Excellence in Teaching and Learning

Scan a laundry list of the regional and national competitions in which College of Engineering students participated this year, and the page looks like a thesaurus for words about “winners:” gold medals, first places, top honors, took nationals, received the highest awards, etc. And to top off even that summary, in many cases that list often includes the word “again,” meaning USU’s College of Engineering students have continued their track record of top placings across the nation whenever they compete.

College Dean Scott Hinton certainly beams as he ticks off the student wins for the year. He is proud, yes, but is he surprised? Not even one bit. The college takes an aggressive and multi-faceted approach to teaching its students to win. And they do. Against the best in the nation — against Harvard, MIT, Stanford, Vanderbilt, Berkeley and any other takers. Against the “best,” who, when pitted against USU’s student teams, actually come to learn they often are only “second best.”

Hinton said these competitions are just one part of a larger effort in the college to focus its curriculum and the overall student experience on concerted excellence in teaching and learning that will prepare its students to face the real world of engineering at graduation. According to the dean and to the college’s teaching and learning model, this “real world of engineering” is a constantly changing technological dynamic in which engineers, in addition to studying traditional subjects always taught in engineering schools, also have to know how to keep learning if they want to excel.

“In today’s world, technology is changing so fast that by the time a freshman receives a bachelor’s degree, they’ve seen at least two generations of computers,” Hinton said. “The field of engineering changes fast and dramatically, so while they’re here, we help them ‘learn to learn’ because once they’re working, they have to know how to keep up the fast pace of change on their own.”

It is not just these “team competitions” that define the college’s attitude about excellence in teaching and learning. The theme is threaded across the curriculum, across departments, across the extra-curricular activities offered — and cultivated — by the college. So the college invites student participation in competitions, the elite professional organizations, undergraduate research publications, national scholarship competitions, student entrepreneurial efforts — anything to get students active in what is now for them the world of learning and what will become for them upon graduation the practical world of engineering.

Hinton said this “learning to learn” theme also is predicated on the equally important theme of “learning to teach,” a domain in which USU’s College of Engineering is one of the nation’s leaders. In fact, the college has one of only three Ph.D. programs in Engineering Education in the nation, along with Purdue and Virginia Tech, with others beginning to follow suit. And the college has focused enormous efforts training faculty to excel at teaching and to understand both how students learn and what they know when they walk into a classroom.

Senior Annika Jensen said her engineering professors vary the in-class media, vary the lecture style, vary the demands of the classroom and the after-classroom expectations of their students. Visual aids might be computer-based models, or they might be the greasy-grimy — in other words, the actual — refrigerator cooling system or heat exchanger that’s on the design block at company headquarters in real-world USA.

“We can draw diagrams or memorize equations, but when the ‘problem’ is really right in front of you, it becomes real and you begin to care a lot more — and to see a lot more,” she said.

Jensen is a senior in Mechanical and Aerospace Engineering. She was on the first-place Rocket Team, serving on the recovery systems team, as outreach coordinator and as a documentation specialist. She said she thinks these out-of-class experiences — experiences that are the norm in the college — have pre-
“The field of engineering changes fast and dramatically, so while they’re here, we help them ‘learn to learn’ because once they’re working, they have to know how to keep up the fast pace of change on their own.”

— Scott Hinton, Dean

pared her for the job world that comes up for her in December at graduation. On the Rocket Team, students worked in teams, wrote the proposal, wrote design reviews, proposed their rocket idea to NASA, actually presented to NASA, and got accepted. Then they designed the rocket, built it, launched it, wrote analysis based on its performance. And, by the way, won the national competition. Again.

“That’s how it works in real life,” she said.

Including the “winning” part, Hinton said. Competitions themselves and the process of competing build character, sure. But winners get the jobs. In the free-market world these students will enter at graduation, Hinton said, there are two types of people: winners … and the people looking for another contract, or another job. “An engineer’s life is one of competition, and they play to win. These students are learning right now to be the very best in their fields.”

In the entrepreneurial world of
“Engineering, they have to do it right the first time: no late assignments, no do-overs, no extra credit. “These interactive projects and competitions teach them to understand exactly what is expected of them the first time,” he said. “In engineering, the details matter and they can matter in dramatic ways, whether you’re building a plane, a rocket motor, a bridge or a road. There is no room for second place, no room for mistakes the first time.”

The college’s entire philosophy of teaching and learning has become refined in an effort to make it a model of excellence.

Chris Hailey, associate dean in the college, said the college has, in her words, “hung out with the ‘education’ experts” in conversations about how students learn, including long discussions about how to keep them involved in their own education — a concept that drives the basic design of hands-on and interactive learning in the college.

The college also recognized that to keep student retention numbers high in an extremely tough curriculum, it had to put its best teachers in front of students in the earliest classes. So now the very best teachers teach those foundation classes that can be some of the most difficult: statics, thermodynamics, circuits, dynamics, etc.

“These classes are the first rungs of scaffold students are going to climb,” she said. “We have the best chance of retaining them if our very best teachers are helping them stay on the right ladder.”

Hailey also said the exceptional research strength of the college plays well to its strength in teaching and learning. Although maybe not obvious at first glance, the college’s best researchers often are the ones who are most adept at teaching also. Researchers, by design and focus, are constantly striving to seek new knowledge themselves, so their interactions with students in the classroom and in extracurricular projects are almost a basic lesson on how to generate and share new information.

“They live at the cutting edge of new knowledge and — as important — the application of that new knowledge, so the combination of great research and great teaching arrives at a very logical end,” Hailey said.

She also name-drops some of the college’s most productive researchers and suggests that they, too, are some of the college’s best teachers: Reyhan Baktur, Ron Sims, David Britt, Bart Smith and, of course, Laurie McNell, who was named the 2010 Utah Carnegie Professor of the Year for her teaching excellence.

“Their research and teaching go hand-in-hand, and it is a cornerstone of our college’s strength to have both in play.”
We are grateful for the support we receive from our alumni and friends, including those who support us through their corporations and foundations.

