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Creating Tomorrow, Fall 2012

College of Engineering

CREATING Tomorrow

COLLEGE OF ENGINEERING, FALL 2012

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The Transforming POWER OF RESEARCH

UtahStateUniversity

THE TRANSFORMING POWER OF RESEARCH

Undergraduate researchers work in the College of Engineering's Synthetic Biomanufacturing Institute.

"At a research university, faculty are focused on new ideas that can change the world, and students work with them, learn from them."

—Scott Hinton

A Message from Dean Hinton

We have had another exciting year of successes in the College of Engineering, and I hope you enjoy these stories that show our continuing innovation and dynamism.

Throughout this issue of the magazine, we have focused on the transformative power of research in its many dimensions, both inside and outside of classroom, and both on campus and off. We experience this transformative power of research at many levels, from the most elemental function of a university — helping students grow — to the most elemental function of the engineering profession — making "products" and communities grow.

But at every level, the transformation of something from an idea to an end product takes a similar, progressive path, and it is this fundamental path that is threaded through the college's core. It is fundamental to the core curricula, through its core research dynamic and through its basic teaching mindset because it also is at the core of the engineering profession itself.

Engineers make things happen. They solve problems. They build products. In other words, they transform the world around us by facing problems head on and by having the skills, the inspiration and the confidence to turn new ideas into new products.

I am always proud when I tell people that there is a little bit of this "transformation nerd" in all engineers: we engineers love technology, whatever it might be, and we all are driven in an almost infectious way to solve problems, not just see problems.

We latch on and are inspired by problems. We're not scared by them! We take a little bit of the science we need, a little bit of technology, a little bit of math … and, in the most simple terms, we put it all together to solve stuff.

That is exactly the process in which we in the college hope to engage students early on and then carry with them through their degree and, more important, into their professional careers. The college pushes them from the start so they realize that the competitive edge demanded of them in college is the same competitive edge they will face in the workplace. In fact, the "workplace" begins as a freshman in the College of Engineering model.

We want them prepped for industry, where there are no second chances on most projects and where that old "late homework" excuse doesn't exist. There are always the senior projects that everyone does, where students design, build and test ideas through the entire process in a way that is similar to industry standards. But our college faculty want to change the way students look at learning right from the start. Why wait until senior projects to show them they can solve real problems.

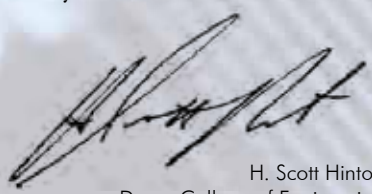
We challenge them right away so they develop a winning attitude. At a research university such as ours, faculty are focused on new ideas that can change the world, and students work with them, learn from them. Students get a chance to see the edge of the marketplace and live it even as undergraduates, so they've seen success and they develop the attitude that they, too, can solve problems and make a difference."

Our faculty in the college are transforming communities and societies through innovative ideas, whether it's through synthetic biomanufacturing, profitable bioremediation, or their engagement with industry on nuclear and other sustainable energies.

These are the ideas that move into the marketplace, making new jobs and transforming society — the next cellphone technologies, the next laptops, the next TVs. They start with engineers like us getting an idea — maybe in the shower, maybe on a morning walk — then taking that small idea and pushing it, taking it to a next level, and making it into a real product that can become a revolution in thinking for an entire generation.

In fact, USU's College of Engineering is at the leading edge not just of the technology of building things, but it is also at the forefront of researching how engineering students learn. The Engineering Education Department is one of three in the nation — along with Virginia Tech and Purdue — studying best practices in engineering education.

We are proud of the work we are doing in this field — one more 'transformative power' we own at Utah State University.



H. Scott Hinton
Dean, College of Engineering

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Moonyeen and Richard Anderson

USU Engineering Alums Give Back

Richard and Moonyeen Anderson

Utah State University alumni Richard and Moonyeen Anderson have played an instrumental role in the development of the College of Engineering. Having met at, and graduated from, USU, the Andersons have consistently donated their time and resources to the well-being of the university.

After receiving a degree in social work, Moonyeen worked with unwed mothers and pre-adoption through the Church of Jesus Christ of Latter-day Saints Social Services program and simultaneously raised six children.

Richard's career began in 1959 as an engineer in the corporate laboratories of Hewlett-Packard. Over the years he held numerous positions, eventually becoming the senior vice president of Hewlett-Packard company's Microwave and Communications Group.

While working at Hewlett-Packard, Richard generously supported USU by securing more than $3.8 million in equipment gifts. Since his retirement he has continued to help the College of Engineering and other areas of USU. Over the years Richard has ceaselessly supported his alma mater through service in various positions, including the President's Roundtable, the Utah State University Foundation Board and the College of Engineering Dean's Advisory Board.

Richard and Moonyeen have made an engineering education possible for dozens of students through the Richard and Moonyeen Anderson Scholarship in Engineering. The scholarship is funded yearly with proceeds from a charitable trust that the Anderson's established to benefit the college long term. The scholarship is awarded to engineering majors who have demonstrated academic achievement, a record of community service and leadership skills and who have graduated from high school in Cache or Box Elder counties.

Kelsi Christensen, a recipient of the scholarship calls it "a confidence booster."

"My family has been my biggest supporter of me attending college and pursuing my dreams," she said. "But this scholarship showed me that there are others out there that want me to follow my dreams as well."

The Andersons' impact has also been felt through the establishment of the Richard and Moonyeen Anderson Wireless Research and Teaching Center. The facility, opened in 2001, provides a state-of-the-art research and teaching facility for wireless communication with emphasis on industry-relevant design projects and has become a hub of wireless technology development.


James O. and Teresa Moore

James O. and Teresa M. Moore

USU College of Engineering graduate James (Jim) O. Moore and his wife, Teresa (Tere) M. Moore, an elementary education graduate, are proud supporters of the College of Engineering.

The Moores annually donate to the College of Engineering Mountain View Engineering Scholarship set up to help civil engineering students. They have also contributed to USU's Engineers Without Borders.

"As a newlywed I received scholarships that helped immensely toward my USU education. We want to do the same for students in similar situations. I will always be grateful for the excellent education that I received at Utah State. It has certainly helped in my career and success."

—James O. Moore

"Tere and I both feel strongly that successful individuals should give back to society as much as possible," said Jim. "We were both fortunate to receive excellent educations at USU and were able to learn from excellent professors who became mentors and friends. As a newlywed I received scholarships that helped immensely toward my USU education. We want to do the same for students in similar situations. I will always be grateful for the excellent education that I received at Utah State. It has certainly helped in my career and success."

Jim graduated from Utah State in 1979 with a bachelor's in civil engineering and is the president and owner of Mountain View Engineering, a structural engineering firm. He also owns and operates Mountain View Building Systems, a construction material supplier. Both companies are located in Brigham City, Utah.

Jim is a licensed structural engineer in 18 states and has been principal designer on thousands of projects during his career. He is currently celebrating his 20th year in business.

As his business expanded, Jim said he has always looked for exceptional employees with strong skills and knowledge.

"Not surprisingly, the employees I have hired have all attended USU," he said.

Tere serves her community through multiple civic organizations, including literacy tutoring, PTA and other organizations.

Both are members of the Rotary International service organization and are Paul Harris Fellows in recognition for contributions and service in leadership positions with the Brigham City club. They have actively participated in many service trips over the past several years, including distributing wheelchairs in Peru; administering polio vaccinations in India; and working with teenage participants building homes in Mexico.

Honoring TRADITION
Securing Our FUTURE
The Campaign for Utah State University

A Tremendous Success

The university's fundraising effort "Honoring Tradition, Securing Our Future, The Campaign for Utah State University" was a tremendous success having earned a record total of more than $500 million. The College of Engineering successfully brought in more than $20 million of the overall total during the campaign. The funds were used for building projects, including the David G. Sant Engineering Innovation Building, to start scholarship endowments that will fund yearly student scholarships and to pay for student projects, department competitions and faculty and equipment enhancements to improve the educational experience in the college. These donations have established, and will continue to establish, a tradition of giving back to Utah State University that lives on through our alumni and friends.

The College of Engineering at USU has experienced an exceptional period of growth this past year. We have had record enrollment in many of our departments, and our graduates have experienced great success in finding jobs in their respective fields. We are proud of the students who have graduated from our college and of those who are currently in the process of earning their degrees. The demand for qualified engineers continues to grow. We are preparing the next generation of trained and experienced engineers. This will require an increased effort to fund the needed scholarships, facilities and faculty to expand and improve our college.

I'm proud of the work we do here in the College of Engineering, and I'm happy to be a part of this successful educational institution. The faculty members are always a pleasure to work with, but it's the students and their enthusiasm for Utah State University that make me happy to do what I do. As they venture out and find success in their specific engineering fields, they will carry on their enthusiasm for this great institution.

Thank you for your help in assisting to improve the College of Engineering and its students. Please contact me with any questions you have about the College of Engineering.

Sincerely,

Val Potter
Executive Director of Development
val.potter@usu.edu

Bioprocessing engineering doctoral student Cameron Copeland holds a spider used to study spider silk proteins that may have the potential to form durable artificial ligaments and useful cancer fighting agents.

USU's Synthetic Biomanufacturing Institute

Creates TECHNOLOGIES to IMPROVE LIFE

The College of Engineering has combined its expertise with expertise from other areas at the university, particularly in the College of Science, to create the powerhouse known as the Synthetic Biomanufacturing Institute (SBI). The institute, housed in the College of Engineering, will provide an infrastructure that enhances research and commercialization opportunities in the field of synthetic biomanufacturing.

With four main areas of focus, the institute provides the framework necessary to strengthen the communication and coordination between research centers, industry partners and the institute's Bioproducts Production Laboratory.

The four areas of focus are: the Sustainable Waste-To-Bioproducts Engineering Center; the Synthetic Bioproducts Center; the Bioenergy Center; and the Bioproducts Production Laboratory.

Doctoral student Troy Munro works with a vacuum chamber that measures how well spider silk conducts heat.

All of the centers in the institute work with USU students at the graduate and undergraduate level.

"This is an exciting opportunity because we are taking advantage of what nature has to offer and then using it to make life better for everyone," said H. Scott Hinton, dean of the College of Engineering and interim SBI director. "There is so much potential from the research we are conducting and it ranges from bioplastics to pharmaceuticals to environmentally friendly energy."

The Sustainable Waste-to-Bioproducts Engineering Center is working on profitable bioremediation of municipal and industrial waste streams through the production of high-value byproducts. The center is working with the city of Logan's Environmental Department to clean up hazardous chemicals in its wastewater ponds by introducing algae that consume nitrogen and phosphorous. The algae is then harvested to be converted into biofuels and other bioproducts. The innovative process not only cleans up the chemicals naturally, it also saves the city of Logan nearly $80 million because it no longer needs a new waste processing plant to clean the water.

