA, Huntsville, Alabama
former ERE Visiting Professor

My home country of Nigeria is located within the Tropics, trisected by two major rivers, bounded on the south by the Atlantic Ocean, and on the north by the Sahara desert. It receives an average annual rainfall of 2,000 millimeters (78.7 inches), yet the last survey by the United Nations and the World Health Organization estimates that fewer than half of the country's 168 million people have access to potable water.

While growing up as a child, I developed a strong interest in trying to understand various water supply and environmental pollution-related problems. Waking up to the beckons of my mum, urging me to proceed to my daily morning chore of fetching water at the "nearby" community borehole some two kilometers away, remains indelible in my memory. The arduous task left a noticeable dent in the middle of my head, but more so, it made an impression on my heart, which sparked my desire to seek a degree in a relevant engineering field.

Young boy collecting water from a "localized" (manufactured by local blacksmith) pump in Apete, situated in Ibadan, Oyo State, Nigeria.

> *"Water, water everywhere, nor any drop to drink"*
> *– Samuel Taylor Coleridge*

Access to water is one of the necessities of life and is an essential prerequisite for the development and growth of any community. The drinking water sector today is recognized for reform and development with a clear policy for sustainable supply and consumption. The world has entered the 21st century with an enormous challenge: providing safe drinking water for all. According to the Global Water Supply and Sanitation Assessment Report of

continued on page 14

IN THIS ISSUE

FROM THE EDITORS

Hello from the Messenger staff! We hope you enjoy this Fall 2014 edition.

Student Editors
Brendan Byrd
Susanne Loutsis
Heidi Otten
Laura Wallace

Proof Readers
Mary Jo Sweeters
Leslie Scopes Anderson

Faculty Advisor
Mike Anderson

Design and Layout
Mike Anderson
Leslie Scopes Anderson

Printing
University Graphic Services

ERESA@humboldt.edu
EREmess@humboldt.edu

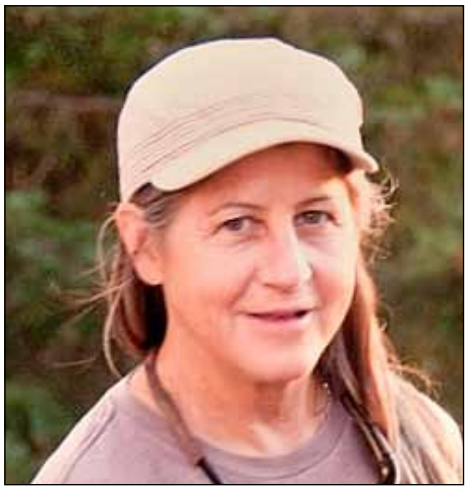
www.facebook.com/hsu.eresa

ERE Messenger online:
www.humboldt.edu/engineering/alumni/notes

"Time is the coin of your life. It is the only coin you have, and only you can determine how it will be spent. Be careful lest you let other people spend it for you."

Carl Sandburg

Alumni Profiles



Margaret Tauzer
BS ERE 1985
Engineer/Hydrologist
National Marine Fisheries Service
Arcata, California

I enrolled at HSU starting on academic probation because I had not completed enough math. I was convinced that I was completely "un-mathematical," but I excelled at beginning algebra and was encouraged by Dr. Bob Hunt to continue in math. I took his advice and found that math classes actually increased my grade point average.

I found I did best combining work and school, minimizing my free time. I drifted to UC Santa Cruz and Chico State before finally landing back at HSU, changing my major from Creative Writing to Physics, to Mathematics, and finally to ERE. After weaving back and forth between school and side jobs as a carpenter/wood worker and a cattle wrangler, I finally graduated from HSU ERE in 1985 with an energy emphasis.

I spent the next two years traveling, playing, and working at odd jobs. Living in Humboldt County in my remote, solar powered, spring-fed cabin, I had access to miles of wild rivers and mountains, and I developed a passion for rivers. I decided then to devote my career to rivers.

For my first engineering job I was hired to construct a physical model of a 7-mile reach of the Arkansas River in Colorado to study sedimentation issues associated with a proposed lock. We built a football-field-sized model to match the scaled version of the river; we hauled coal to be used as the sediment; and we ran the model to simulate the 10-year hydrograph.

My next job was with Hydrocomp, a hydrologic engineering consulting firm and leader in watershed modeling. My work primarily entailed gathering data, mapping hydrologic units in GIS, and assisting in model calibration and simulation. I also returned to school and earned my Master's Degree in Civil Engineering from Colorado State University, with an emphasis in Water Resources and River Mechanics. I remained with Hydrocomp for more than seven years.

Torn between my career and raising my kids, I ultimately returned to Humboldt County and the ranch, taking five years off from work. I was then hired by Humboldt County as an Assistant Roads Engineer, providing the transition from non-working mother back into the working world.

In my current position as an engineer with the National Marine Fisheries Service (NMFS), the majority of my work is to provide technical support to biologists to evaluate and minimize the effects of proposed projects on listed salmon. This involves estimating stream flow and diversions, studying morphological effects of gravel mining, and evaluating road crossing barrier removal projects for fish passage.

The road has been windy, but taking the time to set a goal based on my real passion was key to finding a career focused on water resources in the place I love.

Alumni Profiles

Matt Kennedy, PE

BS ERE 2001
Project Manager
GHD
Santa Rosa, California
www.ghd.com

In 1994 I visited HSU during Spring Preview and sat in on a lecture by former ERE Professor Al Burrows. I didn't know what an environmental engineer actually did, but I decided to pursue an ERE degree. I wasn't a stellar student in high school, and I didn't receive much guidance counseling, either. So I worked hard, studied harder, saved money, and eventually transferred from Santa Rosa Junior College to HSU.

I was a shy kid but I forced myself out of my comfort zone. I got to know my professors, developed speaking skills through presentations, and became an active participant in groups. I became an ERESA member and eventually President. I applied for scholarships and internships, and spent two summers working at the Battelle Pacific Northwest National Laboratory (PNNL), and one summer on the Humboldt County survey crew. These seemed minor at the time, but were important steps that formed my career direction. They gave me valuable experience and put me in a position to meet many people. I have learned that success in life depends greatly on the relationships we make along the way.

I graduated in Fall 2001 and decided to look at both jobs and graduate school. I applied for six engineering positions, took the GRE, and applied to several graduate programs. ERE Professor Mike Anderson connected me with ERE grad David Ahlfeld, at the time a professor of Environmental Engineering at the University of Massachusetts, Amherst. Professor Ahlfeld made me an offer I couldn't refuse. Graduate school was a life-changing experience for me.

In 2003 I made use of my HSU contacts to land a job as a staff engineer with GHD (then Winzler & Kelly) in Eureka. I obtained my PE license in 2006, became a licensed Traffic Engineer in 2007, and in the same year accepted an advanced career opportunity and moved to GHD's Santa Rosa office to begin managing projects. I have now been with GHD for more than 11 years, practicing civil and environmental engineering, and designing and constructing a variety of projects in a variety of places. Projects include water and wastewater treatment, recycled water, pump stations, municipal wells, water conveyance, storm drainage, transportation, traffic signals, slope stabilization, and buildings and structures. Add in sustainable design and clients including the federal government, small municipalities and private companies, and there's never a dull moment. I have also grown my activity in ASCE, and will soon be President of the San Francisco Section. My involvement in ASCE has played an important role in my career, and continues to open new doors.