The future looks bright and our hope for the future is in the hands of those we educate and prepare to take on the responsibilities of creating tomorrow today.

The comprehensive campaign for Utah State University and the College of Engineering has been enormously successful in several areas to this point, but the campaign is coming to an end in the coming year with a marshaled focus on two remaining critical priorities — endowed scholarships and endowed professorships and chairs.

The endowment is our scholarship pool, the funds from which we provide opportunities for our brightest and most in-need students and their professors. The
As other economically hard-hit states are “disinvesting” in education, we are ready to capitalize.

Competitive market profile in higher education right now makes the time right to invest in even more high-quality students and more top-notch professors — and in ourselves for the long term. As other economically hard-hit states are “disinvesting” in education, we are ready to capitalize. First-rate students are waiting in long lines for scholarships at other financially troubled institutions, and outstanding professors are looking for a vibrant place that will reward their exceptional records.

The campaign has helped us build infrastructural foundations with new buildings across campus, including our own cutting-edge David Sant Engineering Building and the main Engineering building itself. Upon that foundation we’ve layered enriching new programs, including donor-funded projects and facilities at the Utah Water Research Laboratory — in Hydraulics and Environmental Quality — and in the new USTAR Innovation Campus building. Now it is time to directly impact the true lifeblood of this place: our students and their teachers.

Thank you for your help in assisting to educate and prepare the engineers of the future. We also welcome those who are interested in talking about the possibility of making a commitment to USU in the form of an estate gift to please contact me and we can discuss this option and how it may work for you and your estate planning.

I would like to invite you to visit Utah State University, to tour the campus, view the first-rate facilities and observe progress being made for the future. Please contact me with any questions about the College of Engineering, and let me know if I can help you in any way.

Sincerely,

Val Potter
Executive Director of Development
val.potter@usu.edu
435-797-8012

SCHOLARSHIPS = ACCESS

- Scholarships support exceptional students (meet engineering student Amanda Johnson in accompanying story).
- Undergraduate research fellowships: aid students presenting projects at national/international conferences.
- Endowed scholarships honor both the donors and the recipients. Recognize a spouse, a family member or your own life-changing educational experience.
- 70 percent of USU students work to fund their own education. Your support helps motivated students focus on learning.

PROFESSORSHIPS = IMPACT

- Professorships raise the bar, become watershed moments for departments. (See highlight on Professor Chris Winstead, one of the college’s “next-generation” of superstars.)
- Provide incomparable experiences for students to interact with renowned leaders.
Who are our Professors?

DR. CHRIS WINSTEAD
Electrical and Computer Engineering

Thanks to Dr. Chris Winstead, wireless networks may soon be used to cure blindness and other neural injuries. Professor Winstead was recipient this year of one of the National Science Foundation’s most prestigious awards — the early CAREER development award. These CAREER awards are given only to a select few researchers in the nation each year — the scientists who the NSF believes will become the research leaders who will make the groundbreaking discoveries of the next century.

Using low-energy electronics for bio-implantable devices, Winstead is working to create artificial communication networks that can bypass damaged neural circuits in the body. His research would allow an implanted network to be inserted in the body and directly stimulate the brain’s visual cortex. The network would transmit neural signals across the injury site at a very low power, similar to a pacemaker. Winstead is working to make this technology robust against outside stimuli, such as metal detectors and cell phone towers, while keeping it very low power, minimizing excess heat against body tissue.

“The primary goal is to bring us one step closer to curing blindness through direct-brain stimulation. In the near term, however, this research may prove beneficial for other application areas, like low-energy communication circuits, which are useful for a variety of sensor-network applications, including medical and veterinary uses.”

Who are our Scholarship Recipients?

AMANDA JOHNSON
Mechanical and Aerospace Engineering

The College of Engineering is conditioned to seeing student “overachievers.” It gets cream-of-the-crop students who excel in and out of the classroom — at many levels — but it would be tough to top senior Amanda Johnson’s résumé.

- President of Tau Beta Pi chapter (the Engineering Honor Society, open by invitation only)
- 3.78 GPA
- Recipient: highly competitive Rio Tinto Scholarship
- College of Engineering ambassador (the shining examples of the best of the best)
- Society of Women Engineers, American Institute of Aeronautics and Astronautics, American Society of Civil Engineers
- Rock climber, pianist, violinist, skier, baker … Baker? (Yes, even her banana bread is first in its class)

Amanda, a Mechanical and Aerospace Engineering major, even joined Civil Engineering’s Concrete Canoe Team, because, oh, in her “spare time” she thought it sounded like a fun activity. Fun, of course, meant an everyday-Saturday time commitment, a lot of hard extracurricular work — and a trip to nationals!

“Academics has always been my No. 1 priority, but I like to push myself in other things too,” she says, voicing perhaps one of the understatements of all time.

And for relaxation? She is working with the LDS Institute of Religion Women’s Association, this year on a service project to provide kits for women putting babies up for adoption.

“I like to keep busy, be involved in things that keep me from going insane at school.”

Chris Winstead: Bypassing damaged neural circuits

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“I like to keep busy, be involved in things that keep me from going insane at school.”
Like many people, Alexa Lunt didn’t know biological engineering existed. So working as a paid research assistant for the department was the last thing she expected to do the summer after high school graduation.

And finding a great student job is hard enough when you’re a student on campus, so how did someone who hasn’t even started yet land such a great gig?

It’s just part of what the Biological Engineering Department is. Ever since it came to be in the ’90s, the department has focused on getting students involved with research projects as early as possible.

“Engineering is a hands-on discipline,” said Department Head Ron Sims. “Our courses give the message that we expect students to work hard, be dedicated to their studies, and become engaged in the program, so we give them opportunities to get involved in projects that give context to their classroom studies.”

But before students even step foot on campus in August, many attend the university’s Engineering State program where high school juniors are introduced to the College of Engineering and participate in classes, projects, tour facilities, and more.

This is how Lunt found out about biological engineering. She was a science fair champion and even competed in international science fairs. Her passion was environmental science, so she had thought about majoring in biology, but when she heard about Engineering State, she decided to explore her options.