"We are using natural organisms to make this happen, to grow products and clean up messes," Dean Hinton said. "We are doing all of this naturally and in a well-defined and safe manner."

The Synthetic Bioproducts Center, while doing research related to the SWBEC, is taking it one step further by identifying the bioproducts that have real value and then engineering an organism to create the desired bioproduct. The center brings researchers together to create new manufacturing processes using biological cells as factories. Varying bioproducts are under analysis at the center, including spider silk proteins that someday may have the potential to form durable artificial ligaments for people who have injured their knees or shoulders and new peptides and proteins that have useful anti-tumor and anti-inflammatory properties.

Using readily available natural resources, the research at the Bioenergy Center is focusing on sustainable energy and fuel products. The center uses a biomass that can come from various sources, including algae or chicken manure and then converts it into an oil, gasoline, biofuel or other energy-related product.

"As engineers, we are always looking for solutions," Dean Hinton said. "But to have a solution, you have to know the problem. USU's Commercial Enterprises office helps us identify those problems so that we can find the solutions that not only benefit mankind, but that are also profitable for the university."

So, not only does the SBI conduct research, it also creates products, spin-off's, patents and licenses with the help of Commercial Enterprises. The SBI has turned in 39 patent filings overall, with 12 of the patents filed in the 2011-12 fiscal year. The institute also has a total of 49 invention disclosures, 18 from the 2011-12 fiscal year. One company, Araknitek, has been spun out of the SBI to commercialize synthetic spider silk technologies.

The Bioproducts Production Laboratory assists with taking what is invented by the three centers and produces it on a large-scale basis. The lab has the equipment and personnel necessary to shorten a product's time to market.

To learn more about the SBI, visit the website (sbi.usu.edu).

The Rotating Algal Biofilm Reactor (RABR) located in the Logan Lagoons is able to cultivate and harvest algae that cleans up wastewater by consuming nitrogen and phosphorus.

Cashing in on the Many Benefits of Algae:

USU's Sustainable Waste-to-Bioproducts Engineering Center

Researchers at USU's Sustainable Waste-to-Bioproducts Engineering Center (SWBEC) are studying ways to clean up hazardous chemicals in wastewater treatment ponds by introducing algae that consume nitrogen and phosphorous. The researchers are now taking the technology one step further by studying a variety of practical applications that range from fish food to bioplastics.

One of the newest projects on the horizon is using algae to feed fish. With traditional fish food becoming more expensive, the U.S. Department of Agriculture's Agricultural Research Service is looking for alternate ways to supplement the traditional fish diet. SWBEC researchers are working with the USDA to look at ways to introduce algae as part of the fish diet in Idaho's fish hatcheries.

The USDA visited with SWBEC researchers in August 2012 to learn about the algae being produced in Logan's wastewater ponds and to do a study on its nutritional content. This fall, SWBEC researchers visited several

Synthetic Biomanufacturing Institute

Sustainable Waste-to-Bioproducts Engineering Center
Converts society's waste into valuable products to promote national energy independence, sustainable local production of bioproducts, new industries for new jobs and the protection of human health and the environment. Currently, these products include biodiesel, biodegradable plastics, health-related nutritional chemicals and methane biogas.

Sythentic Bioproducts Center
Takes advantage of recent bio-scientific advances to enable living organisms (single-cell organisms, plants and animals) to transform raw materials into environmentally friendly products such as low-cost therapeutics, antimicrobials, biomaterials and pharmaceuticals.

Bioenergy Center
Focuses specifically on the needs and resources of the Intermountain West to develop technologies that will lead to environmentally responsible energy independence for the United States. The center utilizes and maximizes readily available natural resources and waste streams as feedstocks for liquid transportation fuels, biomass for advanced materials and high value co-products.

Bioproducts Production Laboratory
Provides the prototyping and production capabilities for the institute's centers, as well as bioproduction contract services for industry. Houses the facilities and technical support necessary to scale-up the production of products created by the institute's centers.

fisheries in Idaho in preparation for fish feeding trials that began in October and November.

"We are working toward producing thousands of pounds of algae per month," said Ron Sims, director of SWBEC and Biological Engineering professor.

And just how do SWBEC researchers produce hundreds of pounds of algae a day?

"Good old farming," Sims said.

By using a Rotating Algal Biofilm Reactor, or RABR, the center is able to literally cultivate, harvest and process algae. The RABR, designed at USU and manufactured in partnership with WesTech Engineering in Salt Lake City, Utah, is a device that sits in the wastewater with several spinning ropes. Add some sunshine and CO_2 and the algae are able to grow on the ropes. A bar on top scrapes off the algae where it is then harvested and processed to be used for various applications.

One of those applications is the creation of bioplastics. SWBEC researchers have genetically engineered harmless bacteria to convert the algae chemicals into bioplastics and then to secrete, or basically sweat, bioplastics from the cell. The bioplastics created from the algae are 100 percent biodegradable and are cheaper than traditional petroleum plastics due to the use of inexpensive algae that are fed to the bacteria and allow the bacteria to sweat out the bioplastics rather than destroying the bacteria to get the bioplastics out of the cell.

Sims said there are multiple benefits to using algae because it is cost-effective and it doesn't compete with the food supply.

"Using algae is sustainable and profitable and builds the economy from the ground up," Sims said. "We all have wastewater and by using that to our advantage we won't have to rely as much on others for our sources of energy and byproducts."

If it works in Logan, Utah, it can work in other communities around the United States and the world, Sims said.

In the Microbionanotechnology Lab Yue Cui studies various ways bionanotechnology can be used to solve everyday problems ranging from disease diagnosis to self-cleaning windows.

Studying the Small for Big Results:

USU's Microbionanotechnology Lab Solves Everyday Problems

Medical diagnosis, defense, environmental monitoring and energy storage may seem like they are not related, but for Utah State University Biological Engineering assistant professor Yue Cui, they are. In the Microbionanotechnology Laboratory, Cui is studying the various ways bionanotechnology can be used to solve everyday problems.

The research conducted in the Microbionanotechnology Laboratory encompasses tailored solutions from across the biotechnology and nanotechnology spectrums, including biological recognition, nanofabrication/nanoassembly, micro/nanofuidics, materials characterization and electrical measurements.

"There are so many useful applications for bionanotechnologies," said Cui. "Whether we are looking at devices that can detect biomarkers in order to give a diagnosis for a disease, or studying bio-inspired materials that can be used to create a self-cleaning window, the research, although very high-tech, has very basic applications."

And while taking the research and using it in practical applications is the main focus of the lab, Professor Cui also conducts several fundamental research projects to create a further understanding of bionanotechnologies.

"Fundamental research is very important because it provides for the future of society," Cui said. "The research doesn't always have an immediate use, but it has the potential to be very useful in the future."

Being part of a research university is an important component of what Cui does because it challenges her to further understand her research so she can pass along her knowledge and skills to her graduate and undergraduate students.

"I need to teach my students how to solve problems, be independent and be competitive," Cui said.

The trickle effect of research is important as well, Cui said. Research creates invention, invention creates manufacturing and manufacturing creates jobs. Not only does the research have a social impact, but an economic impact that many people don't realize, she said.

So whether one is receiving a life-saving early diagnosis for heart disease or doesn't have to get the ladder out to clean that second story window, it all starts with research. Research that makes a difference. Research that matters.

Graduate student Ben Friend prepares to use the loading RAM.

Meeting the TRANSPORTATION NEEDS of the FUTURE

The United States has one of the most complex transportation systems in the world. Millions of cars and trucks travel more than 250 billion vehicle miles per year on the nation's roads, highways and bridges. The U.S. economy is completely dependent on the system running smoothly and efficiently and, unfortunately, the transportation infrastructure is showing signs of age. Roads are falling apart and bridges are deteriorating due to limited replacement funds from state departments of transportation.

Research currently being performed at the Utah Transportation Center at Utah State University will help to mitigate the effects of aging and keep the nation's roadways safe.

Paul Barr, associate professor of Civil Engineering and director of the Utah Transportation Center (UTC), knows that the UTC's research plays an important role in determining bridge integrity as well as other transportation issues.

Recently the UTC, as part of a $3.5 million grant given to a consortium of universities led by Rutgers University, initiated a study to investigate the shear behavior of aging bridge girders, Accelerated Bridge Construction deck panel connections and the development of a sign management system for departments of transportations.

The UTC will receive $550,000 each year for the next two years. Barr said the funding will be used primarily to study the structural integrity of bridge systems.

"The work we perform at the UTC lab has a direct impact on the U.S. Department of Transportation's overall strategy," said Barr. "The results of our research enables them to make critical infrastructure decisions based on sound scientific data. We can quantify performance in our lab that is not possible in the field."

The UTC lab is located in a modest-sized metal building next to the Logan River. The building contains a ceiling-height hoisting system that allows researchers to move 40-ton bridge girders into place for testing. They then

use a loading RAM that is capable of applying more than 1 million pounds of force on the structure.

Graduate students, Ben Friend and Arek Higgs, are both grateful for the opportunity to work in the lab.

"The work we get to perform in the lab directly relates to the work we hope to do after graduation," said Higgs. "Having the experience under my belt can only help me find a great job when I'm done."

Friend also values the research work.

"It is amazing to get to work on these large structural projects," said Friend. "Dr. Barr knows that we are gaining a ton of knowledge to take with us into our professional careers."

Barr is proud of the program and cites praise from people like Joshua Sletten, the bridge design manager for the state of Utah, as evidence of success.

"After hiring a recent USU graduate, Sletten told me to 'keep sending us students like him'," said Barr. "They are prepared for the real world."

Barr hopes that the research will continue to not only help graduate students but will also provide solutions to age-related structural issues on bridges. He is quick to point out though that the UTC has other important projects underway that also deal with infrastructure issues.

Marv Halling, professor of Civil Engineering, leads the Long Term Bridge Project (LTBP) which studies the integrity of active bridges by placing instrumentation on the bridge and performing an array of tests. These include live load, vibration and deck tests in hopes of capturing stress data while the bridge is in use.

Halling's team currently has three pilot bridges in Utah, Minnesota and California. He understands the benefits of teaming up with a Tier 1 university for such high-profile research.

"Being a part of the consortium led by Rutgers truly validates the quality of work we perform at the UTC," said Halling. "We have been testing for more than 18 years so it is nice to be recognized as one of the leaders in the field."

Halling's students also benefit from the high visibility of the project.

"My students have fantastic opportunities to make contacts and network through this research," said Halling. "They get great offers when they graduate because of their involvement in such a large-scale study."

The Utah Transportation Center doesn't just look at aging infrastructure though. It also researches and develops sustainable transportation systems for the future. Kevin Heaslip, assistant professor of Civil Engineering, leads a team that hopes to transform the nation's entire system by developing the Automated Electric Transportation (AET) system.

The research is sponsored by the U.S. Department of Energy and investigates a system that integrates the electric grid of vehicle, highway and communication infrastructures.