I have been fortunate in my life, but it hasn't been easy. The path we each follow takes relationships, hard work, time, and motivation. Don't be afraid to try something new; you never know where it might lead.

Elisabeth Johnson

BS ERE 2013
Assistant Engineer
Blankinship & Associates Inc.
Davis, California
www.h2osci.com

I grew up in northern California just outside of Chico, with access to the beautiful natural resources in the area. I hiked along the local rivers and creeks, walked to school through pine forests, and explored the canyon near my house. In my teen years I moved to a small farming town just south of Chico, where I saw first hand just how much labor and resources go into our food production system. This gave me an appreciation for the environment and a desire to preserve and protect it.

I became interested in sustainability and agriculture, and at the age of 16 started making biodiesel. Because of this hobby I enrolled in a chemistry course at Butte College. I found it fascinating that science could explain the world around us.

My chemistry professor asked if I had ever considered engineering. I hadn't, and I didn't really know what it entailed. Like many people I assumed it was designing bridges and skyscrapers. My professor gave me a brochure for the ERE department at HSU. What it described combined my love for

Alumni Profiles

sustainability, alternative energy, and natural resources. I was hooked, and I transferred to HSU in the fall of 2009.

Through my classes I realized I had a love for water. During my senior year I had an internship with GHD in Eureka, and this great experience gave me an idea of the direction I wanted to go in my career. I got to work on many water-related projects including hydrologic routing, low-impact-development, and SWPPPs.

I took the summer after graduation off to have a little time to myself. It was very much needed after all the hard work it took to get through the ERE Program. However, a word of advice from personal experience – start your job hunt early. It can take a while to get interviews, and it takes a while after your interview to actually start your job. After many, many applications and several interviews I landed a position that was right up my alley.

In May 2014 I started my job as an assistant engineer with Blankinship & Associates in Davis, California. We are a small firm specializing in agricultural and environmental engineering. Most of our work is related to regulatory compliance. I have a great mix of office and fieldwork, including collecting water samples, meeting with clients, and writing reports. I work on nutrient and vegetation management, waste management, stormwater compliance, and risk assessment. Landing that first job out of college may be hard, but once you get it, it is great!

HSU prepared me very well for the work I do. I am thankful for the guidance and mentoring I received from my professors, including Brad, Eileen and Beth, to name a few. My advice to ERE students is to work hard, have fun, and don't get discouraged by the work load. All of that hard work will pay off! Not to mention all the great friends you will make at HSU. Ω

Renewable Hydrogen Production via Waste Heat Recovery

by

David Vernon, ERE Assistant Professor
Mark Severy, Research Engineer, Schatz Energy Research Center
William Karis, Grad Student, Environmental Systems, ETaP Option

ERE Assistant Professor David Vernon is leading a research team of ERE students to study alternative pathways for biomass to displace fossil fuels in existing power plants. The focus of this research is on using waste heat from engines or gas turbines to convert biomass-derived feedstocks into a hydrogen-rich fuel that can be blended with the natural gas already being burned. In addition to displacing fossil fuels with bio-derived fuels, blending hydrogen with natural gas increases the thermal efficiency of the engine and reduces NO_x emissions. Our work shows that chemical reaction waste heat recovery has the potential to offset 50% of the fossil natural gas consumption with a renewable feedstock, increase overall efficiency by up to 25%, and reduce NO_x emissions by up to 95% in two of the most widely used power sources: engines and gas turbines.

Over the past two years, we have conducted experiments at the Schatz Energy Research Center (SERC) analyzing the chemical conversion process from biomass-derived feedstocks to gaseous fuel. These experiments investigate the reaction rates of a process called aqueous phase reformation, or APR, which converts bio-derived sugars and sugar alcohols, such as glucose, sorbitol, or glycerol, into a gas composed primarily of hydrogen, carbon dioxide, methane, ethane, and propane. The reformation reactions are endothermic, meaning that they convert thermal energy into additional chemical energy. The resulting hydrogen-rich gas contains more chemical energy than the initial feedstock and thus the gas products can displace more fossil fuel than the feedstock alone.

APR keeps the water and feedstock solution in liquid phase by operating at elevated pressures, typically between 400 psi and 1,000 psi. In liquid phase, the hydrogen bonding between water molecules and feedstock molecules enables the hydrogen production reactions to occur at lower temperatures than the traditional reformation processes which occur in vapor phase. By enabling operation at lower temperatures, between 200°C and 275°C, APR has the potential to recover much more waste heat from typical exhaust streams with temperatures around 500°C. APR also reduces the overall energy demand of the process by avoiding the need to vaporize the entire feed solution, which reduces the cost of heat exchanger components.

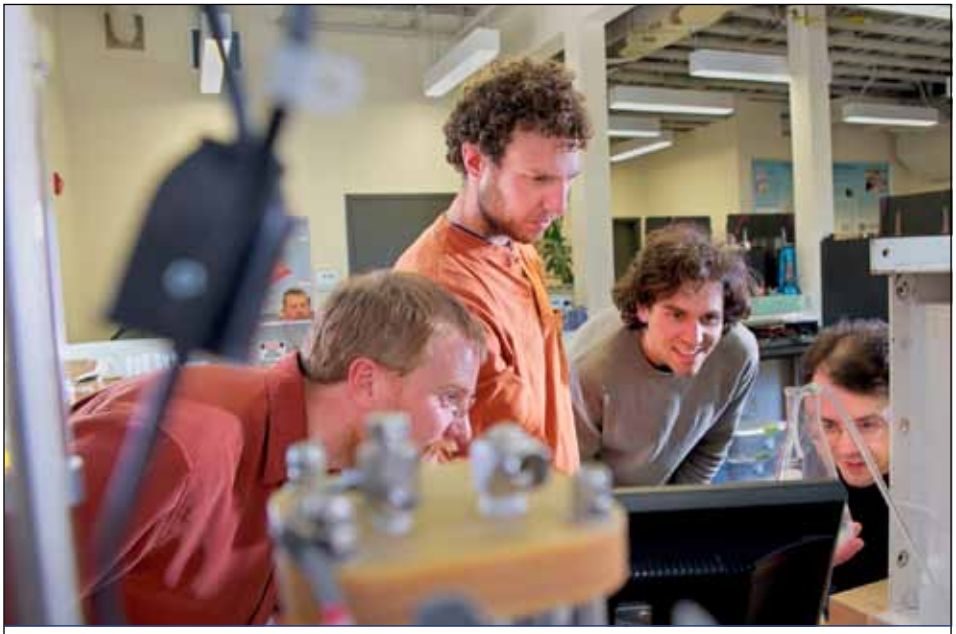
> *"Dream no small dreams, for they have no power to move the hearts of men."*
>
> *Johann Wolfgang Goethe*

The most common way for plants to store energy is in the form of sugars. In fact, the cellulose and hemicellulose that make up biomass, the majority of all plant structures, is a polymer of sugar molecules linked together. Recently there have been significant breakthroughs in methods to treat biomass very cleanly, cheaply, and at large scales to produce low cost sugars.

In our APR experiments, the sugar is mixed with water to produce an aqueous solution with a concentration between 1% and 10% by weight. The aqueous solution is then pumped into a reactor where it is heated to the reaction temperature before flowing over a catalyst bed. The reaction occurs on the surface of solid catalyst particles to produce a gaseous fuel, which exits the reactor along with some effluent water and any unconverted feedstock.