Lunt learned that the Biological Engineering Department had a strong environmental component, with a multi-faceted project at the Logan City sewage treatment plant. She had already interned at the...
Davey County sewage treatment plant, so she was a perfect fit to work with Ph.D. student Maureen Kesaano, whose research focuses on using algal biofilms to clean wastewater through bioremediation.

“I can’t believe I got this opportunity right away!” Lunt said. “I thought I wouldn’t get a chance like this until I had been in school for a few years, and I haven’t even started yet.”

Her new friend, Katie Glaittli, had a similar experience.

Glaittli just finished her freshman year in the program and has been showing Lunt the ropes. Glaittli said engineering chose her; her parents are engineers, her grandparents are engineers, and she tried to fight her inevitable tie to the field by exploring teaching and music. But she finally gave in, and she doesn’t regret it.

After Engineering State, Glaittli participated in the department’s three-day summer camp, Discover Biological Engineering. And, like Lunt, Glaittli started working for a graduate student, Ashton Young, before she was even a freshman. “It’s a small department — it’s like they hug you and don’t let go,” she said. And that’s the key. It’s a small department.

Class sizes range from just 15-20 students, providing an atmosphere that allows for group discussions and team problem solving. In this traditional and effective setting, students get to know their professors well. Glaittli said the key to passing the introductory (and infamous) course, BENG 1880, was working in a study group that strategically met in the study lounge just outside the professors’ offices. “That way, whenever we got stuck, we had easy access to Dr. (Timothy) Taylor for help.”

The department may be small, but it is growing…and has been growing. The number of tenured faculty has more than doubled over the last eight years, and so has the number of students.

The key is growing proportionally. Sims aims to keep the teacher-to-student ratio near 1:25.

This growth resulted as a combination of support from USU administration and from alums and students working together as ambassadors for the program.

It is not uncommon for undergraduates in the program to publish journal articles with faculty, present at national conferences, and win awards. So when these students graduate, they are well prepared to move into graduate or professional programs or begin a career. As these students move on, it builds the reputation of USU’s program and opens up employment, internship, and partnership opportunities for current students and the department. “It’s a cycle of students building jobs for future students,” Sims said.

These connections are already apparent. Five graduates work at Thermo Fisher in Logan and several are interns. WeStech in Salt Lake City employs six graduates and frequently contacts the department looking for interns, five of IMDS’s (Logan) employees came from the department, and the list goes on.

So, when Lunt starts school this fall, she’ll be the next step in the cycle.
This rotating algae photobioreactor is the only one that grows algae and harvests it in the same reactor. It was developed at the pilot facility by graduate student Logan Christie and Department Head Ron Sims. A patent application has been filed.

1-2-3 Go!
From test tubes to fueling trucks: By spring 2012, Logan City’s fleet of trucks will be fueled by biodiesel created from algae

Successful research projects typically progress through three stages: 1) lab scale, 2) pilot scale, and 3) full scale. It can be a time-consuming process, but for many engineers, getting to Stage 3 is what keeps them going.

Dr. Foster Agblevor, one of the department’s newest professors, with a track record for taking research full scale (he has 15 patents), says “it’s not enough to keep it in a test tube; it’s exciting to see things implemented.”

One of the department’s most well-known projects is about to reach Stage 3: the algae biofuels project at the Logan Lagoons (Cache Valley’s wastewater treatment facility).

The problem was that phosphorus levels in the water were too high for the new federal and state standards, and the city risked not meeting environmental regulatory requirements.

When faculty from the department got involved, they focused on using the naturally occurring algae, which use phosphorus as a nutrient for growth, to treat the wastewater and at the same time looked at how to harvest enough algae so it could be used to produce other valuable byproducts.

And so began the process:
1. Discovery: This phase began just two years ago, and researchers proved that bioplastics, biodiesel, and industrial solvents could be produced while cleaning wastewater. As always, students were a part of this process. About 20 undergraduate and graduate students

Similar projects exist at other universities, but USU’s is the largest in the country and can serve as a model for other large lagoon systems for municipalities, as well as industries, such as food processing and mining plants.

BIOLOGICAL ENGINEERING DEPARTMENT PROFILE

- Biomedical engineering, a focus area within the department, is the fastest growing career field through 2020 (U.S. Bureau of Labor Statistics).
- Students in the department make up just 1 percent of the USU student population but took nearly 30 percent of the Undergraduate Research and Creative Opportunity grant money in 2010.
- This is one of only three programs in the country with courses in the new field of synthetic biological engineering.
- Department Head Ron Sims was elected president of the Institute of Biological Engineering, the country’s leading professional organization in the field — he will serve throughout 2012.

Access Video
What is Biological Engineering?

Since biological engineering has only been around for about 20 years, it’s not surprising many people are unaware of the discipline. For this reason, the department is involved with outreach programs focused on bringing awareness to the field.

Outreach Programs

- **High school teacher workshops** — Last year, the department hosted nearly 30 high school science teachers for a full-day workshop where they learned how to help their students learn about this up-and-coming field.
- **Discover Biological Engineering** — Since 2009, the department has offered a free, three-day summer camp for high school students. Participants tour labs, look through microscopes, and learn about current research projects.
- **Elementary and middle school field trips** — Students tour the college and then stop by the department to play with models of microbes and learn about the algae project from graduate students.
- **Uniondale students** — This year, six high school students from New York came for a summer internship. At the conclusion of their stay, they presented their research posters and will enter their projects in future Intel and Siemens Westinghouse national competitions.

Growing Discipline; Growing Department

The BE Department welcomes two new professors

New to the department this year are Drs. Foster Agblevor and Yue Cui. Agblevor was hired as a USTAR* professor and his research takes the concept of recycling to a new level. During his previous tenure at Virginia Tech, he invented a pyrolysis reactor that essentially creates gas (in the form of bio-crude oil, bio-diesel, or bio-gasoline) from things like saw dust, waste grease from restaurants, grass, and more.