"The system will transform the way we think about energy for transportation," said Heaslip. "AET has the potential to simultaneously and dramatically reduce petroleum use, carbon emissions, air pollution, traffic congestion and highway crashes all while creating new jobs."

The system will provide energy directly to vehicles from electrified highways as well as automate control of the vehicles. Heaslip hopes to drastically reduce the number of vehicle-related fatalities, reduce congestion and improve safety.

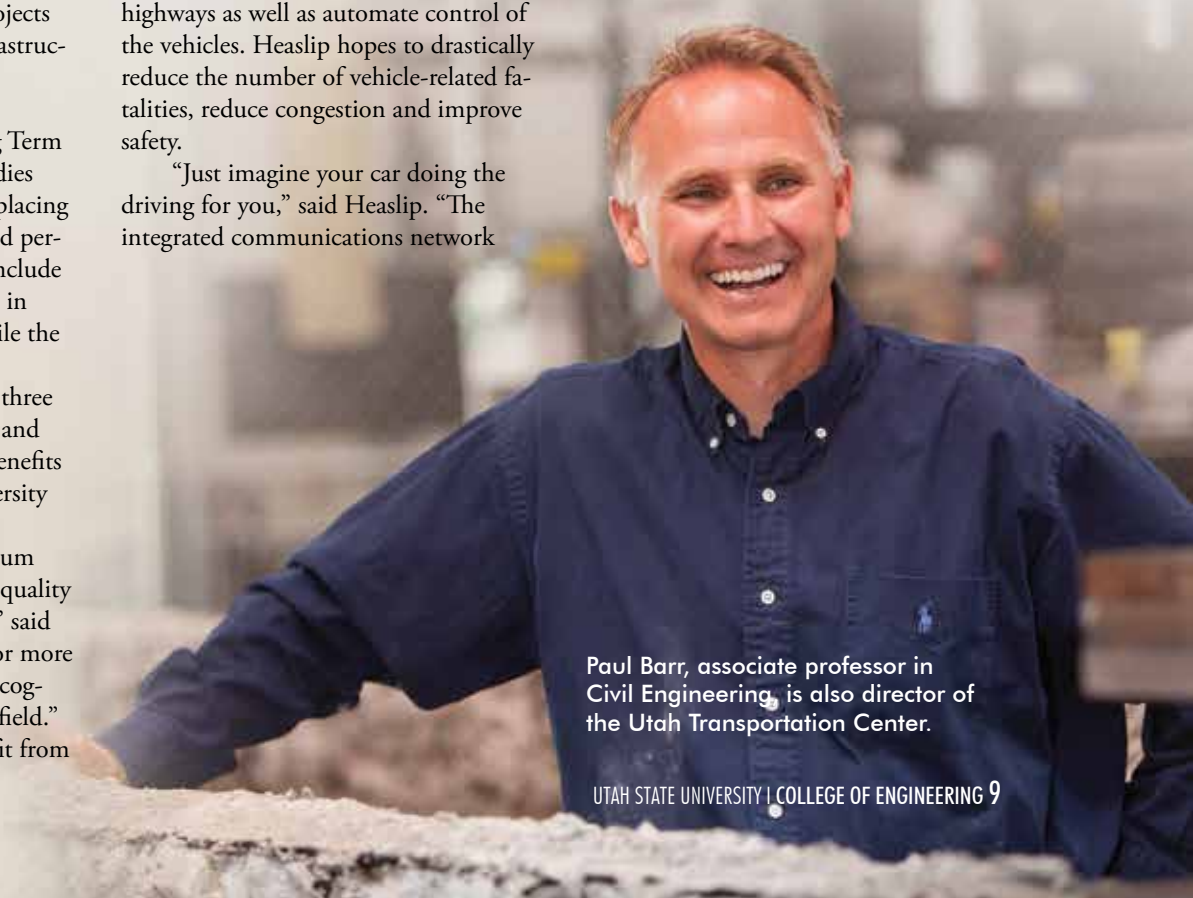
"Just imagine your car doing the driving for you," said Heaslip. "The integrated communications network with the road, as well as other vehicles, will take drivers out of the 'loop.'"

Heaslip knows that things won't change overnight but he does believe we are already moving toward automation within individual cars with features like automated parking and adaptive cruise control. He hopes that in 40 to 50 years, the nation's transportation system will look very different than it does today.

"We are well into the process of automation," said Heaslip. "Now, it's a matter of creating buy-in from the full spectrum of stakeholders who believe that the electrification and automation of transportation not only benefits individuals but has a direct relationship to creating a more sustainable future."

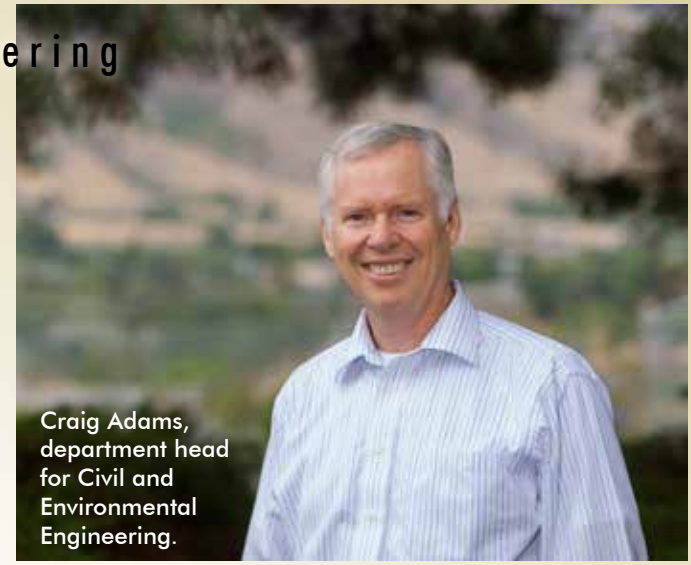
Heaslip's research group has investigated alternative energy for transportation as part of the Mountain Plains Consortium, a group of six regional universities led by North Dakota State University.

The Utah Transportation Center may just be the most understated research facility on campus. From bridge integrity to high-tech vehicle electrification and automation, the work produced by the center is some of the most practical and useful in the nation. With little fanfare, the faculty and students of the UTC are transforming the future of transportation.



Paul Barr, associate professor in Civil Engineering, is also director of the Utah Transportation Center.

New CEE Department Head Looks Forward to Outstanding Collaborative Research Opportunities


Craig Adams, department head for Civil and Environmental Engineering.

Craig Adams, new department head for Civil and Environmental Engineering, is excited about his move to Utah State University and northern Utah. The move allows him to take advantage of the multitude of opportunities, both at USU, and in the surrounding mountains. After four years at the University of Kansas and 13 years at the University of Missouri, Adams and his wife can't wait to enjoy the benefits of living in the West.

"Now that our kids have grown up, my wife and I are looking forward to exploring a new place," said Adams. "I am especially excited about the outstanding collaborative research opportunities in the department and the Utah Water Research Laboratory."

Adams' research concentrates on developing innovative sustainable water and sanitation technologies for both the developed and developing world.

"My research focuses on protecting human health from toxic organic and inorganic chemicals through prevention of their discharge to the environment and understanding their formation and/or removal in water and wastewater treatment, in water distribution systems and in the environment," said Adams. "For the developing world, I am focused on technology to treat water for inorganics such as arsenic, cadmium, fluoride and other metals with locally available technology, as well as solar disinfection composting latrine technology."

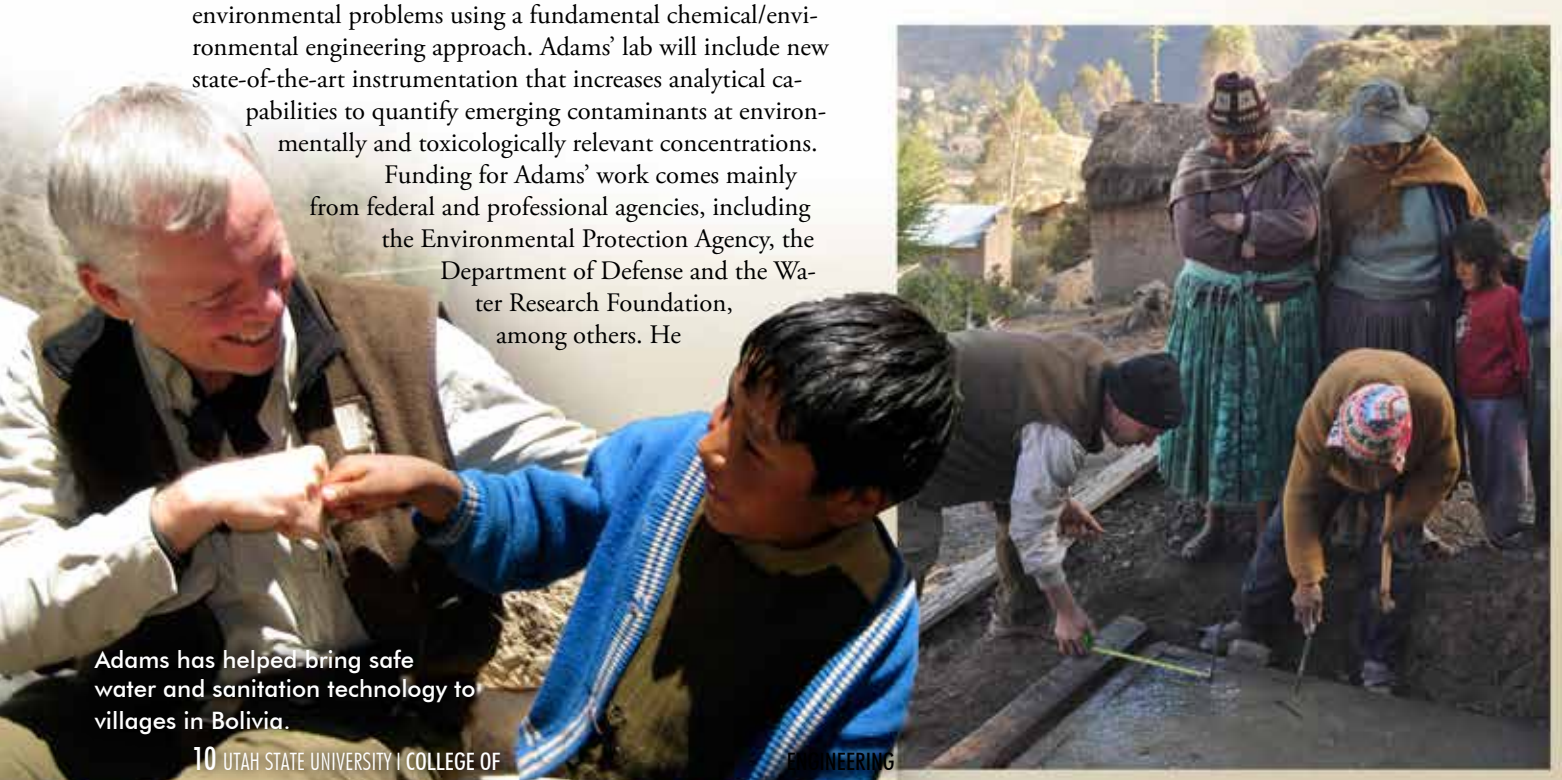
Adams is interested in finding solutions to real-world environmental problems using a fundamental chemical/environmental engineering approach. Adams' lab will include new state-of-the-art instrumentation that increases analytical capabilities to quantify emerging contaminants at environmentally and toxicologically relevant concentrations.