Students, staff, and faculty all helped design the APR test bench at SERC to control and monitor the flows, temperatures, pressure, and chemical composition throughout the system. The reactor system is built primarily out of stainless steel tubing and is rated up to 1,000 psi at operating temperatures. The feedstock flow rate into the system is monitored by a scale connected to the data acquisition system. Feedstock is heated to the reaction temperature with external heaters that use PID control and feedback from internally mounted thermocouples to hold the liquid at ±2°C of the target temperature. Effluent liquid and gas exit the reactor through a back-pressure regulator; effluent liquid is collected manually for further analysis while gas products are sent to a gas chromatograph to determine the chemical composition. The liquid samples are analyzed to determine carbon content and measure the conversion rate of feedstock to gas. A gas chromatograph mass spectrometer also identifies species that remain in solution. These measurements coupled with the data collected through the data acquisition system provide a complete picture of the system's performance.

Two main objectives of the experiments are to maximize the chemical energy production rate and hydrogen concentration in the produced gas from APR using sorbitol as the feedstock. Sorbitol ($C_6H_{14}O_6$) was selected for these initial experiments because it is easily produced via hydrogenation of the most common bio-derived sugar, glucose, but exhibits much greater gas production rates than glucose itself.



ERE Professor David Vernon, graduate student Billy Karis (Winter 2014) and SERC Research Engineers Mark Severy and Marc Marshall (left to right) inspect a sample during an experiment.

One interesting result from these experiments is that the catalyst strongly affects the conversion rate of the feedstock and hydrogen concentration in the effluent gas. We began testing with a commercially available catalyst comprised of 1% platinum (the active metal) by weight on aluminum oxide ($A_{l2}O_3$) support pellets. Using this catalyst the product gas consisted of about 40% hydrogen, but only converted about 25% of the feedstock into gas. To achieve higher conversion rates, we set out to produce our own catalyst in the lab at SERC. A higher concentration of 3% platinum by weight was precipitated onto an activated carbon support, which has a larger surface area than aluminum oxide and thus more sites for the reaction to occur. Experiments with this new catalyst converted about 60% of the feedstock into gas with a concentration of 50% hydrogen. Additionally, we synthesized a third state-of-the-art catalyst that consisted of 3% platinum and 3% rhenium on activated carbon. The addition of rhenium to the catalyst further increased the conversion rate to 95%, but the hydrogen concentration dropped to 20% and the concentration of alkanes (methane, ethane, and propane) increased from 7% to 20%.

While production of alkanes is not the desired outcome of APR, they are still a valuable fuel for an engine or gas turbine. The faster conversion rate with the platinum-rhenium catalyst is beneficial to produce a higher rate of chemical energy output, but the platinum catalyst still exhibits the fastest hydrogen production rate. Ongoing work at SERC continues to evaluate these tradeoffs as we are working to optimize the process conditions and catalyst composition to maximize a function of conversion rate and hydrogen production rate. Ω

Radical Sabbaticals

by
Beth Eschenbach, ERE Professor and Department Chair
Eileen Cashman, ERE Professor

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

ERE Professors Eileen Cashman and Beth Eschenbach spent the 2013-2014 academic year on sabbatical. Every seven years HSU faculty have the opportunity to request a sabbatical. One of the requirements is that the tasks done during that time be beneficial in some way to the HSU community. As Professor Eileen Cashman says, "…we are given the opportunity to focus on research, advance our knowledge in the field, and revitalize our classes by bringing our experiences back into the classroom." As you will read below, Professors Eileen Cashman and Beth Eschenbach spent their yearlong sabbaticals in amazing places, doing exciting work.

BETH ESCHENBACH

Last academic year, I spent my sabbatical with my husband Wes Bliven (HSU Physics) and our daughter in Central Queensland, Australia. We lived in a town called Yeppoon, located on the ocean near the southern part of the Great Barrier Reef. Wes and I were Senior Lecturers and Visiting Scholars at Central Queensland University (CQU) in Rockhampton. My main effort at the university was to assist CQU faculty interested in becoming more involved in engineering education research. I helped faculty write papers, present their work at different conferences, and think about how to flip their classes. Rather than tell you about that work, I thought this article could explain the engineering degree requirements at CQU.

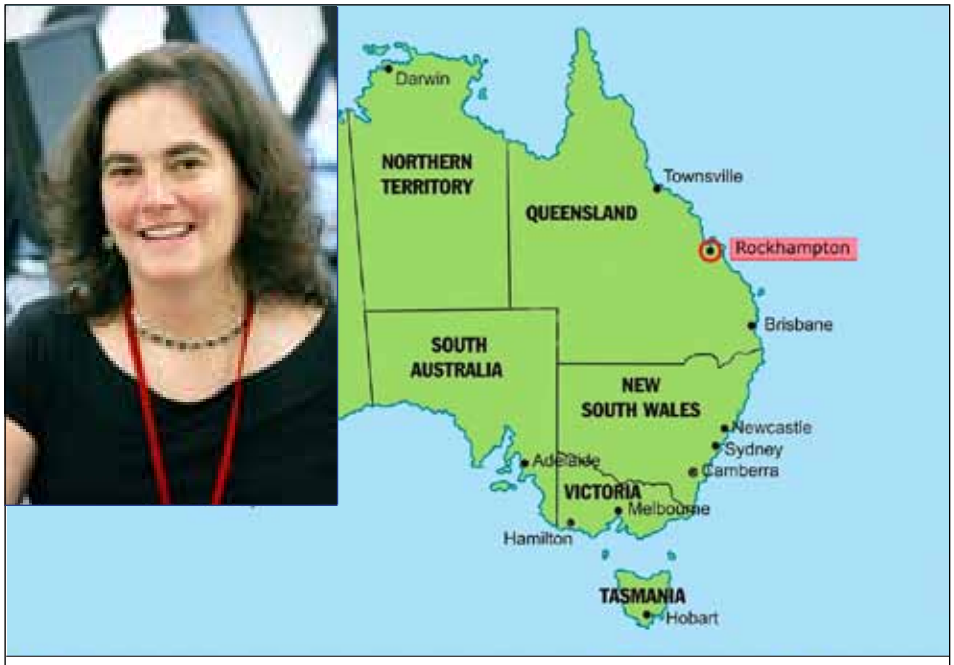
CQU is well known for its problem-based learning curriculum. In the Bachelor of Engineering (Honours) and Diploma of Professional Practice (Co-op) Program, students choose to major in Civil, Electrical, Mechanical or Mechatronic Engineering, and they gain paid industry (co-op) experience. Approximately half of the courses incorporate problem-based learning (similar to ENGR 215), while the other half are taught more traditionally. The newer Bachelor of Engineering (Honours) Program is for students, such as distance learners, who choose not to include the paid co-op experience.

The two aspects of this program that are quite different from HSU's program are the Project Based Learning and the Co-op components. I will describe each of these below.

Students take about 24 credits a term (not semester). They go to classes in Term 1 (starting in February) and in Term 2 (starting in July). They do not take classes during Term 3 (from about the middle of October until the next February). This long break provides them time where they can obtain a co-op position and work through Term 3 and their summer (which occurs in December and January).