“It’s only waste when you don’t know what to do with it,” he said. “It’s our job to figure out how to add value to so-called waste.”

Originally from Ghana, Africa, Agblevor grew up on a farm. From a young age, he came to appreciate how flawlessly elements of nature work together without producing pollution or other harmful byproducts. He also grew to understand how dependent the agricultural industry is on oil. “Creating gas from waste reduces harmful pollutants and gives us more control of gas prices,” he said.

He is excited to join USU because he feels that the vision and enthusiasm at USU is a perfect match for his own dreams regarding creating valuable products from waste.

Cui joins USU after a two-year postdoctoral position at Princeton University. Her research focuses on bionanotechnology with application in medical diagnosis, defense, environmental monitoring, and energy storage. She’s developing a noninvasive biomimetic nanoelectronic device in microfluidic channel, which scans a person’s health using a small amount of saliva, and even helps detect multiple diseases before symptoms are manifested.

She’s been at USU for less than a year and already has seven students working in her lab and teaches classes on bio-inspired nanotechnology and microfluids.

“Teaching is one of the best ways I can contribute to society,” she said. “By helping students better understand science and engineering and how to solve problems, we will be in good hands as these students take our world into the future.”

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*The Utah Science Technology and Research initiative (USTAR) is a long-term, state-funded investment to strengthen Utah’s “knowledge economy” and generate high-paying jobs.*
The trailer and two outdoor canopies in the middle of a Cache Valley field with people rushing about is not a three-ring circus, but it sort of feels like one. There are plenty of aerial acrobatics and no shortage of feats of skill and daring. Behind the magic are engineering students and faculty from Utah State University. They are the researchers, developers, navigators and pilots of what is affectionately called the AggieAir Flying Circus.

The circus is really a fleet of three unmanned aerial vehicles more simply called UAVs. These eagle-eye aircraft provide a big-picture view minus the expense and limitations of satellite imagery. They are, like their namesake, nimble as the World War I German “Flying Circus” fighter squadron led by the Red Baron, Manfred von Richthofen.

What started the circus was a need to inexpensively gather and measure high resolution images over wide expanses and over an extended period of time, says Mac McKee, director of USU’s Utah Water Research Laboratory and professor in the College of Engineering’s Civil and Environmental Engineering Department.

The ability to monitor and gauge is at the core of any sound research. It is the commonality that flows through the Water Lab. “If you don’t measure it, you can’t manage it,” McKee is fond of saying. “If you want to manage it, you’ve got to know where it is and its quantities and qualities.”

It’s a benchmarking frequency, agility and prudence that satellites and conventional airplanes cannot provide. Much of the satellite imagery and short-term
forecasts from the National Oceanic and Atmospheric Administration (NOAA) only provide data at spatial resolutions of 1 km (3,281 feet) by 1 km, and that’s still too broad. “I could fit a lot of farms down inside a pixel. That kind of satellite data does not give me the spatial resolutions I need to say something about water management on the ground except at a very, very gross scale and that’s not the scale we are interested in.”

Well then, how about 10 inches by 10 inches available whenever you want? Now he’s interested.

To obtain this incredibly narrow scale is why the Flying Circus was created.

First came Raven, then Spitfire and then Mustang. Crucial to this fleet is its ability to take off and land without a runway. The eight-pound aircraft are slingshot into the air with a bungee and land by gliding to a swishing skid. Take them up to 3,281 feet and they are specks in the sky with their 72-inch wingspans. But oh how they love to circle and sweep while hanging in the air for up to 60 minutes at a time. With the two onboard digital cameras shooting every four seconds, one recording imagery in the visual spectrum of red, green and blue and the other to record near-infrared, a large amount of solid, specialized data can be collected.

Engineers and water resource managers appreciate the versatility of these flying robots that help them to make sense of changing landscapes through meticulous low-altitude, high-resolution recording of terrain facts and stats fast and cheap. The sophisticated airstrike capability of AggieAir is a culmination of scientific progress that has been decades in the making, and just in time to take on the mighty Phragmites, a scrappy aquatic plant with a frightening ability to reproduce through both seeds and rhizomes, displacing native aquatic species.

USU has been battling the plant in full force at the Bear River Migratory Bird Refuge where AggieAir is flying over Phragmites patches of 12-square miles each and capturing images with a resolution less than 12 inches. You can almost see individual plants. But none of that is of value if they can’t train their intelligent algorithms to actually see Phragmites in the high-resolution images at a pixel level. That’s the deal stopper. The flying of the craft is trivial if it brings back imagery that can’t see Phragmites. So how’s that working out?

“Well, I’m happy to report that the answer is yes; at 95-percent accuracy,” McKee says. That’s phenomenal precision and 10 to 15 percent better than anybody else in the world has done. That’s a big deal. And best of all, it’s the Water Lab’s algorithms. They are not even commercially available yet.

“Now where it gets goose pimply is this: we are now looking in our imagery to see if we can tell from our spectral bands if we can correlate what we are seeing there with what they are seeing from the project’s DNA sampling.”

McKee says if researchers can get that correlation, then they will be able to see from nearly 3,300 feet up these tiny DNA samplings. While the samples represent a huge amount of DNA work, they only cover very small dots on the ground — a small, much less than a hundredth of a percent fraction of the total area that Water Lab engineers can see with their aircraft.

McKee says they have funding through another year for the Phragmites research. If they can turn the corner at the Bear River Bird Refuge — and refuge officials are excited about the probabilities — then the actual application potential across the United States is enormous. Indeed, if this was a circus act, it’s akin to a high dive from a thousand feet above the ring into a tiny pool below. Step right up, ladies and gentlemen, and see The Incredible AggieAir Flying Circus.
Making Water Pollution Pay

The idea of using an economic incentive to bring about environmental change is not new. You need only look as far as Cap and Trade to see this in action. Applying the concept to water, however, is rather novel.

So innovative, in fact, that the Utah Water Research Laboratory at Utah State University doesn’t even have a name for the trade-sell system that it’s developed, let alone a client to use it. But when you look at the challenges that pollutants in water pose for taxpayers across the country, you can’t help but see that what the Water Lab is offering holds tremendous promise.