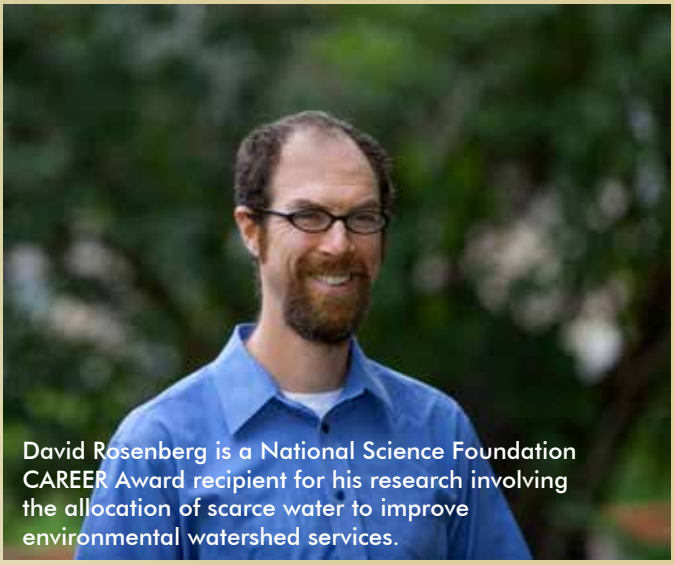
Funding for Adams' work comes mainly from federal and professional agencies, including the Environmental Protection Agency, the Department of Defense and the Water Research Foundation, among others. He is looking forward to many new collaborations with his new colleagues offering complementary areas of research.

"One of the main reasons I came to USU was because of the strength of the faculty," said Adams. "The Water Research Lab is home to some of the most innovative research in our field as well as some of the finest faculty."

Adams is also eager to continue his work with Engineers Without Borders. He has been involved in the program for five years and has traveled to Bolivia five times to bring sanitation and safe water technology to rural villages.

"I am thrilled to see that USU has a thriving EWB chapter," said Adams. "At this point in my career, I find it a privilege to work with our students to help with the massive sanitation and water issues facing developing nations. Not only do the students get to make a major impact in the lives of others, they also develop their leadership and engineering skills in a real and significant manner."


Adams has helped bring safe water and sanitation technology to villages in Bolivia.



David Rosenberg is a National Science Foundation CAREER Award recipient for his research involving the allocation of scarce water to improve environmental watershed services.

NSF CAREER Award Winner David Rosenberg

David Rosenberg, assistant professor of Civil and Environmental Engineering, isn't looking for perfection. His research goal is actually to find near-optimal solutions that offer more options to a wider group of stakeholders than just one "perfect" answer.

Sounds a bit backwards for someone who recently received a National Science Foundation CAREER Award, but Rosenberg's approach is nothing short of innovative.

Rosenberg's research applies uncertainties and near-optimal modeling to the problem of allocating scarce water to improve environmental watershed services.

"The project is developing new techniques to manage water for environmental and ecological purposes in the lower Bear River," said Rosenberg. "We are defining and measuring new performance indicators for wetland and riparian areas within the river basin (such as habitat suitability) and linking those performance indicators to water flows."

In the process, Rosenberg is developing new mathematical procedures to identify and recommend numerous promising near-optimal water allocations and water infrastructure developments to improve environmental and ecological performance within the river basin.

"This near-optimal approach contrasts with standard optimization methods that identify only a single, best or optimal solution," said Rosenberg. "We're looking for more flexible options to achieve environmental and ecological objectives within the river basin that still respect existing water uses and constraints."

Rosenberg's research integrates engineering, economic, environmental, ecological and, when necessary, social and political considerations to plan, design, manage, operate and re-operate water systems. The project has a technical advisory committee composed of representatives from the Nature Conservancy, the U.S. Fish and Wildlife Service and the Utah Geological Survey. Rosenberg is also trying to involve PacifiCorp, local farmers, recreation guides, the Bear River Land Conservancy and irrigation companies, among others.

Rosenberg plans to use graduate students, research basin professionals and undergraduate students in his CAREER project with the hope that "mutual learning and deeper discovery" will take place.

"The project has started a new Bear River Fellows Program in collaboration with the USU Outdoor Recreation Program," said Rosenberg. "We took five incoming freshmen out on the Bear River for a five-day river trip to collect wetland, riparian and flow data. Following the trip, we support the undergraduate fellows with one-year research assistantships to synthesize and present the field data they collect."

Rosenberg is hopeful that his project will not only change the way we approach water allocation issues but will also transform the lives of those involved.

Rosenberg's research on the Bear River will provide new answers to age-old water resource and infrastructure issues as well as provide leadership training for five freshman.

Mechanical and Aerospace Engineering students created and built a system for special operations forces personnel to scale buildings or mountain faces under a variety of conditions. The design earned the USU team first place in the national Air Force Research Laboratory Design Challenge.


ORP
N F. PETERSON
NGINEERING

USU RoboSub Team Shows Poise in Rigorous Competition

A Utah State University Computer Science team did not have to fly to London to experience the thrill of international competition this summer.

It wasn't an Olympic diving event, but they dove; it wasn't an Olympic rowing race, but they glided; it wasn't an Olympic rifle competition, but they shot; it did not involve 10,000 competitors from 204 countries, but 200-plus challengers from 10 countries came to compete; and even though it wasn't in London, it was in San Diego where the sun annually shines 83 days more than it does on average in London.

This year's competition, July 16-22, marked the 15th International RoboSub Competition sponsored by the Association for Unmanned Vehicle Systems International and co-sponsored by the U.S. Office of Naval Research. And while the USU team of seven didn't take gold, silver or bronze, they did make it to the semi-finals out of 30 teams and among such prestigious schools as Cornell, Virginia Tech, the U.S. Naval Academy and Kyushu Institute of Technology, Japan.

"They made tremendous progress," said Dan Watson, Computer Science department head. "There was a huge last-minute effort by these guys."

The eleventh-hour struggle involved a source code malfunction that forced them to scramble in their first diving attempt. They got it fixed, though, and just in time to get their four-foot long craft back into the water before it eventually succumbed to motor failure.

It is a challenging event since teams not only have to assemble their robotic submarines in time for the competition shortly after arriving in San Diego, they also have to program them to accurately and quickly maneuver through a huge Navy research pool built to simulate the ocean.

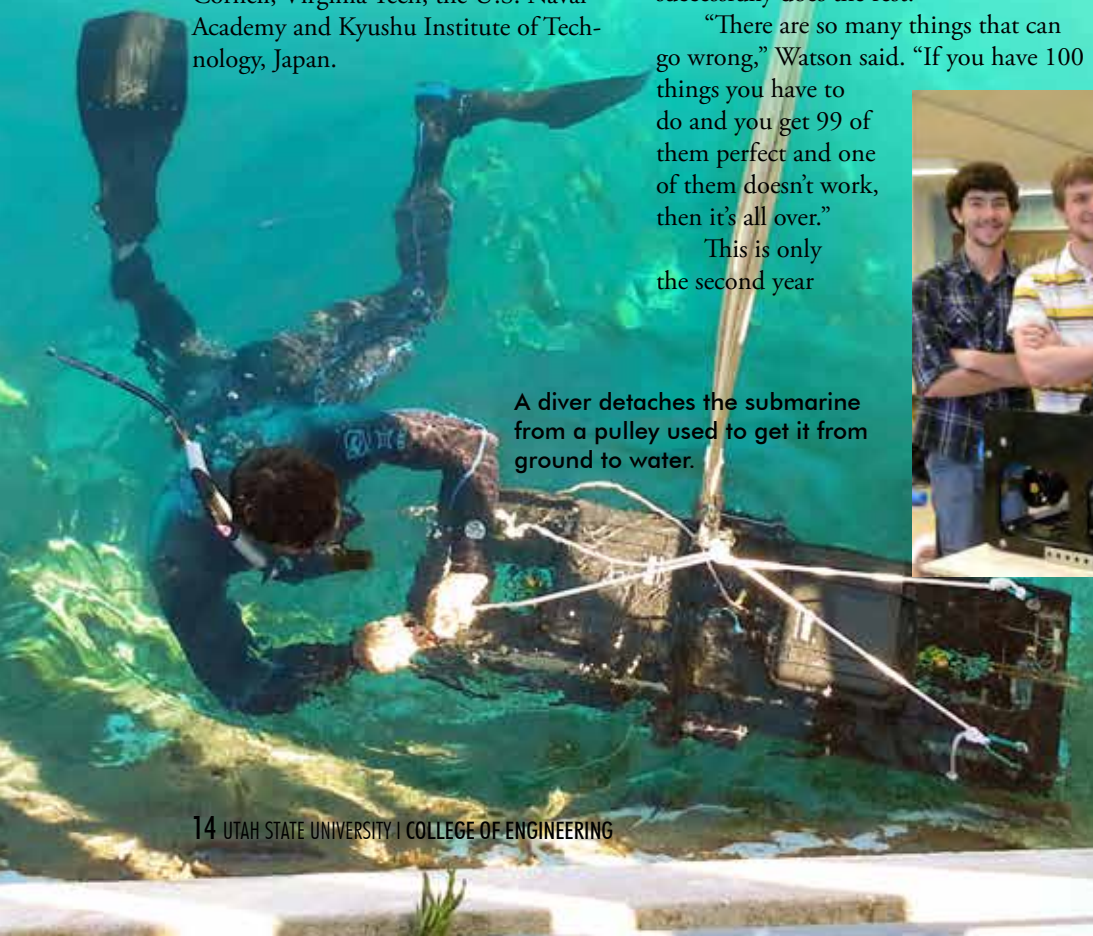
The hands-free maneuvering includes tricky moves such as diving, going around and above obstacles, shooting a torpedo and successfully resurfacing. Once they launch their subs, all they can do is watch and hope their software programming successfully does the rest.

"There are so many things that can go wrong," Watson said. "If you have 100 things you have to do and you get 99 of them perfect and one of them doesn't work, then it's all over."

This is only the second year that a USU team has competed and the university has already established itself as a serious contender. In the process, it has helped the students to become more poised and self-assured for future competition, Watson said.

"This is an opportunity for us to go out and compete against large universities and for our students to see that they can compete," he said. "The quality of our program is a source of pride and confidence."