Students are required to have two co-op experiences during their 4.5-year program. The first happens after their second year of study and the second happens after their fourth year of study. At the co-op they have a professional supervisor and an academic supervisor. After their second co-op experience, they return to the university to complete an individual capstone project. Often this project is related to their co-op work experience, and both their professional and academic advisors attend their final presentation.

Each term, 12 of the 24 units that the engineering students take are Project Based Learning. In these classes, students usually do not have graded assignments or exams during the term. These classes are managed similarly to ENGR 215 Introduction to Design and ENGR 492 Capstone Design. The students are given projects and they work in groups to develop solutions. The course grade is based on the student's portfolio.



ERE Professor Beth Eschenbach and location map for Rockhampton, Australia.

At the end of the term, the students are required to submit their portfolio for evaluation. They are responsible for providing evidence that they have met the course's learning objectives and to showcase the work they completed in the course (usually their part of the group design project(s)). The students use a rubric provided by the course lecturer to justify their grade in the course. These portfolios are submitted electronically.

A large part of the portfolio is professional reflection. In both Australia and New Zealand, the professional engineering accreditation bodies require that the students show they are able to reflect on their practice as engineers. Thus, students write weekly in their professional journal about how their engineering design process is progressing. They may reflect on how well a team meeting went and how to improve in the future. Or, they might reflect on what mistakes were made in their design project and how to improve in the future. Students must submit these reflections in order to pass their courses.

The students really enjoy being able to work in industry. That experience provides them a context and focus for their studies at CQU. Their final capstone project can be a real pinnacle event as well, as they have an opportunity to work on a problem that their co-op supervisor needs solving.

I hope you have found this introduction to the CQU engineering degree interesting. I strongly encourage you to study at another institution however you can – be it through international or national exchange or by going to graduate school. I find it fascinating to see how different cultures and institutions work. I find these types of experiences help me appreciate that there are many ways to look at and solve a problem. Also, I come away with a better understanding of people – how we are the same and how we are different. If you have questions about Australia, I hope you will come by during my office hours. I would be happy to share more.

EILEEN CASHMAN

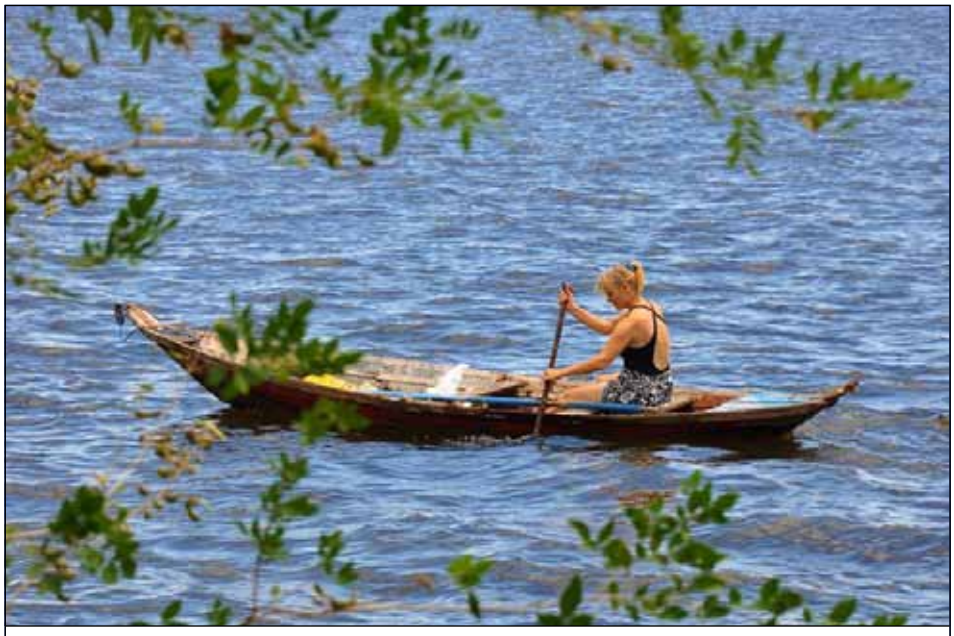
The 2013-14 academic year was a fantastic sabbatical year for me. It incorporated several research projects, including: modeling analysis of erosion of channel banks along the Platte River in Nebraska as part of the Platte River Recovery Implementation Program, modeling analysis of a new brackish mixing pond at the Arcata Marsh, engineering education research on strategies to promote success of students in the classroom, and a three month research fellowship to travel to the Brazilian Amazon. Through these experiences, I had the opportunity to work with local consultants, ERE alumni, ERE graduate students, colleagues from other universities, and new colleagues from Brazil. Although all these experiences were all very interesting and rewarding, I am going to dedicate this article to my experience in Brazil.

In March of 2014, I traveled to Brazil as a Fulbright Scholar affiliated with the Fulbright-Brazil Scientific Mobility program to work with faculty at the Federal University of Western Pará (UFOPA) in Santarém, Brazil. The Fulbright Program is the flagship international educational exchange program sponsored by the U.S. government, and is designed to increase mutual understanding between the people of the United States and the people of other countries.

UFOPA is a relatively new federal institution (established in 2009) located in Amazonia that began offering classes only last year (2013). My original plans to teach a graduate course in English, which I had carefully researched and proposed, quickly fell by the wayside as I learned that my original contacts were no longer available.

So, I quickly formulated and implemented Plan B. I was lucky to meet Dr. Julio Tota and his colleagues in the Atmospheric Sciences department at UFOPA and another Fulbright Scholar, Dr. David Fitzjarrald, from the State University of New York in Albany. I latched onto their lab activities and was able to participate in a number of these activities during my three months in Brazil. Some of the research activities I participated in include:

Continued on page 13



ERE Professor Eileen Cashman sampling the water quality in Largo Verde, Alter do Chao on the Tapajos River, Amazonia, Brazil.

HEIF

The Humboldt Energy Independence Fund

by Susanne Loutsis, ERE Senior and ERE Messenger Student Editor

Do you have an energy-saving idea that you would like to see implemented on campus? Then you should know about the Humboldt Energy Independence Fund (HEIF). In 2000, a group of students went to the Associated Students council with an idea to create energy independence on campus through student driven projects. Being energy independent means reducing our overall energy consumption and directly producing our own energy. After much work the idea was put to a student vote and approved, and a HEIF Committee was formed. An Instructionally Related Activity (IRA) fee was put in place, so that each HSU student currently pays about $12 per semester into HEIF.

Since its origin, more than 30 student-driven projects have been developed on campus with the fund. Each project either produces or conserves energy and usually has an educational component to it. You may have noticed some of the projects around campus, such as the PV panels on the Music Building, the hand dryers in bathrooms, the hydration stations in the halls, or the PV panels on the new Natural History Museum in Arcata.

One HEIF project implemented last summer of interest to ERE students and faculty is the Science D and E HVAC retrofit. The retrofit included insulating the buildings' hot water pipes so that less heat is lost in transit to classrooms. Variable frequency drives (VFDs) were also installed, so that air handlers can operate at lower power levels instead of full power during times of low demand. These changes are positively affecting our comfort in the buildings while saving an estimated 180,000 kW-hr of energy annually.

Students are the heart of all HEIF projects from start to finish, but we of course have much support from HSU faculty and staff along the way! Here's a little about the process of bringing energy savings from idea to fruition. First, any student or group of students can submit an Idea Paper to the HEIF Committee via their webpage. The Committee is made-up of students, faculty, and staff, who are sustainability and energy specialists. Committee members discuss the idea and, based on HEIF goals, decide whether or not to develop it into a full proposal.