USU Still Flying High

The retiring of the space shuttle, with its strong ties to Utah State University’s College of Engineering, is a university legacy its students continue to honor, most recently this past summer when they took home the gold out of a field of 24 schools participating in the ninth annual Student Unmanned Air Systems Competition at Lexington Park, Md.

USU is the first repeat winner of the competition, having won the aerial contest for the first time in 2009. In addition, the USU rotary team won ninth place in its first-ever appearance in the national competition.

“We did pretty darn well,” said Calvin Coopmans, the team’s graduate advisor, doctoral student and CSOIS graduate assistant. “We cleaned house.”

The house cleaning included a near sweep of the categories with the fixed-wing team taking first place in Flight Mission, Journal Paper and Oral Presentation (flight readiness review). Not only did they beat out the likes of North Carolina and the U.S. Air Force Academy, they also earned an invitation a week later to present at a prestigious symposium hosted by the Johns Hopkins University Applied Physics Laboratory.

And stay tuned for what’s to come. It was a young team of six students on the fixed-wing unit and four on the rotary team that Coopmans took with him this year; next year they’ll be seasoned competitors.

Sounding like a coach with a card up his sleeve, Coopmans said he plans to change the fixed wing system in a surprising way. “I won’t say exactly what we will be changing, but next year things are going to be drastically different.”

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So innovative, in fact, that the Utah Water Research Laboratory at Utah State University doesn’t even have a name for the trade-sell system that it’s developed, let alone a client to use it. But when you look at the challenges that pollutants in water pose for taxpayers across the country, you can’t help but see that what the Water Lab is offering holds tremendous promise.

WATER LAB DEPARTMENT PROFILE

• The Utah Water Research Laboratory began in 1959. Dean F. Peterson, former dean of the College of Engineering, paved the way for the creation of an irrigation hydraulics laboratory that eventually led to the Utah Legislature approving and funding the Utah Water Research Laboratory.

• The Water Lab is best known for hydraulics modeling, computer modeling of hydrologic systems, hazardous waste remediation and as an emerging leader in cyber hydrologic systems and remote sensing.

• Faculty — now numbering 28 — at the Water Lab were among the first to pioneer computer simulation of hydrologic systems in the 1960s.
The model the lab has developed over the past seven years is a marketplace of buyers and sellers of water pollutants, such as phosphorus. It centers on using tax revenue streams to stem the flow of phosphorus into the wastewater treatment plant instead of paying millions of dollars to treat it once it’s there. The potential for tax savings is significant, said David Stevens, professor in the Water Lab and head of the College of Engineering’s Environmental Engineering program.

But how do you do this without stiff regulations? Financial incentive would help. Why not use money collected through the sewer bill or, better still, private investors, to pay non-point source generators of phosphorus flow among the 80 percent to reduce that stream? From that concept, the Water Lab’s nutrient buyer-seller model was born.

What if a waste water treatment plant, for example, is mandated to reduce 5,000 kilograms per year of phosphorus flowing from its pipe and it’s known that Farmer Jones upstream produces 50 kilograms per year? If the plant can provide a financial incentive for the farmer to reduce his 50 down to five, then the plant can take 45 kilograms off its balance sheet. If this is done enough times with other farmers and participants, the waste water treatment plant can effectively reach its mandated reduction without having to pay for costly treatment. And so instead of spending, say, $10 million dollars per year on operating costs and amortization of the treatment plant, a treatment plant can do it for $5 million per year. That means it has $5 million in savings and all with the same net outcome, Stevens said.

This is an oversimplification of a complex mathematical model developed by the lab over the past seven years. It has been a joint effort among 15 or so graduate and undergraduate students and researchers with a huge dividend potential.

“It’s a program in which the city gains, farmers make money, the environment gets better and everybody is happy,” he said. “What could be better than that?”

**USU Lab Helping to Surf a World Wide Web of Water**

The romantic notion that engineers with the Utah Water Research Laboratory frequently get out of the office and into the mountains to measure snow pack in scenic western watershed settings is not exactly accurate unless mountains of data count. If that is the case, then Dr. David Tarboton is an alpine marvel.

It’s not that he’s a stranger to mountain watersheds, some of his first work at USU took him there, but he’s been to the mountaintop and if you look at what he has done since then, you will appreciate his expanded view.

His sights are on the peaks and distant ranges of hydrologic data and how to help people better access it the world over, quicker than ever before. He wants to dispense data that is easy to use and be able to pull information from multiple data sources to more accurately provide a picture of what exactly is taking place in any given watershed at any time by any person who may be interested in seeing it. Think world wide web of water.

Not only is he talking about data from watersheds, but also data about precipitation, water quality and stream flow. And at the basis of all of this fluidity lies data flow — the ability to serve up waves of information, broadcast it and make that broadcast available at the touch of a computer key the world over.

“We’re creating software at all parts of the system,” he said. This includes software for publishing water data, software for cataloging the data and software for interrogating the catalogue. It’s mind boggling when you think about the ramifications of bringing all this data together — and, unfortunately, not very sexy.

But when you’re thirsty or in water above your head, sexy doesn’t matter. Good data does. That has been the driving force behind USU’s involvement with the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI). Tarboton, with Jeff Horsburgh, research assistant professor, and Kim Schreuders, senior programmer and analyst, have focused primarily on developing software for publishing water data.

Maybe it was those early years in the mountains above Logan that helped Tarboton expand his hydrologic vista to include the world. Maybe in this age of the water-bearer, Aquarius, he began to see it intersecting with the Information Age and the fresh possibilities of linking minds and data in ways never thought possible. “Hydrology is not going to advance unless we, as hydrologists do it,” he said.