He said most of the teams from the other schools are comprised of mechanical engineering students. What makes USU unique is that its team consisted primarily of computer science students. He considers the computer science dominance an edge since it's the robotic software that usually proves the most challenging in these competitions. Not that he is downplaying the importance of mechanics. It's just that…well… his department now resides in the same college that houses the award-winning Mechanical and Aerospace Engineering department. Good for USU, bad for the competition, once they connect the dots.



A diver detaches the submarine from a pulley used to get it from ground to water.

RoboSub Team (left to right) Chris Blay, Brandon Holdway, Schuyler Manchester, Ivan Jimenez, Dan Morwood and Jacob Christensen.

Battling the Bugs in Old Main

Seven elite students from Utah State University and across the nation participated in the Research Experiences for Undergraduates (REU) site at USU in connection with the College of Engineering's Computer Science department under the guidance of Dr. Daniel Bryce.

Bryce's research objective is to create new knowledge to improve software testing for web applications. This is significant when you think of online store applications and the billions of dollars that flow through them.

Consider the host of computer actions — inputs and outputs — that you set into motion when you shop on a website such as Amazon. It took countless hours of painstaking coding to make that happen — computer instructions created to give the user an unencumbered browsing and shopping experience sans broken links and page crashes. Such a flawless shopping encounter comes with a lot of testing first.

The analysis part is what attracted the students to spend their summer at USU. They came for the chance to do research on software testing and artificial intelligence planning. What is novel about this REU is that it involved both competition and collaboration.

Students were split into two teams with a mission to find the most faults in the web application systems selected for testing that used a novel testing technique. One team collected, reduced and prioritized user-session-based test suites. A second team used machine learning to build models of the software and artificial intelligence planning to generate test suites. This gave students the opportunity to learn and practice research skills in two different, but related areas.

Since this is a three-year grant, Bryce anticipates that 24 students in all will be given the opportunity to learn basic research skills and pursue graduate programs.

Spend some time with the first group of six seniors and one junior and you sense a genuine camaraderie and respect. Quite often they finish each other's sentences. When Quenten Mayo, from Tuscany, Alabama, began describing how the project involved testing strategies involving two-way combinations and prioritizations, he spoke at a pace that matched the quickness of his mind. Mercifully, Chelynn Day, a USU senior from Orem, Utah, volunteered to translate.

"What's he trying to tell you …" she said, "Sometimes you do one thing and then something else next. The combination of doing those two things will cause a problem and so we're looking at ways to not have to test every two things together, but to test the two things together that are most likely to cause a problem."

Got it?

Yes, it is complicated. Everything about computers is complicated. Spend more time with these gifted students and you become increasingly appreciative of their smarts and passion for all things mainframe. Your eyes may glaze over as they talk about user-session-based testing versus model-based testing and machine learning and free-form observational logging, but when that happens, just retreat to the safe harbor of metaphor: these empirical data entomologists are nothing more than bug catchers, plain and simple.

"It is my hope that students who participate in this program have a positive experience and later pursue graduate studies," said Bryce.

He said the students are better prepared for graduate school as they gain basic research skills, including the formulation of research questions, design of experiments, critical evaluation and written and oral communication.

Aaron Andrews, a USU senior from Buhl, Idaho, and Michael Burton, a senior from Indianapolis, Indiana, are perfect examples of the NFS project intent. The students plan to attend graduate school for doctorates in computer science.

"Part of the program is making sure that students can interact with each other to get to know what's going on outside of their world and their university," Andrews said. "That's what research is all about. You get to know people from all around the world. You start building your contacts."

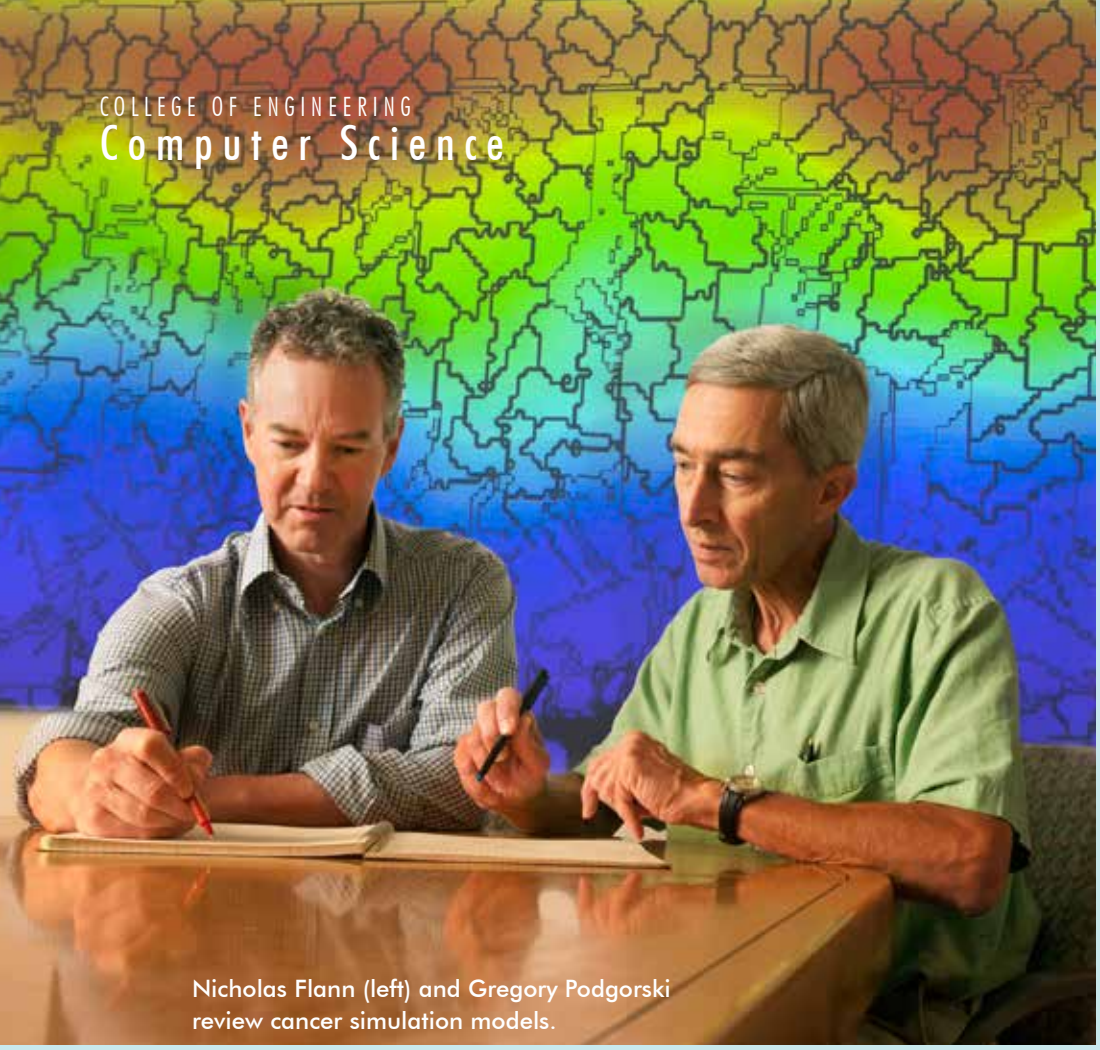
His six fellow students on the fourth floor of Old Main over the past summer constitute a very good start.

Computer Science Department in Brief

The fourth floor of Old Main is not an easy place to reach. Try getting to it from the north or south stairwells and you're out of luck. You have to take the elevator. It's complicated and even mysterious, which only adds to the lofty and unassailable aura surrounding the department housed there — Computer Science. Even though it's safely tucked beneath the eaves of the university's flagship building and a couple quads away from its Mothership, it's really as close as … the nearest computer.

"The college extended a warm welcome to us," said Dan Watson, department head. "We have found a great home."

The department, composed of 17 faculty and five staff, has been with Engineering since the fall of 2011. And though new to the college, it's anything but novel to the university. It first booted up in 1967 as a department in the College of Science. Originally it granted only a bachelor's degree. Today the department has grown to offer an array of post graduate degrees and a host of programs, research and learning opportunities with one goal in mind: engagement. Students in the department don't just learn about computers, they experience directly what it means to be a computer scientist.



Nicholas Flann (left) and Gregory Podgorski review cancer simulation models.

Unleashing the Power of Computers in the Fight against CANCER

This is a story about the space of possibilities and the hope it brings in the fight against cancer.

Three Utah researchers are keenly aware of the dire statistics connected to the world's leading cause of death. By 2020, some 13 to 17 million people worldwide are predicted to die each year from cancer out of some 26 million people diagnosed. With survival rates at 65 percent, the urgency is in finding new, more effective cancer therapies, said Nicholas Flann, associate professor of Computer Science at Utah State University.

Flann teamed up with USU biologist Gregory Podgorski, associate professor in the Biology department, in research that combines computer science technology with biology, a new approach to battling cancer. Assisting them at the time was Arthur Mahoney, a USU Computer Science undergraduate who is now a doctoral student at the University of Utah.

They are pioneering research using a computational search-based method for greatly accelerating the process in developing cancer-fighting treatments. Their work is being supported by the Luxembourg Centre for Systems Biomedicine, the University of Luxembourg and the Institute of Systems Biology, Seattle. Their findings are detailed in the January/February 2012 edition of *Transactions on Computational Biology and Bioinformatics* published by the Institute of Electrical and Electronics Engineers and the Association for Computing Machinery.

Browse through their research report and you quickly see just how intricate and complex their biologically realistic models are in charting tissue-level behaviors. You come to appreciate and understand why the byzantine bits and bytes of computer wizardry are absolutely necessary in the battle against the equally perplexing class of diseases known as cancer. With more than 100 different types of cancer, no single cure is possible because there is no single disease. With so many moving targets, rapid computational algorithms may hold the key to hitting the bull's-eye.

"If you think about scientists working at a lab, there are many possible things that can be done and tried to answer their questions," Flann said. "There are many ideas and approaches that can be pursued and explored. The challenge is that there are so many of them and it takes time to do each one. The point of our work is to try and improve the efficiency of that process."

Discovering drugs that block tumor-induced development of new blood vessels, called angiogenesis, is an important method in cancer treatment, especially for solid tumors. They explored numerous treatment possibilities that led to the discovery of an intriguing few. The most promising of these were further scrutinized based on their effectiveness in reducing nutrient and oxygen delivery to starve cancer cells, coupled with the cost, or difficulty, of intervention. If a treatment was fairly doable using today's technology, they considered the treatment low cost; high cost, on the other hand, is more pie-in-the-sky-maybe-someday, kind of treatment.

Looking at problems and finding solutions through intuition is a very human quality. But the immense number of potential solutions to a cancer treatment can quickly overwhelm intuition. But happily, it's no sweat for computers to test premises on a scale impossible for human researchers. What's even better, computers are not biased in

their searches. It is why Podgorski, who received his doctorate in cellular and molecular biology, began to gravitate toward computer science.