Development team members, often ERE students, are hired by HEIF to write full proposals and expand upon original committee approved Idea Papers. The teams meet with Facilities Management employees and HEIF student project managers (also often ERE students) for guidance and to work out details needed for full project implementation on campus.

Completed proposals are presented to the Committee who vote on whether to fund the project in question. Funded projects go out to bid and are put on Facilities Management's schedule for construction and implementation. The completed projects are then monitored for energy use and savings. Suitable projects are

HEIF Project: Installing PV panels on the HSU Music Building.

HEIF Quick Facts

Mission Statement

Reduce the environmental impact of energy use at HSU through student-driven projects.

Goals

- Present energy savings both qualitatively and quantitatively.
- If possible, connect projects with curriculum.
- Include a public outreach component.

eligible for reinvestment funding. This means that for the first three years, fifty-percent of the money saved from energy conservation or production is reinvested back into the funds for these projects.

The overall project development process is as follows:

- Student Idea Paper submission
- HEIF Committee review
- Approved Idea Papers developed into proposals by student employees
- Proposals written and presented to Committee
- Committee funds proposals for development by majority vote
- Funded projects go out to bid
- Projects fully implemented and energy savings begin
- Energy savings is monitored
- Suitable project energy savings reinvested into Fund for new projects
- New Student Idea Paper submission

Historically, ERE students have been very involved in achieving HEIF energy independence goals. They have held committee positions, worked as project managers, submitted idea papers, and worked on development teams to write proposals. Each position offers you the potential to positively impact our environment and reduce HSU's operating costs, while at the same time helping you to gain valuable work experience while in school.

To learn more about the organization, employment opportunities, past projects, or Idea Paper submission, visit the HEIF website at: <http://humboldt.edu/heif/>. Ω

FE Exam

Continued from back page

chaos on exam day. Of course there are many other available resources, so by all means explore beyond these three options.

To register for the exam and schedule your appointment, go to the NCEES website and create a user account. Then select and pay for the version of the exam you wish to take, which costs $225. After the payment has been processed you can schedule an appointment at one of many testing centers throughout the state. Most appointments start in the morning. Please note that changing the test you take (Other Disciplines, Environmental), or the time you take it is associated with a fee, so make sure you've got what you want.

Finally, the glorious day will come when you get to sit and take the exam that has become your destiny. As for testing center etiquette, you are allowed to bring an FE approved calculator <http://ncees.org/exams/calculator-policy/>, a light jacket, eyeglasses, an I.D., and your wits. If you choose not to bring your own calculator, an electronic version is provided on the screen during the exam. If you are only ever going to use the FE-approved calculator on the exam day and never again, do yourself a favor; figure out how to use it! Simple functions like Sine, Arctan or nCr will be much easier if you actually know how to use them. The FE reference manual is provided electronically, which is perhaps the most advantageous aspect of the new test format. In the electronic version of the manual, you may simply search (Cont + F) to find the topic or equation of need instead of rifling through a paper copy of the manual (take that coefficient of restitution!). After completion of the first ~55 questions you will be given an optional 25 minute break where you can have a snack or a drink. Upon returning to the exam, the questions from the first half of the exam are no longer available to you. Pacing the exam is the most important part. The average time you have per question is less than 3 minutes, so keep that in mind as you prepare. Another nice feature about the electronic exam is that you can mark questions for review, move to the next question, and then when you're ready, go back and address all of the questions you marked for review. So in short, when you get a problem you know how to do, do it. When you get one that will take some time or struggle, maybe mark it and move on. This will ensure that you will see every question that you know how to do quickly during the allotted time interval.

The FE exam is one of the most interesting experiences you will undertake as an engineering major. You will hear peer testimony anywhere on the spectrum from, "I never studied and passed!", to "I studied a TON and really struggled." Some will feel very influenced by those they speak with who have already taken the exam, and perhaps model their choices accordingly. Others will operate in a mental vacuum and not let any testimony sway them from how they want to approach it. The best thing I can say is, the most difficult experiences in life are those for which you are unprepared. If you take your preparations seriously, regardless of the route you take, you should be just fine. Good luck! Ω

Why SWE Membership Rocks in College and Beyond

by Ashley Pietz, SWE Governor – Region A
Materials Engineer, Lockheed Martin Space Systems Company, Sunnyvale, California
http://www.swe.org

As you walk across your college campus, you are bombarded from every side by a great variety of student organizations. What makes you stop and pick up a flyer? What excites you to attend that first event? For me it's the people at the table (do they seem friendly and interesting) followed by the message (is the topic/speaker/event worth my time). I found that excitement with a Society of Women Engineers (SWE) flyer that was advertising a back-to-school social for female engineering students.

I joined SWE in 2004 when I transferred to San Jose State University to complete my Materials Engineering degree. I was hooked from my first meeting. The women varied in age, ethnicity, and major. They were all eager to tell me about their upcoming events and planned speakers; I instantly felt included and energized. It didn't take long before I held my first officer position. After that it was a whirlwind of conference attendance, event planning, and outreach activities. I met experienced women from many different engineering disciplines and was thrilled when they agreed to answer my questions about engineering and life after college.

Now in my 10th year as an active SWE member, I want to share some of the many reasons I joined the Society in college – and why I stay as a professional.

• **People**: Number one on my list is the people I've met because of SWE, women mainly, but men as well. Being a member of the Society of Women Engineers has exposed me to inspiring and wonderful engineers from across the country. My SWE section in college included Electrical, Mechanical, Civil, Materials, and Chemical engineering students from diverse ethnic backgrounds. Through SWE, we were all able to find an outlet for our similar interests. As a professional in SWE, I interact with engineers from every possible industry and technical discipline.

• **Leadership Experience**: You can be the leader you want to be in SWE. You can learn how to delegate, create and follow a budget, pull together a team, manage interpersonal relationships, and troubleshoot unexpected problems. You can volunteer to lead a hands-on activity at an outreach event, serve as a section officer, lead a Society committee, serve as the Governor of your region, or even be elected the Society President. All avenues are open to SWE members regardless of your educational background or physical location. If you need to develop project management skills you can volunteer to lead an all-day outreach event or plan a professional development seminar for your section. SWE has helped prepare me to take on a management or leadership role in my professional career.

Ashley Pietz (standing, center) and other SWE leaders at the 2014 Regional Governor Summit.

SWE Quick Facts

The Society of Women Engineers was founded in 1950 as a not-for-profit educational and service organization.

There are ten geographic regions in the U.S. comprised of 300 collegiate member sections and 100 professional member sections.

SWE has approximately 27,000 individual members.

Mission Statement

Stimulate women to achieve full potential in careers as engineers and leaders, expand the image of the engineering profession as a positive force in improving the quality of life, and demonstrate the value of diversity.

• **Public Speaking**: Strong communication skills are a must for any engineer. SWE gave me a forum to practice my public speaking and presentation skills. There were endless opportunities to speak to groups of children and to professionals. I have spoken at outreach events, teaching elementary students about bridges and engineering. I have also presented at SWE conferences on technical and professional development topics. These early opportunities to improve myself put me miles ahead of my peers and helped me land my first internship. Today the professional development that I get through SWE supplements what I do at work and improves my skills faster than through work experience alone.