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*The Water Lab’s notable alumni include Mary Cleave, astronaut; George Dewey Clyde, former Utah governor; Gretchen Rupp, director of Montana Water Center; Eva Neiminski, engineering specialist, Utah Division of Drinking Water, Department of Environmental Quality; and Robert Hinchee, senior research leader, Battelle.*

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*Dr. David Tarboton*
Competitive Streak: CEE Teams Make LEARNING A NATIONAL EVENT

Russian-American novelist Ayn Rand once said “the ladder of success is best climbed by stepping on the rungs of opportunity.”

Student teams from the Utah State University Civil and Environmental Engineering Department saw an opportunity, climbed the ladder and successfully competed at not one, but three national competitions in 2011.

A total of 28 CEE students ranging from freshman to seniors joined to compete at both the National Student Steel Bridge Competition at Texas A&M University and the National Concrete Canoe Competition at the University of Evansville in Indiana. In addition, three students are scheduled to compete for a second time at the Water Environment Federation’s Annual Technical Exhibition and Conference in California in October.

The Concrete Canoe and Steel Bridge team worked throughout the 2010-11 school year preparing for regional competition. Both teams met and began working on designs in fall 2010. As the year progressed, designs became more solid and academic papers, required for the competitions, were written. Faculty mentors oversaw the process along the way. At the 2011 American Society of Civil Engineers Rocky Mountain Regional Competition in March, the USU ASCE Chapter, comprised of both the Concrete Canoe team and the Steel Bridge team and other ASCE members, took first place overall, with the Concrete Canoe team taking first and the Steel Bridge team placing third in their respective areas, giving both teams a chance to compete at the national competitions.

“I attribute the success to the commitment and leadership provided by each and every one of the students involved in the competition,” said William Rahmeyer, department head of Civil and Environmental Engineering.

Rahmeyer said he only knows of two other schools in the nation that have taken first place at regionals, and who have also had both the concrete canoe team and steel bridge team move on to the national competitions. He was particularly excited for the Concrete Canoe team which moved on to nationals for the first time in USU’s history.

“The competition made me so much more excited about engineering. We were able to see the entire process of building a bridge from imagining it in our minds, to designing, drawing and drafting, to fabricating and then to completing.” — Nephi Johnson

Both teams said the basic engineering knowledge gained in the classroom laid the foundation for success at the competition.
“The competition made me so much more excited about engineering,” said Nephi Johnson, Steel Bridge team member and a senior in Civil Engineering. “We were able to see the entire process of building a bridge from imagining it in our minds, to designing, drawing and drafting, to fabricating and then to completing.”

The Steel Bridge Team raised $16,000 from donors, including the College of Engineering, Jacobsen Construction and Ducworks to help pay for the bridge, necessary supplies and travel to both the regional and national competitions.

The bridge was 22-feet long, nearly 3-feet tall and 3-feet wide. The team was judged on lightness, construction speed and deflection.

“Our team focused more on the stiffness component of the bridge versus the swiftness of building the bridge,” said Burke Peterson, Steel Bridge team co-captain and a senior in Civil Engineering. “Despite practicing the assembly of the bridge back home, we had some setbacks while constructing the bridge during the competition, giving us the 28th out of 48th place at the national competition.”

There were other, less obvious, skills gained while preparing for the competition, according to Peterson.

“We learned so much about teamwork, fundraising, networking opportunities and business,” said Peterson. “These are all skills that make us more competitive in the job market.”

And while most of the work done in the Civil and Environmental Engineering Department is on paper, it’s the hands-on experience that makes the difference for these students.

“Creating a canoe out of concrete made me see things differently,” Chipman said. “What looks good on paper isn’t always great in real life or vice versa.”

The experience outside of the classroom proved successful for the Concrete Canoe team as it placed 16th out of 23 at the national competition. The team was judged on the race, a presentation, a technical paper and display. Team members raised a total of $19,500 from more than 30 donors for supplies and transportation to the competitions.

And as for the three students scheduled to compete at the WEFTEC conference in October, they said preparing for the competition has been one of the highlights of their collegiate careers.

For the regional competition, the students were given a problem that entailed finding a solution to lowering the phosphorous levels discharged from the Logan Lagoons into Cutler Reservoir in Cache County, Utah.

“I’ve learned what engineers actually do in their profession by creating a product that would be similar to one produced by practicing, professional engineers,” said Cami Snow, a senior in Environmental Engineering.

Spurred by general population growth and the related need to improve the nation’s infrastructure, more civil and environmental engineers will be needed to design and construct or expand transportation, water supply and pollution control systems and to help companies comply with environmental regulations and hazards. USU’s Civil and Environmental Engineering degrees are accredited by ABET, Inc.

Fast Facts

• Environmental engineers and civil engineers can expect employment growth of 31 percent and 24 percent respectively by 2018, far above the national average for all occupations, according to the U.S. Bureau of Labor Statistics.

• Civil and Environmental Engineering Professor Laurie McNeill was one of 38 national winners named as a 2010 Carnegie Professor of the Year.

• Wynn Walker, senior associate dean for the College of Engineering, was the 2011 recipient of USU’s inaugural International Professor of the Year Award in recognition of
Driving is the most used form of transportation in the United States. However, poorly maintained roads, hard to see signage, pavement irregularities and debris put thousands of motorists at risk every year.

Utah State University’s Utah Local Technical Assistance Program (LTAP) Center works hard to reduce the hazards on Utah’s roadways. The program was established in 1988 in cooperation with the Federal Highway Administration and the Utah Department of Transportation and provides local governments affordable or no-cost training on the basics of roadway infrastructure safety.

The Utah LTAP travels the state and provides seminars on everything from paving to snow removal, signage, construction zone safety, lane markings and heavy equipment operation.

“LTAP is more important than ever because city and county budgets throughout Utah have been dramatically reduced due to the recent economic challenges,” said Kevin Heaslip, assistant professor of Civil and Environmental Engineering and LTAP principal investigator. “The center is considered a national leader in the area of asset management, Heaslip said.

Nearly 50 USU students at the graduate and undergraduate levels from USU’s Civil and Environmental Engineering Department have assisted in LTAP workshop presentations and helped local governments with data collection.