This curious collaboration between biologists and computer scientists works so well because both fields of study delve into the infinitesimal worlds of input and output – whether living cells or binary coded symbols. It is the nature of their disciplines and it parallels the way in which they think, that is, in the space of possibilities.

"For me, coming into this field and not knowing that much about computer science, I found it interesting to think of the vast search a computer allows," he said. "It is the searching of this vast space for potential solutions that drew me to it."

"I think that is the way computer scientists think, in the space of possibilities," Flann said. "And it's huge. Billions of possible things; and that is exactly why we need the computer."

Possibilities for cancer treatments were given all the space they demanded as the scientific trio ran their discovery algorithms through super computers. Their program evaluated potential interventions by measuring the amount of simulated oxygen provided to a tumor during the first 72 hours of angiogenesis.

So, for example, one of their computer program discoveries was that if certain types of cells developed higher affinity for cells in the surrounding tissue, this caused adjacent blood vessels to get caught up and trapped. Subsequently, instead of growing toward the tumor, they tangled up. The result: poor nutrient and oxygen blood flow to the tumor. Bingo!

"This was one of the discoveries the system made that basically said, 'hey, this looks really interesting,'" Flann said. Interesting because it presented a solution they would have never thought of on their own.

With this discovery in hand, Flann said the next natural step is to develop a drug that could change the expression of the surface proteins on either the tip cells of the blood vessels or the normal cells in the surrounding tissue that would increase the affinity of these two cell types for each other. Whether that can be accomplished or not is ultimately a task for a lab biologist. That is where the hand-off takes place.

"We will never say we found an answer, but at least we found some potentially interesting interventions to try that nobody would have thought of by just sitting down and saying, 'you know, this might be a good combination,'" Flann said.

The beauty of this is the computer search can find promising treatment combinations outside a traditional laboratory. This process would help biologists to cut the time needed to develop effective drugs. It is a process that could save years of lab time in the fight against a disease in which every minute counts, Flann said.

They were able to compress about 20 years of computer time by running their program on 20,000 high-powered computers at Eielson Air Force Base over a three-week period. Each powerful machine took part in a massively parallel search as it was tasked to test different, random combinations of potential treatments, all running at the same time and all trying out different possibilities.

"What happens is we pool possibilities together and then we organize them based on how good they are so the program, the simulation process, can evaluate treatment," Flann said. "Each treatment is scored with respect to its effectiveness. The more effective ones are pooled together and reported back to us. In a sense, it is the best possibilities found through this search process that become the final results of the system search."

To give you an idea of how intense this is, one pixel within the simulated tissue, represents a small part of a cell that would grow and move from one location to another. Each pixel captures a minute movement of part of a cell so that every simulation sums billions of little decisions that the system makes as cells grow and reshape: "should I extend or do I retract? Do I divide or do I change my type?" Each movement, like on a chessboard, becomes a step closer to or farther from a possible checkmate, or solution. And every time you run a simulation, the pattern is different under those same parameters because you randomize the system. Nothing is manipulated or hard-wired. No biases are introduced, Flann said.

"That is how the simulation runs," he said. "It is just changing these tiny little pixels billions and billions of times for this to happen."

The best possibilities that emerged became part of their Top 100 discoveries. Of that number, they pared the list to six novel potential treatments that they presented in their academic paper – six out of some 10 million solutions the computers offered.

Flann said he has no doubt that what they are doing will lead to a more effective process in tackling complex biological conundrums that will ultimately lead to real-world solutions. But in the short run, is what they are doing really benefitting a cancer patient?

"It would be great if it does, but that's not the immediate goal," he said. "Right now it is: 'can we push this kind of approach and bring it further along so that in the not-too-distant future it is a value and recognized that way by clinicians and biologists?'"

For Podgorski, forever the biologist, the similarities between the computer programs and biology do not go unnoticed.

"Life runs at a very low level in molecules," he said. "It is all just chemistry at the lowest levels, yet from chemistry life emerges in all its complexity. It is very similar on the computer. From the primitive and small operations in the program emerges a much more complex system that is very hard to predict what will happen and so you always get a lot of nice surprises."

"Posterity makes the judgments," said playwright Irwin Shaw. "There are going to be a lot of surprises in store for everybody."

Electrical and Computer Engineering

College of Engineering USTAR Professor Regan Zane (left) with Daniel Costinett, a USU visiting scholar and instructor, working on a 4kW bidirectional power converter.

POWERING UP
a New Lab

Multiple elements have aligned at Utah State University in the development of a new Utah Science Technology and Research — USTAR — lab in the field of power electronics. Leading the effort is Regan Zane, a USTAR professor in the College of Engineering's Department of Electrical and Computer Engineering. Zane, who arrived on campus July 1, 2012, is in the process of setting up his lab.

The focus of Zane's lab, simply named the Utah State Power Lab, is crystal clear. Zane and his colleagues propose a world-class research center on energy efficient power electronic systems with a primary emphasis on transportation electrification and dc distribution systems and buildings. That means more efficient hybrid vehicles, better and more efficient lighting systems in both residential and commercial settings and better two-way power transfer within systems that include mirco-grids and nano-grids at the building level. And in the season where the Olympic motto of "Faster, Higher, Stronger," has been in the public ear, Zane repeats his lab's credo often — "higher efficiency, power density and performance" — when discussing his research and the lab's goals.

"It is important that Utah institutions of higher education play an active role in order to stimulate continued growth in these areas by developing and supporting commercialization of new technologies, collaborating with local and international industry and training a new workforce," Dr. Zane said.

Those goals fit nicely into the objectives of the Utah Science Technology and Research initiative that was created by the Utah legislature to bolster Utah's high-tech economy by investing in university research programs while recruiting new, high caliber faculty.

Zane joins the faculty at USU from the University of Colorado, Boulder, where he was an award-winning teacher and researcher with an active lab. He brings two graduate students with him who will work with him to set up the USTAR lab while completing their doctorates through the Colorado school, as well as a visiting scholar from Spain. Among Zane's credentials is a 2004 National Science Foundation CAREER Award. Zane earned his doctorate at University of Colorado, Boulder in electrical engineering.

"Students need to understand and apply topics such as control systems, semiconductor devices, electromagnetics, energy conversion and embedded systems. When students are skilled in all these areas they can bring them together to solve the challenges of power electronic systems."

— Regan Zane

While Professor Zane brings a number of ongoing research projects with him, additional contract awards are forthcoming, including a $3 million grant from the U.S. Department of Energy to develop systems that reduce electric vehicle battery pack costs.

Zane's addition to the ECE department brings immediate academic impact. He, along with one of his graduate students, team teach a new course in fall 2012, Power Electronics for Electric Drive Vehicles, a course offered in collaboration with University of Colorado, Boulder. The course is also a prerequisite for Electric Vehicle Lab to be offered in spring 2013. Both courses draw from Zane's extensive experience and expertise.

Collaboration is important to Zane in the classroom and his lab, as well as with industry. His research focus on transportation electrification provides "a rich base of research challenges in electric energy topics" and couples with opportunities to collaborate with the Utah Transportation Center.

Plans to expand the program and lab include the addition of a second faculty member in the discipline area and the eventual involvement of up to 15 students at both the undergraduate and graduate levels with an emphasis on doctoral students.

"Students enjoy the multi-disciplinary nature of this field. It spans the core areas of electrical engineering," Zane said. "Students need to understand and apply topics such as control systems, semiconductor devices, electromagnetics, energy conversion and embedded systems. When students are skilled in all these areas they can bring them together to solve the challenges of power electronic systems."

In the delivery arena the energy grid is understood, and media-highlighted failures, including a recent incident in northern India, make news around the globe. Zane and his students focus on multiple areas in grid delivery, including the interface from the system to the load. The goal is to make the interface more intelligent and to communicate during the process. Conservative restraints on the design approach need to be eliminated, Zane said.

And back to the 'efficiency, density and performance' mantra, delivery systems need to weigh less and cost less while still covering delivery needs.

"Energy efficiency is critical to the future," Zane said. "We are building a power lab to focus on efficiency, performance and reliability for electronic systems of the future."

DICE Offers a Great Pay-Out for Engineering Students

"Yhatzee" and "Farkle," two CubeSats satellites, blasted into space on a Delta II rocket early in the morning of Oct. 28, 2011. The twins are a part of a National Science Foundation project that brought together a team of Utah State University students mentored by engineers from the university and its Space Dynamics Laboratory. Also on board was NASA's next Earth-observing research satellite dubbed NPP.

Christened the Dynamic Ionosphere Cubesat Experiment — that's DICE — Yhatzee and Farkle are the first and second small satellites to be launched into space by Utah State University.

During the October launch, NPP was placed into its polar orbit first, then the upper stage of the Delta II restarted and Yhatzee and Farkle were placed in different orbits. About the size of a loaf of bread, the two satellites measure 10x10x15 cm and weigh in at about 2 kg each. The DICE orbit ranges from 820 to 400 km, with one satellite chasing the other at 102° inclination. Both satellites are expected to remain in orbit for about 15 years and the goal is to get at least six months of scientific data from them.

An objective of DICE is to understand the mechanism that allows parts of the Earth's ionosphere to be lost in space during geomagnetic storms. Project advisors said DICE is in the perfect position to make these observations during its first year in orbit.

More than 20 graduate and undergraduate students from two USU departments — Electrical and Computer Engineering and Mechanical and Aerospace Engineering — worked on the DICE project that had its beginning in October 2009.

The impact on the USU students involved in the research and development of DICE has been immediate.

"Building DICE was more fun than I could have imagined any student could have," said Steven Burr, an ECE master's student and an electrical system lead on DICE. "I really learned how to be super detailed and how to do it right so that you know it works."

Preparation for the launch was difficult but not without rewards.

"The last couple of months were just crazy busy getting things tested, rebuilt and fixed," said Erik Stromberg an undergraduate ECE student. "But looking back, it was almost the best part of it all. It taught me a lot about being a team."

The National Science Foundation recently began supporting CubeSats for science and education, encouraging revolutionary new ways of doing science in space. CubeSats are small-form, fixed spacecraft that adhere to international standards and can catch a ride on most United States and international launch

Engineering students Erik Stromberg (left) and Crystal Frazier inspect a pair of satellites in preparation for launch.

DICE

Keith Bradford (left) and Josh Martineau remove the DICE instrument from its P-Pod before final testing.

"The last couple of months were just crazy busy getting things tested, rebuilt and fixed. It was almost the best part of it all. It taught me a lot about being a team."

—Erik Stromberg
undergraduate ECE student.