• **Friendships**: Many of my most lasting and supportive friendships are with SWE members. My network is far greater than the engineers I work or went to school with. I stay in touch with my SWEsters via email, Facebook, LinkedIn, and text messages. Because of these friendships, I never feel alone when I go to a SWE event or conference. I also know that I can rely on them to give me honest advice and encouragement when needed.

• **Giving Back**: From the moment I started college, I was surrounded by teachers, friends, and family who said "Go for it, you'll be great!" As a SWE member I get the opportunity to be a supportive advocate for girls and women. By volunteering at outreach events and talking to students and young professionals, I am able to give back some of the good will and positive outlook that I was given. SWE allows me to share my love for engineering and education to support a new generation of women.

• **Networking**: SWE has always been my go-to network. Society events and conferences are "speed networking" opportunities. Through SWE I know engineers from Washington DC who work for the EPA, as well as engineers who work as high level managers for bio tech firms in California. Without my SWE experience and conference attendance over the years I don't think I would have met these women or have the variety of professions and locations in my network.

• **Annual Conference**: More than 7,000 women engineers and scientists from around the world come together each year to celebrate technical careers. The annual career fair boasts 250+ companies. The schedule includes more than 200 professional development workshops and seminars. I attended my first Annual Conference in 2006 in Kansas City. It was overwhelming and energizing to be surrounded by so many women engineers coming together to support and advance other women. Every year I find myself leaving the annual conference with a stronger resolve to be the best engineer I can be, and to be a stronger supporter of other women trying to achieve their career goals.

For more than six decades, SWE has given women engineers a unique place and voice within the engineering industry. It is the driving force that establishes engineering as a highly desirable career aspiration for women. SWE empowers women to succeed and advance in those aspirations, and be recognized for their life-changing contributions and achievements as engineers and leaders.

I'm sure by now you can see that I love the Society of Women Engineers and think SWE members ROCK! Membership in the Society of Women Engineers is not a golden ticket to professional accomplishment, but it can be a gateway to broader and more fulfilling experiences. I wish you luck in your engineering program and success in your future, and I hope I have enticed you into attending a meeting or event to check SWE out for yourself. Ω

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

Up next: EWB

Summer Internship at NCAR

by Julian Quick, ERE Senior
with Laura Wallace, ERE Junior and ERE Messenger Student Editor

When I took Computational Methods during my first semester as an ERE student, I found programming to be one of my primary engineering interests. Using online tools such as Khan Academy and Project Euler, I taught myself both Python and Java programming languages. I also took a course in C++ which, along with Fortran 90, made me quad-lingual in the world of computer programming. As I approached summer 2013, I applied for more than 30 REUs and internships. Unfortunately, this large number of applications proved to be overambitious, and I did not spend enough time on my resume or any of my cover letters. As a result, I received many rejection emails. I was disheartened of course, but I didn't give up. When the summer of 2014 approached, I went to the career center with my application materials. There, you can go to drop-in career advising, or make an appointment with a career counselor. The career counselors provide an informed perspective on resumes, cover letters, and more. They are an invaluable resource for students hoping to gain summer experience.

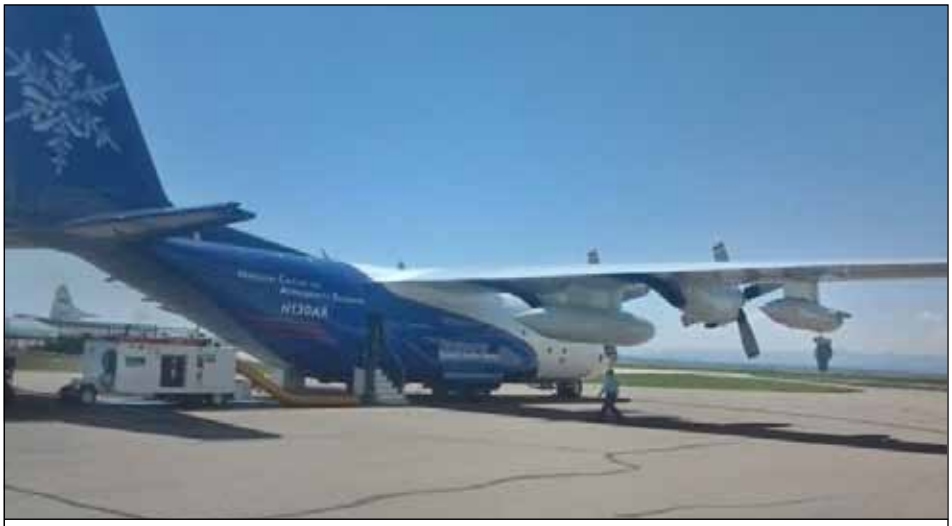
The additional time and effort put into my applications paid off. The internship I was most excited about was a software engineering position with the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, and they informed me two months after I sent in my application that I had been selected for a phone interview. The interview went well, and they called one of my references, TK Williams (big thank you TK – you rock!) Two weeks later I was notified that I had gotten the internship. Not only that, my travel and housing would be paid for, a bike would be provided for travel around town, and I would be paid $15.50 per hour to work 40 hours per week. I accepted the position, packed my bags, and headed to Colorado. The housing NCAR provided, a spacious loft on the top floor of a building overlooking the Boulder skyline, was much more than I had expected.

I found out I would be working at the airport, and on my first day I was set up with an access badge, office space with a personal computer and two monitors, and a transit pass. I was thrilled to have a software engineering mentor – but after three weeks he suddenly left for a month-long research expedition in New Zealand. From that point on, my work was self-directed and I often worked from home. My assigned summer project was to develop a live data monitoring system that could be operated by aircraft technicians. I became familiar with the Nagios monitoring system, and developed a shell script to calibrate Nagios to monitor new variables and then, every thirty seconds, send the status of those variables to Nagios. I also restructured an important file from binary to XML.

My data monitoring system performs a real-time data check for airplanes collecting atmospheric data. Prior to implementation of this system, the only forms of data monitoring were live plots consisting of more than 300 simultaneous variables – a bit overwhelming to manage during a flight! My system can be configured before each flight to monitor either one variable or the interactions of several variables for suspected problems. The results are displayed by Nagios, and they are accessible by any on-board computer. If there is an error, it is displayed on-screen in the aircraft, and technicians are informed immediately so they can compensate for the issue.

The pinnacle of my summer experience occurred at the end when I flew in a C-130 research plane and sat in the cockpit during takeoff and landing! I was free to roam the plane during the expedition, so I could verify through an on-board computer that the data monitoring system was functioning.

Near the end of the summer I made a presentation of my work to the aircraft technicians who would be using it. They were very excited about the usability and versatility which it offers. It felt great to know that my countless hours behind a computer that summer were directly benefiting these individuals work experience. All in all, I had an amazing experience in Colorado. If you are interesting in gaining summer work



NCAR's Lockheed C-130 Hercules research plane equipped with the live data monitoring system developed by Julian Quick during his summer internship.

experience relevant to engineering, I have several points of advice for you:

• Don't apply for too many positions. Instead, send out only a handful of applications. Spend lots of time on each of them, get feedback from other people (friends, professors, career counselors, etc.), and really think about how you represent yourself. Gear each cover letter, resume, and application to the position you are applying for. Treat each opportunity like it is the only one you have.