Keeping Utah’s roadways updated and safe is a full-time job and the state’s varying landscapes from desert to high mountains can pose many challenges. While Utah’s four-season climate attracts year-round tourists, it can also have negative impacts on the roadways.

“There is no one formula for road maintenance,” Heaslip said. “The change from chillingly cold to extreme heat causes early wear-and-tear on roads, signs and equipment.”

And while driving over a freshly covered pothole or pulling onto a wide shoulder isn’t something every driver thinks about, at the Utah LTAP Center it’s a top priority to keep Utah drivers safe.

The Utah LTAP Center is part of the Utah Transportation Center (UTC), a Tier II University Transportation Center funded by the U.S. Department of Transportation. For more information, visit the website (www.utahltap.org).
The USU Micron Research Center

Where serious work meets hands-on learning

In late 2007, Utah State University's College of Engineering received an impressive $1 million grant from the Micron Foundation to create the USU Micron Research Center. The goal was to involve students and faculty mentors in the area of emerging hardware and software technologies, with an emphasis on reconfigurable hardware technologies.

With its grant in the University Resources area, Utah State University joins an elite group of institutions — all included by invitation only — from not only the United States but around the world.

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site for research, with work by individual professors and teams spreading beyond its walls.

In the summer of 2010, calls for proposals from the USU Micron Research Center went out, and three projects were selected. Dr. Todd Moon, acting director for the center, leads one team, with additional teams led by ECE faculty Dr. Koushik Chakraborty and Dr. Sanghamitra Roy.

Moon’s team focuses on “smaller, faster and error free” reliability in error correction coding. Breaking down the team’s focus, doctoral student David Torgesen is working on new, soft-input algebraic decoding algorithms for Reed-Solomon codes.

Another student, David Neal, has a research focus looking at bursts — bursts of errors. He’s working with Low Density Parity Check error correction codes and extending them to deal with bursty error patterns.

And not to be left out, Moon is working on a project building a soft-input/soft-output decoder that is capable of working with any block code. The foundational work has value on its own, but also contributes to the work of his students Torgesen and Neal.

**Process Variability Effecting DRAMs**

Dr. Sanghamitra Roy and graduate student Satyajit Desai’s research project is titled *A Comprehensive Framework for Analyzing and Mitigating Process Variability Effects in DRAMs*. The pair, like Moon’s team, is concentrating on smaller-faster-reliability issues.

This Micron project team is looking at unreliability challenges in microprocessor memory structures like the DRAM.

As an undergraduate, David Torgesen didn’t have his sights set on graduate school. Not a master’s degree and certainly not his doctorate. That changed when he worked with Dr. Todd Moon on an undergraduate research project. Now, with financial support from the Micron Research Center, he is hours away from completing a master’s and continuing at USU in a doctoral program. In the research project, Torgesen meets regularly with Moon to review his work and to look ahead. These sessions, he said, are valuable. “He is an inspiring man. Taking his classes and now working with him on research shows me how hard he works, but he is also a good family man. His example shows me I can do that too, that I can aim as high as completing a Ph.D. while making room for a family. He has given me the opportunity to expand my experience.”

While he looks as youthful as his fellow student collaborators, David Neal brings a bit more to the game. He’s been out there in the working world. He’s worked as a mechanical engineer and as an electrical engineer. He made a career choice to leave ATK and return to school. That’s how he landed at USU studying electrical and computer engineering and joining Dr. Todd Moon’s Micron Research team. Now in the master’s program, Neal said he hopes to continue with a doctoral program and the financial support from the Micron Center helps. Being engaged in research enhances work in the classroom, he said, “Research and classwork reinforce each other. I didn’t take classes in the summer but by working on research I’m really increasing my knowledge. I’m learning things and keeping my skills at a high level.”

When he completed an undergraduate degree in India, Satyajit Desai knew he wanted to continue his education at the graduate level. He investigated several programs, including USU’s College of Engineering. “I knew I wanted to do something with computer engineering, so when I was accepted at Utah State, I traveled to Utah to begin my studies.” He met with Dr. Koushik Chakraborty to discuss thesis options and became familiar with Dr. Sanghamitra Roy and her Micron research. “This experience has been quite different from what I did as an undergraduate. I’ve studied a lot of new material on my own and that has been a good learning experience. It is valuable to work directly with a faculty member. The discussion and exchange of ideas is important. I’m improving and gaining knowledge. It goes far beyond the classroom.”
With undergraduate and master’s degrees under this belt, Dean Michael Ancajas travelled to Logan and USU with a purpose. He knew he wanted to earn his doctorate and he knew what he wanted to study. “I found Dr. Koushik Chakraborty’s website and saw that his research areas matched mine.” Ancajas left his native Philippines and travelled to Logan to begin his doctoral studies in fall 2010 and a class project transitioned to his work with the Micron Research team. He enjoys his work with the team because it’s a collaboration. “We work closely. If I have a problem and get stuck, Dr. Chakraborty gives me direction but he doesn’t spoon feed me the answers. Doing research helps you develop problem-solving skills that you can use anywhere.”

The biggest surprise for his relocation to Utah? He likes the snow and has become an avid snowboarder!

An impressive feature of all the graduate students working in the various Micron Research teams is their focus, and like his peers, Kshitij Bhardwaj has that quality. He knew he wanted to study computer architecture and actively looked for and investigated programs in that area. In his case, he was doing the investigating from India, where he had earlier earned a bachelor’s degree. When he found USU it was a match because Dr. Chakraborty’s research happens to be computer architecture. Interestingly, Bhardwaj uses the same phrase as his fellow teammate to describe Chakraborty’s style: he doesn’t “spoon feed.” And, like his fellow student researchers, while he agrees that research helps in the classroom, the reverse is also true. “The concepts I’m applying in my research are concepts I learned in the classroom. I’m taking that knowledge and I’m putting it to work.”

High Performance Three-Dimensional Multicore Systems

Dr. Koushik Chakraborty’s team, including graduate students Dean Michael Ancajas and Kshitij Bhardwaj, is investigating combining virtualization techniques and distributed memory controller designs to design high-performance, three-dimensional multicore systems.