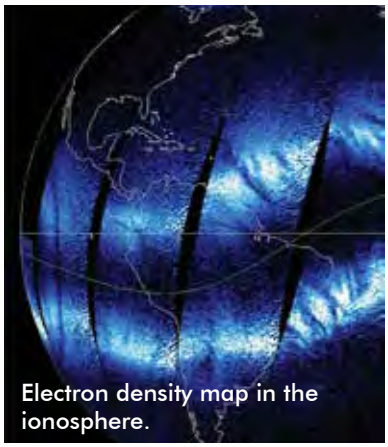
vehicles. DICE is only the second of NSF's CubeSat-based science missions for space weather and atmospheric research. Utah State University Space Dynamics Laboratory, in conjunction with ASTRA, a small business, was selected to conduct the mission. ASTRA president Geoff Crowley is principal investigator and ECE professor Charles Swenson is his deputy overseeing the development of the spacecraft and their science instruments. Chad Fish and Tim Nielsen at SDL formed the backbone of the project, providing day-to-day management and technical support for the student team. The team also included engineers at L3-Communications in Salt Lake City and additional faculty from USU, Embry-Riddle Aeronautical University and Clemson University.

NASA selected DICE for launch through its newly created Educational Launch of Nanosatellites program and provides tracking and communications with a 20-meter dish antenna from the Wallops Flight Facility off the coast of Virginia.

"Without the facilities and staff of the Space Dynamics Laboratory, something as revolutionary as these spacecraft could never have been accomplished," Professor Swenson said. "We brought together a great team for these students to be a part of with DICE."

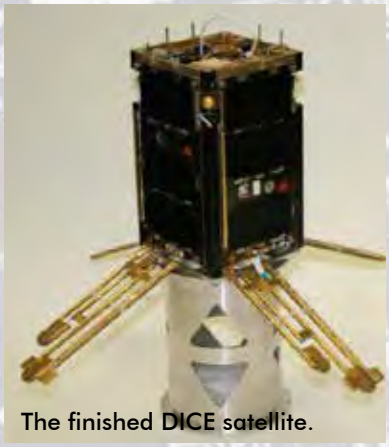
The project is an example of the hands-on approach to learning and research in USU's College of Engineering.

"Students at USU have played integral parts in the design and manufacturing of the DICE satellites and have received valuable hands-on experience they can take with them after graduation," said USU's H. Scott Hinton, dean of the College of Engineering. "Students need to have access to cutting edge projects to prepare them for the global market, and DICE has been a tremendous program to do that."



Electron density map in the ionosphere.

Research students doing system integration testing on DICE.



The finished DICE satellite.

Photos courtesy of Jacob Given, USU Research Foundation.

Department of Engineering Education

CEER AT LEADING EDGE OF ENGINEERING EDUCATION

The Department of Engineering Education, or EED, is tasked with teaching the fundamentals to pre-professional students and providing a relevant and sound learning experience. The department is also home to one of only three engineering education doctoral programs in the nation.

The newly launched Center for Engineering Education Research (CEER) helps faculty and doctoral students to continually develop pedagogical research and methods that will better serve students. The research conducted in CEER will have lasting effects in advising, teaching and learning experience for students that will better fulfill the department's mission — preparing pre-professional engineering students with the knowledge to be successful in their field.

Over the past eight years, the National Center for Engineering and Technology Education, or NCETE, has researched the needs of students studying engineering. NCETE, funded by the National Science Foundation, has been tasked with conducting research that improves the understanding of learning and teaching of engineering design at the high school level. However,

Engineering Education students explore the metacognitive relationship of dynamics.

"We're trying to understand the thinking and learning that goes on in an engineering student's mind so that we can modify the existing curriculum to better prepare for their needs."

—Kurt Becker

the NCETE has fulfilled its eight-year mission and closed August 31 of this year.

"We're evolving, taking a lot of the work [done in the NCETE], and expanding it into the Center for Engineering Education Research," said Kurt Becker, CEER director.

One example of the expanded research can be found in the grade band being researched. CEER will research engineering education from grades 6–20, where the NCETE had a narrow 9-12 grade band.

Understanding how students learn about engineering over this wide range of ages will develop more effective teaching of pre-college engineering, and thus better prepare students as they enter collegiate studies.

The research being executed in the CEER is extremely important for the profession of engineering. In recent years, there has been a slide in the number of engineers graduating from institutions in the United States (20 percent fewer graduates, to be exact). Coupled with the fact that more than half of the professional engineering work force in the United States is nearing retirement age, the need for developing ready trained engineering students is crucial.

Current research with metacognition is being conducted with current undergraduate students. Essentially, the research explores how the students learn to think about what they are learning. This work will better help retain students within the college and combat the national trend of fewer engineering graduates.

"We're trying to understand the thinking and learning that goes on in an engineering student's mind so that we can modify the existing curriculum to better prepare for their needs," Becker said.

Some of Becker's own research deals with the cognitive process of engineering design over a continuum of years. In these studies, high school students, college freshmen and seniors and expert professional engineers are all given the same engineering design problem. Through protocol analysis, the research is focused on what each group does in their thinking. The collected data is essential in shaping effective pedagogy that will transition those studying engineering from the start of the continuum to the end, as easily as possible.

Engineering education research is not isolated to the EED. In fact, the CEER supports cross-departmental collaboration with a goal of improving research and best practices of undergraduate engineering education. For example, faculty from the department of Mechanical and Aerospace Engineering are working with EED faculty to better understand the learning outcomes of the department's senior capstone design class.

CEER research is also benefitting from Utah State's nationally ranked College of Education. Becker explains that engineers tend to be drawn to more quantitative studies and that the collaborative efforts with the Emma Eccles Jones College of Education and Human Services are helping to capture both quantitative and qualitative data in the center's cognitive research.

"The center facilitates the interdisciplinary research across engineering programs that is necessary for the development of responsive engineering degree programs," said Becker. "Our research will better teach future engineering professionals who can rapidly adjust to the changing needs of the economies and technologies of Utah, the nation and the world."

A USU student observing and learning during a lecture. USU Engineering professor Oenardi Lawanto researches how people learn through his National Science CAREER award project "Cognitive Metacognitive Activities in Engineering Design Education."

THINKING ABOUT THINKING

Oenardi Lawanto's Enthusiasim for Research Wins NSF CAREER Award

Learning about how people learn doesn't sound like the typical topic for engineering research, however Dr. Oenardi Lawanto isn't a typical engineering professor. Lawanto was recently recognized by the National Science Foundation and was awarded a CAREER award for his project "Career: Cognitive Metacognitive Activities in Engineering Design Education."

"I love researching about things I've never learned before," said Lawanto. "That is the reason I get so excited about metacognition; these are new things! I've been researching for many years, but I still get excited."

Professor Lawanto's excitement about his research is genuine. His career is a crescendo of enthusiasm for learning. Much like a musical dynamic increase, his passion started softly. After teaching engineering at an Indonesian university for 15 years, Lawanto found himself getting bored.

"If it was boring for me, I can imagine it was even worse for the students," said Lawanto. "If I don't get excited in the classroom, how can I expect my students to get excited about engineering?"

Lawanto decided that he needed to improve. After being able to take part in multiple World Bank Institute workshops — workshops that lasted from a week to a full year — focused on improving teaching methods, his passion for learning about learning was ignited. This passion fueled his doctoral work at the University of Illinois at Urbana-Champaign in metacognition in engineering design. Now, anyone who speaks with Professor Lawanto about his work can feel his excitement.

Lawanto's research is targeted at helping students from multiple engineering disciplines to improve design skills through self-regulated thinking. For those not familiar with the term

NSF CAREER Award winner Oenardi Lawanto.

metacognition, which literally means being self-aware of how one processes thoughts and information, it could seem like a research vacuum, a lot of theory and not a lot of application. Lawanto's work however, is based soundly in theory and application.

"The CAREER award requires that you have a plan, not just doing research, but to also be able to translate the findings from your research into a practice," he said.

The funding from the NSF award will have a very real effect at Utah State. It will pay graduate and undergraduate students to participate in Lawanto's research and fund the senior capstone design projects.

Being part of a faculty program that is very unique (USU's EED program is one of only three in the nation), Lawanto is contacted frequently by researchers from all over the country and across multiple disciplines. However, Professor Lawanto modestly sheds the praises of being an expert.

"I don't consider myself an expert," said Lawanto. "I'm still learning. We are all still in the learning process."


V. Dean Adams

LONGTIME AGGIE NAMED

Associate Dean and Engineering Education Department Head

V. Dean Adams filled the position of associate dean in the College of Engineering after former Associate Dean Wynn Walker retired in July 2012.

Additionally, Adams holds the title of the Engineering Education Department Head. Having been a department head previously, USU's Engineering Education Department brings unique opportunities for Adams, as it is one of only three programs of its kind in the country.

Adams is a longtime Aggie, and his career has continually benefited from research. Receiving a bachelor's in chemistry at Idaho State, he studied as a doctoral student at Utah State, earning his doctorate in organic chemistry in 1972. After finishing his graduate studies, Adams continued his career as an Aggie, spending the next few years researching and teaching at Utah State University, USU Extension and the Utah Water Research Laboratory.

"I've had some great mentors, not only during my academic career, but after I finished my degree and started working with Joe Middlebrooks and Don Porcella," said Adams. "They were phenomenal writers and we wrote numerous proposals together. It was a wonderful experience."

Adams explains that he experienced a learning curve when he first started working in the Water Research Laboratory.

"I was learning a lot of new things, new terminology, because my degree was not in engineering," said Adams. "When I started working in the environmental engineering discipline my chemistry background was phenomenal. Being able to learn from Joe and Don and the several others we had on our team at that time was absolutely wonderful. We became very successful in obtaining research projects. We had lot of research opportunities and a lot of students."

Adams understands the important role mentorship plays in a student's research.

"I think it's important that you have good guidance," said Adams. "Your mentor can mean a lot in terms of assisting you along the way: little subtle ideas, direction. Then when the students really latch on to what is required they can really take off."

Guidance is critical to the research processes. Adams has tried to repay the positive guidance he received by moving that mentorship forward.

"I think I've been a mentor for about 70 master's and doctoral students," said Adams. "It's just wonderful seeing students grow and progress and do well. Many of my students are at academic institutions around the country. A lot of them work for consulting firms and some work for state and federal government."

Learning through research is a gradual process. For Adams, seeing that process positively affect a student is the reward of mentorship.

"Whenever you do research, you are delving into new things," said Adams. "It's really interesting to see a student grow. They start out with small steps, they gain some confidence and then they start to take off. It's wonderful to see that transformation take place. The nice thing about it too, is that they learn so much in the process, new things that they'd never anticipated or thought of."

In his self-described "very long career," Adams has had professional experience in teaching, research, service and administration. While the new position will be primarily an administrative role, he looks forward to still working with students.

"I will probably be doing some teaching (but not right away)," said Adams. "I'll be doing some research too, so I'm hoping to find a student or two who are interested in the kind of things that interest me, and we'll pursue some avenues together."

As associate dean, Adams is involved with undergraduate curriculum, advising and retention. He has goals to help students get through their programs in a more timely manner and with less stress.