• Don't limit yourself based on geographical location. Some positions provide travel to and from the job as well as a housing allowance.

• Have strong references who are relevant to the position you are applying for. For me, TK was an obvious choice because he is an active and respected member of the programming community, and I developed a relationship with him while being his teacher's aide for Comp I. For academically-based opportunities, such as REUs and graduate school, it is important to use professors as references. For positions more rooted in a working environment, a previous employer is a great choice. Be sure you ask your references for permission in advance, and give them plenty of time to write one.

• Check websites such as usajobs.gov, notice postings on the ERE department website, and go to career fairs. Do all of these things well before you are desperate for work, and apply early. This makes a good impression on whoever reviews your application material because it exhibits drive and shows that you really want the position.

• Believe in yourself, and don't give up because of rejection. Remember, I was rejected more than 30 times, and still came out on top. You, too, can have an experience of this kind, in whatever field interests you most.

I will never forget my time in Colorado, and the connections I made will continue to benefit me in the future. Happy searching, and good luck! Ω

Sabbaticals

Continued from page 7

• Assisting with the initial set-up and calibration of a PTR-HRTOF-MS (Proton Transfer Reaction-High Resolution-Time of Flight-Mass Spectrometer) to measure volatile organic compounds (VOCs) emitted from the vegetation in the Floresta Nacional do Tapajós. The data obtained from this field campaign will contribute to a more thorough understanding of the atmospheric chemistry in the Amazon forest. The sensors were mounted on a 64-meter-high tower that extends above a 40-45 meter tree canopy. I had to leave Brazil to return home before the data collection was completed, but not before learning of the many difficulties of running sensitive, expensive instrumentation in the harsh environment of the Amazon forest. Imagine the problems with an instrument mounted just above the canopy of the forest that must be protected from power surges, and in a place where there are intense rainstorms every day and lightning strikes on a regular basis!

• Collecting water samples to contribute to the River Ocean Continuum of the Amazon (ROCA) project. The samples I collected were analyzed for O_{16}:O_{18} fractionation to determine the balance between photosynthesis and respiration in the river system. The ROCA project is led by Dr. Jeffrey Richey from the School of Oceanography at the University of Washington, and is in part attempting to determine the source of the relatively high outgassing of CO_2 observed in tropical rivers like the Amazon. Initial findings suggest that lignin and other terrestrially-derived carbon sources are highly reactive in the lower portion of the Amazon River system. This finding runs counter to the long held belief that lignins are recalcitrant to decomposition and remain buried in marine sediments for decades.

• Interacting with the graduate students in Atmospheric Sciences at UFOPA, in part by helping them write their thesis abstracts in English, and assisting Dr. Fitzjarrald, (who is fluent in Portuguese) teach a mini-course on turbulence in micro-climatology, drawing upon relevant analogies from fluid mechanics.

In addition to my work at the university, I had the incredible opportunity to explore Santarém and the Amazon forest surrounding the city. Santarém is a city of approximately 300,000 in the middle of the Brazilian Amazon forest. It sits at the confluence of the Tapajós River and the Amazon, and is one of the main hubs for riverboat travel up and down the Amazon. Following are some of my non-academic highlights:

• The Brazilian people were warm and gracious. Families welcome you into their homes and immediately feed you copious amounts of food and drink. They wanted to know about our lives and they smiled, pretended to understand us, and told us our Portuguese was getting better all the time!

• The rainstorms were amazing! We were there during the rainy season (on average 9 inches of rain per month). I have never seen it rain so hard.

• Futbol! My 14-year old son traveled with me to Brazil and attended school (in Portuguese) and was able to play "futbol" on two different teams. We were also there for the World Cup and were fortunate to attend two games in Manaus and Fortaleza.

• The natural beauty of the Amazon will take your breath away. Being there in the wet season meant the water was high and the floodplains and forests were flooded. Exploring the flooded forests in canoes and on stand-up paddle boards was an enchanting experience, complete with all kinds of interesting wildlife, including monkeys, birds, fish, snakes and some very weird-looking insects. Ω

West African Water Crisis

continued from front page

2000, about 1.1 billion people across the world are still without access to safe drinking water facilities. An additional 3 billion people are expected to join this group within the next two generations. Most of these people live on the continents of Asia, Africa, and Latin America. Water is fast becoming a scarce resource, and in many regions of the world the lack of fresh water has already reached a stage of crisis. The poor continue to be the most vulnerable to changes in water resource availability, and are the least capable of adapting their livelihood to the changes. They will suffer the most if an effective solution to water resource management is not found.

The scenario in developing West African countries, including Nigeria, is similar to that of the global status – it is a pitiable state. Decades after independence, about 70% of Nigerians claim that they have no access to potable water. Based on my observations and assessments, I will discuss the reasons I believe the current water crisis persists.

Unfortunately, accurate information on available water resources is lacking data that are crucial for its proper assessment, utilization, and management. Fewer than 300 of the 1,058 rain gauging stations established since 1965 by the Nigerian Meteorological Services were found to have, as of 1971, any form of reliable records extending for 30 years or more. The stations reported a network density of 1 to almost 900 km^2, instead of the recommended 1:50. As a result, water development projects in developing countries such as Nigeria still rely largely on crude estimates based on water budget equations. The weakness of this method of calculation is illustrated by the discrepancy between the figures provided by this water surplus approach, which falls far below those derived from actual observations. Again, as in the case of surface sources, knowledge of the quantity, quality, and distributional pattern of the country's groundwater resources is far from satisfactory. It is only in recent years, with advancement in technology and intensified field research, that attention is being refocused on these areas.

There are many examples cited in both literature and policy documentation on the successful development of the water resources in developing countries, as evidenced by the large numbers of denizens reported to have unhindered access to safe pipe-borne water and adequate sanitation facilities. The paradox here is that a sizable proportion of the citizens still reportedly died from water-related disease. Such "sudden" availability of water resources has sometimes been characterized by the emergence of a variety of improved industries, highly sophisticated agricultural systems, and complexities in the lifestyle of inhabitants. This "rushed growth" squeezes social welfare amenities and infrastructure, including water, resulting in inadequate water supply and effective sanitation coverage in these areas.

In developing countries the enforcement of drinking water standards tends to be a lower priority than in industrialized countries. Government, traditionally involved directly in the provision of services, may rank addressing the lack of access to water and sanitation as a higher priority than the enforcement of standards. Additionally, some developing countries may have gradually evolved to highly sophisticated water storage and diversion/distribution systems within the past decade aided by loans and assistance from local and international organization. The task of those involved in both technical and administrative aspects of water storage, diversion and distribution pricing, have been made particularly difficult by corrupt political leaders or other leading groups who believe that the provision and supply of water should be diverted for their own political or economic benefit.

In spite of decades of government and donor-supported investments in water supply and sanitation, public utilities in many African countries have been unable to fully meet the demand for water and sanitation services. In nearly every case, studies have shown that the root cause of these problems has been poor choices with regard to the systems related to sector policies and institutional and regulatory frameworks. Often times the water sector is regarded only as a social service, not as an economically viable endeavor. Tariff levels tend not to recover costs and subsidies, and are justified as a means of helping the poor. These low returns have made the sector financially unattractive for utilities and allowed financially capable citizens to enjoy artificially low tariffs. At the same time, many water utilities have also been inefficient, at times wasting half of the water they produce for technical reasons and through pilferage and poor account collections. As a result, potential private investors and operators have stayed away from what they perceive to be a risky business venture.

I believe that the approaches and solutions to these problems need to be changed. Water is an economic, social and natural resource that must be managed by taking into consideration all of the factors. Hitherto, the issue of water resources management has in most instances been ignored and relegated to the background in the water supply sector. To ensure sustainability, it is essential that communities be fully engaged at every stage. There is a growing realization in many parts of the world that projects based on existing technologies and community-based participation are far more likely to succeed and be sustained than those based on models imposed from individuals or corporations with no community support. For a water project to be sustained and widely accepted, it is essential that effective and supportive institutions exist. It is also important that the necessary local human resources be available to ensure that these institutions continue to function effectively even after external agency assistance is withdrawn. Ω

ERE Clubs Information Board

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

Organization	Fall 2014 Activities	Spring 2015 Planned Activities
ERE Student Association (ERESA) **Email:** *eresa.hsu@gmail.com* **Webpages:** *http://www.humboldt.edu/clubs/club_sites/eresa.1* *&* *http://www.facebook.com/hsu.eresa*	• Weekly meetings 6 PM in SD-5 • ERE Coffee table • All-clubs meeting • ASCE Pizzas with Professionals • New officer elections • Fall Follies Thanksgiving Bash • Resume review by professionals • Tour of engineering firms • Community Outreach	• Weekly meetings TBA • ERE Coffee table • ASCE local water treat competition • ASCE MID-PAC water treat comp • Mock interviews at local firms • ERE Rafting Trip • Fundraising at Entrepeneurship Day • Ice Cream Social • ASCE ERE Awards Banquet • ASCE Order of the Ring Ceremony • ERE Graduation reception • Community outreach
Engineers Without Borders (EWB) **Email:** *humboldtewb@gmail.com* **Webpage:** *http://www.humboldt.edu/ewb/*	• Redesign and construct ram/rope pump II • Design fish and wildlife cleaning station for Wiyot Tribe • Design and implement rainwater catchment systems locally • Write grants for projects in Camoapa • Repair CCAT grey water system • Present interactive demonstration at Sister City Project's I-Block Party	• Construct Wiyot fish and wildlife cleaning station • Develop Appropriate Technology curriculum for schools • Demonstrate ram/rope pump at local schools • Write and publish manual for ram/rope pump • Continue implementing rainwater catchment systems locally
Renewable Energy Student Union (RESU) **Email:** *resu@humboldt.edu* **Webpage:** *http://www.humboldt.edu/resu/*	• Global Energy Forcasting Competition • SoRMS • CCAT MEOW assessment • HEIF proposals • Rock Creek Ranch energy analysis and PV system update	• Hydrogen Fueling Station Design Competition • SoRMS • Soldering workshop • CCAT PV Monitoring System assessment
Society of Women Engineers (SWE) **Email:** *swe@humboldt.edu* **Webpage:** *http://humboldt.edu/clubs/club_sites/society_of _women_engineers1/* **Facebook:** *http://www.facebook.com/groups/swehumboldt/*	• PaddleFest Cardboard and Duck Tape Kayak Race • Webinar Viewing and Bowling Night • SWEshi • Brown Bag Lunch speakers • Zane Middle School outreach program development with SHPE • Develop new SWE project	• 2015 Regional SWE Conference at University of the Pacific • 4th annual SWE Social • Girl Scouts Day • Brown Bag Lunch speakers • Zane Middle School outreach program development with SHPE • Implement new SWE project
Society of Hispanic Professional Engineers (SHPE) **Email:** *jl2357@humboldt.edu* **Webpage:** *coming soon*	• Weekly meeting for club logistics • Tri-weekly study sessions • Zane Middle School outreach program development with SWE	• Weekly meeting for club logistics • Weekly study sessions • Zane Middle School outreach program development with SWE

The Modern FE Exam

Prepare, Persevere, Prosper

by Brendan Byrd, ERE Senior and ERE Messenger Student Editor

The Fundamentals of Engineering (FE) exam is one of the first steps taken by engineering students in the process of obtaining professional licensure. After completion of the FE, you are eligible to become an engineer in training (EIT) and begin working toward becoming a Professional Engineer. California requires two years post-graduation engineering work as an EIT, then the professional engineers exam, referred to as the PE Exam. If you plan on working in another state, it would be wise to familiarize yourselves with that state's policies on obtaining licensure.

The FE exam includes the fundamental concepts covered in an ABET-accredited undergraduate engineering program, and comes in one of many flavors (Civil, Mechanical, Environmental, etc.). In the past, the exam was administered via pencil and paper, 8-hours and 180-questions, offered at limited times and locations twice each year. In a recent stroke of good fortune the exam has been restructured as a 110-question, 5-hour 20-minute exam that can be taken at any one of many licensed testing centers, the closest to HSU being Redding. The test can now be taken on almost any day desired, as long as an appointment is made via the NCEES website: <http://ncees.org/exams/fe-exam/>.

While it may seem intuitive as ERE students that you would take the environmental version of the FE exam, this is not so obvious. Historically, the most common version taken by ERE students is the "Other Disciplines" version, which covers the basic material that is common throughout any engineering major. This material includes, but is not limited to: Mathematics, Probability and Statistics, Engineering Economics, Statics, Dynamics, Thermodynamics, Fluid Mechanics, Materials and Heat Transfer. The advantage of this version is that there is almost nothing foreign to you. Upon completion of your 300 level coursework, you will have been exposed to most of the material, except possibly Phyx 315: Electronic Instrumentation and some of the Heat Transfer material (Engr 416: Transport Phenomena). You can take the environmental version of the exam; however, there are many topics covered that would not be taken by students until their senior year (Hydrology) and some that would be exclusive to specific design electives (Hazardous Waste, Air Quality, Groundwater). That being said, many students I have spoken with have had no problem with the content of this exam. When it comes time for you to sign up, the best advice is to be tested on the material YOU feel comfortable with, not what other people say is 'easier' or not. More information regarding the content and composition of specific exams can be found under the 'FE Exam Specifications' section of the NCEES link listed above.

As one, two, or even ten blue moons have passed since you last thought about some of this material, studying for the exam becomes quite important. The most common resource I came across (and the one I used personally) was the FE Review Manual by Lindeburg. This book was nice as it synthesized all test subjects into a small amount of text and FE style example problems. On Amazon, the rental price was less than $30 for a three-month rental, a pretty good deal. Additionally, this book comes with a full-length version of a practice FE exam. Another helpful resource is the practice version of the exam, available for purchase on the NCEES website ($50). This exam is a 55 question, 160-minute exam that can be completed in any combination of time increments over a period of 14 days (14-day timer starts when the exam is first attempted). This practice exam is a good resource as it gives you a feel for the pace of the test, and the difficulty of material you will be faced with. Additionally, it can help you identify your weaknesses, and where you should spend your time studying. Several students I have spoken to took this exam either for the other disciplines or environmental versions of the test, and all have found it helpful. For the environmental version of the exam, several students who took the test this summer said the most valuable study tool for them was the Engr 115 book, so keep your books! Lastly, familiarizing yourself with the FE reference manual is one of the most beneficial things you can do to prepare yourself for the test. Not only does looking at the subjects and equations jog your memory, but it will also serve to help you navigate the

Continued on page 9