The College of Engineering is extremely fortunate to pull from Associate Dean Adams' knowledge and guidance. He understands that life itself has a learning curve, and he encourages students, faculty and staff to continue learning.

"Some things you try and they work, and some things you try and they don't work," said Adams. "What's important is to make sure that you are continually learning from what works and what doesn't."

USU Mechanical and Aerospace Engineering graduate student Colby Jensen looks into an atomic force microscope. The microscope helps TMP researchers map thermal property profiles in irradiated materials.

Research is Power for USU Center Studying

Thermohydraulics and Materials Properties Research Center Looks to the Future of Energy

NUCLEAR ENERGY

As the world continues its quest to find a sustainable, clean and safe energy source, USU Mechanical Engineering Department (MAE) researchers are doing their part with the creation of the newly formed Thermohydraulics and Materials Properties Research Center (TMP) that will focus on nuclear engineering research.

And while nuclear energy may have had its setback in recent times, specifically with the meltdown of Tokyo's Electric Power Company's Fukushima nuclear plant after an earthquake and tsumani in spring 2011, the Nuclear Energy Agency and the International Atomic Energy Agency predicted in July 2012 that world nuclear electricity generating capacity is expected to increase 99 percent by the year 2035.

With that growth in mind, researchers at the center are working on basic and applied research to enhance the safety and efficiency of nuclear energy, raising USU's visibility, credibility and reputation in the nuclear engineering field to secure the university's long-term position as a competitive contributor in nuclear engineering research.

Heng Ban, MAE associate professor and director of the center, said the creation of the center will help solidify USU's reputation as one the country's leading experts on the thermohyrdaulics and material property side of nuclear engineering research.

The center has established itself in two primary areas of nuclear engineering research: mechanical and thermal properties in nuclear systems, and validation

of thermalhydraulic models used for advanced nuclear power generation and safety analysis

Nuclear power is an appealing option as an energy source because it generates the least amount of carbon dioxide, even less than solar, Ban said.

"We need a balanced portfolio to meet the world's energy needs," Ban said. "And we have not yet created a solution for a sustainable energy supply."

Most of the world's energy currently comes from fossil fuels, while renewable energies, including solar, biofuels and wind, make up a very small percentage.

And while fossil fuels provide a baseload form of energy, the resources are not infinite and the renewable energies do not provide a stable form of energy, for instance, fluctuating during day and night for solar, Ban said.

Nuclear power does provide a stable source of energy and it is cheap in terms of electricity generation, he continued. That is why developing countries such as India and China are building an increasing number of nuclear power plants to meet the electricity demand.

And while nuclear reactors continue to become more appealing, the safety of old and new power plants, as well as waste storage and disposal become key issues to be addressed through research and technology development, said Barton Smith, MAE associate professor and co-director of the center.

"That is where we, as mechanical engineers, come in, to provide the fundamental knowledge and technologies for the design of materials and systems that will enhance the safety and prolong the life of the power plant," Smith continued.

TMP researchers exhibit strength in several nuclear engineering areas and supported nuclear research in the department totals more than $5 million, which include research and development, faculty development, student scholarships and fellowships and facility support. Researchers are engaged in funded research on nuclear fuels, thermophysical property and instrumentation, thermo-hydraulics, high-temperature materials, turbulence modeling, welding, efficient high-fidelity modeling of thermo-mechanical properties of nuclear materials and structures and other nuclear-related topics.

The center has close collaborations and partnerships with nuclear industry and other education partners. The center is already working with Idaho National Laboratory on many research projects including reactor safety analysis and will continue to collaborate on an increased number of projects in the future. MAE researchers are also actively working with the U.S. Department of Energy's Nuclear Engineering University Programs and the Nuclear Regulatory Commission's research and education programs.

"There is a need to further establish and expand USU's core research capability and expertise to meet research and education demand in nuclear energy," Ban said. "This will reinforce USU's position as a research partner and workforce incubator for the industry."

The center's prominence also allows the MAE department to attract top-tier graduate students who will positively impact MAE's graduate enrollment. As the visibility of the research conducted by the center continues to grow, more MAE undergraduate students will also likely enroll in its graduate program. The research will also further strengthen MAE researchers' credibility as they compete for proposals and external funding.

"The research we are conducting is a crucial part of our graduate and undergraduate education," Ban said. "The basic mechanical engineering principals we teach in classrooms are intended for students to apply them to any field they wish to pursue and will allow them greater success as they further their research interests."

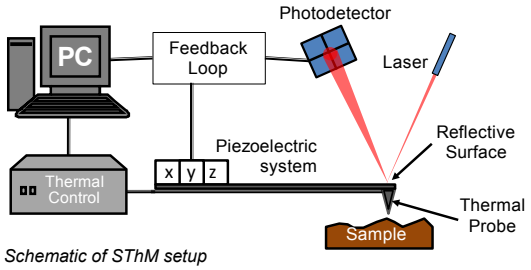
So while the USU MAE department doesn't have a specific nuclear engineering program, it is counting on its expertise and prominence in the field of nuclear engineering research, along with the founding of the Thermohydraulics and Material Properties Research Center, to allow USU to become known as one of the world's experts on the subject.

"Nuclear power is a priority at the national and international level," Ban said. "And we intend to play a big part in its success."

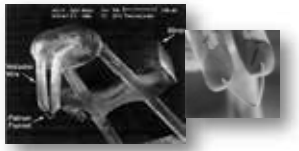
Thermal Microscopy (SThM) Setup

TA Instruments μTA 2990 Micro-Thermal Analyzer (AFM-based SThM)

- DC constant temperature mode - probe current ∝ $k \cdot r_c$
- Measurement spatial resolution ~ tip size (< 1 μm)

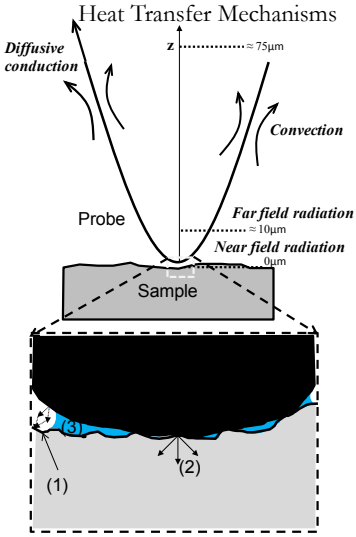


Schematic of SThM setup



SEM images of Wollaston wire thermal probe

Tip-Sample Heat Transfer Mechanisms



1) *Ballistic conduction*
2) *Solid-solid conduction*
3) *Conduction through water meniscus*

Scanning Thermal Microscopy (SThM) uses a temperature-sensing probe mounted on an Atomic Force Microscope to measure thermal phenomena at length scales smaller than can be seen with optical microscopes.

A member of USU's Army ROTC uses the Aggie Ascender created by MAE students. The device uses three components — a vacuum ascender, an adhesive anchor and a rope ascender — to assist a person with climbing a wall.

Members of USU's Chimaera Rocket Team show USU alum and former astronaut Mary Cleave their rocket design that took first place at NASA's 2012 University Student Launch Initiative.

MAE Students at the Top in Two National Competitions First-Place Wins Earn Accolades

Mechanical and aerospace engineering students earned first place in not one, but two, prestigious national competitions, the Air Force Research Laboratory's Design Challenge and 2012 University Student Launch Initiative.

Mechanical and Aerospace Engineering Welcomes Three New Faculty

Aaron Katz

Research Areas: Thermal fluid dynamics, computational fluid dynamics

Dr. Katz is an assistant professor whose interests focus on teaching computational fluid dynamics through hands-on coursework and in-depth research activities. Among his continuing research interests is developing cutting-edge computational algorithms and methods to solve problems of interest in national security and other emerging areas.

Dr. Katz earned a doctorate in aeronautics and astronautics from Stanford University in 2009, a master's in aeronautics and astronautics from Stanford University in 2005 and a bachelor's from USU in mechanical and aerospace engineering in 2004.

AFRL's Design Challenge 2012

MAE students pulled out their best superhero tricks, using engineering principals, some basic math and a lot of ingenuity, to design a system for special operations forces personnel to scale buildings or mountain faces under a variety of conditions. The students' efforts garnered the group first place in the AFRL's Design Challenge.

Using three components — a vacuum ascender, an adhesive anchor and a rope ascender — the USU team took its design to the National Center for Medical Readiness training facility in April 2012 to compete against 16 universities that included Arizona State, Johns Hopkins and Brigham Young University for the top honor.

In August 2011 teams were given the warfighter-focused engineering design challenge, $20,000 for materials and fabrication and nine months to come up with a demonstrable solution. Teams were judged on both objective measures (weight, size, velocity achieved) and subjective measures (ease of operation, usability, stealth, innovation and elegance).

The team ended up with a design that allows a person to put their hands and feet into a spider like vacuum contraption allowing them to climb a wall. After reaching the top of the wall, the climber then places adhesive anchors on the top of the structure before sending down a rope strong enough to hold 300 pounds with which the other team members are able to ascend the wall.

NASA'S 2012 University Student Launch Initiative

Making the first-place title official, NASA awarded USU's student team the top prize during the 2012 University Student Launch Initiative.

USU's Chimaera Rocket Team bested more than 500 students, representing 41 colleges and universities in 28 states, when the team launched its rocket and payload at Bragg Farms in Toney, Alabama This year's victory marks the fourth first place entry by USU in the previous five years. The USU-built rocket was also recognized by the NASA peer review panel as the best overall vehicle design.

The USU student design deployed an inertial navigation and closed-loop energy management system to target the one-mile altitude. The team goal was to come to within 12 inches of the target altitude. Weighing in at approximately 30 pounds and measuring eight feet, USU's rocket came within two percent of the target altitude and was sufficient to allow USU to win the overall competition.

Ling Liu

Research Areas: High-performance multi-scale modeling and design of advanced materials

Dr. Ling Liu is an assistant professor whose research interests include high-performance multi-scale computation with applications to biological macromolecules, engineering composites and nuclear systems. This includes simulation and design of advanced materials for energy and environmental applications as well as fatigue and crack simulation of advanced engineering composites and structures.

Dr. Liu received a doctorate in mechanics of nanomaterials from Columbia University in 2010, and a master's in 2006 and a bachelor's in 2003, both in engineering mechanics from Dalian University of Technology in China.

Jason Quinn

Research Areas: Microalgae to biofuels assessment and microalgae growth modeling

Dr. Jason Quinn is an assistant professor whose research interests include microalgae to biofuels assessment, microalgae growth modeling, life cycle assessment, photosynthetic characterization of microalgae and high-temperature plasmas.

Dr. Quinn earned a doctorate in mechanical engineering from Colorado State University in 2011, a master's in nuclear engineering and engineering physics from the University of Wisconsin Madison in 2004 and a bachelor's in mechanical engineering from Colorado State University in 2002.

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