A new paradigm is the prospect of three-dimensional integrated circuits (3-D IC) and it looks promising as a future alternative to current two-dimensional integrated circuits (2-D IC). At the heart of this paradigm is the promise of reducing wire-delay: a problem that plagued the conventional 2-D designs, causing both loss of performance and energy efficiency, Chakraborty said.

In his project, Chakraborty and the team will explore new techniques and design methodologies to exploit opportunities presented in a 3-D multicore design.

In the CLASSROOM …

Engaged Learning Aims High

Many faculty engage students in ambitious projects but ECE Professor Charles Swenson stands out. In the course Space Systems Design, Swenson and colleague Chad Fish (USU Space Dynamics Lab), engaged students in real-world engineering. The objective? Create a systems engineering plan assessing the viability of using the International Space Station as a launch platform for numerous small satellites (CubeSats) to study space weather.

The conceptual design for the system was named ICES.

The course was unique. It included undergraduate students and graduate students; it grew from a National Science Foundation grant; and stu-
students worked in teams led by graduate students. *The NASA Systems Engineering Handbook* was used as a text.

“We used NASA as a model in our work,” Swenson said. “Our process mirrored the processes and steps that NASA would use.”

Students collaborated with multiple NASA institutions and the geospace community. An abstract summarized the students’ goals to study the ionosphere/thermosphere region. By semester’s end, a draft report and PowerPoint summary were created. A final report wrapped up by August 2011 with three students as lead authors with faculty mentors Swenson and Fish. Findings were presented at USU’s Small Satellite Conference, reaching an international audience of leading industry experts.

The course has concluded but opportunities may continue. The project is under review by the NASA Ames Office of Technology and might take flight in the EtherSat program. Time will tell.

That’s not a bad learning outcome.

### Students Learn by Teaching

Graduate students in Electrical, Computer, Mechanical and Aerospace Engineering encounter convex problems in their research but the topic is not taught in the curriculum. Associate professor Jake Gunther studies and uses convex optimization in his research so, when a group of students requested he offer a course in the topic, he was interested.

The problem was, Gunther was already teaching a full load. Everyone wanted the course but who would teach it? The solution? The students themselves.

A textbook was selected for the 6000 level course that included online lectures. Students watched two lectures a week outside the classroom and came to class prepared to “teach” an assigned section to their fellow classmates. They were also expected to complete a homework problem in class.

At the end of the semester the students were graded on viewing the online lectures (the honor system was used), for class participation and a final project.

“We had a class of six highly motivated graduate students,” Gunther said. “Everyone contributed and learned a ton. The students worked harder knowing they would be accountable every class period. They came prepared and learning soared.”

And while the course is not on the schedule again, there is a need since the subject is fundamental for many disciplines. Gunther received positive feedback on the class and while it was an experiment, it went well. And, he admits, he is negotiating its return — even if it’s another teaching overload.

### Radio Receiver System Engineering

Radio has long been an important part of the electrical engineering scene. In the last 30 years, however, the curriculum has diverged, splitting radio receiver systems into two separate disciplines — radio frequency analog circuits and digital signal baseband processing. There has been a growing curricular gap between these two worlds: the RF carrier world and the digital baseband world.

A new course at USU, taught by Dr. Jacob Gunther, addresses this curriculum gap.

Offered for the last two spring semesters (2010 and 2011), it focuses on designing receiver systems, considering design at the component level. Students don’t design frequency mixers, but they learn about the behavior of different types of real mixers and then design a receiver using an off-the-shelf component.

“Because of the many tradeoffs involved in designing a radio receiver system, this offers a perfect setting to teach systems engineering principles,” Gunther said.

Students in the class divide into teams to design receivers, then build and test their designs.

With the availability of so many off-the-shelf components and high-speed analog-to-digital converters, most of the student groups were able to get their radios working in real-time during a single semester, but all groups were able to demonstrate functionality. Learning, designing, selecting parts, ordering parts, putting it all together and making it work is a lot to accomplish in a 14-week period. Several groups extended their class projects to become senior projects.
MAE’s capstone “Creeper” team: Stuart Goble, Nick Clifford, Andrew Shupe, Larry Wilde.
The department of Mechanical and Aerospace Engineering has restructured the senior design capstone class, allowing students to fully show off their acquired knowledge while affording the opportunity to make a real difference in the lives of others through their designs.

A real difference was made in Albert La Bounty’s life. La Bounty lost the use of his legs over 20 years-ago in a motorcycle accident, but he never lost his love for “wrenching” on cars and trucks. MAE capstone students were tasked with creating a device that would transport La Bounty from his wheelchair to a mechanics’ creeper, thus allowing him to slide under a vehicle.

“The old structure of the design capstone class was all packed into one semester,” said Research Professor Steve Hansen. “The new class structure helps students to really apply themselves to projects, both in designing and building.”

The redesign of the course is focused on developing students’ “design-to-realization” skills and is now two semesters, a design semester and a build semester, instead of just one. Working in year-long teams of four to 12, depending on the size of the project, students design and build their projects while reporting progress to a “customer.”

“If someone can provide us parts and materials, we’ll provide all of the engineering,” explained Hansen.

Real-world customers are preferred, but capstone professors Hansen and Department Head Byard Wood stand in as customers when customers with specific needs aren’t available. The Center for Persons with Disabilities at USU has been a repeat customer, including the “creeper” project.

“Amazingly, parts and materials for the creeper project cost under $750,” remarked Hansen.

For a few thousand dollars in parts and materials, an organization with little development resources could get $50,000 to $60,000 in return from the course’s efforts.

The product design forces students to think outside of the box, and unlike standard classroom pedagogy, the capstone course is designed to have no right answers.

“This is what makes the capstone so unique,” said Hansen. “When these students get into their careers, there isn’t going to be a book with all the right answers. They will come up with the right answers.”

As project teams select their one best solution and start designing, they must also convince their customers that the selected design is the best solution. Then teams execute the critical design, filling in every detail of the project. The first semester’s end product is a drawing package so well-articulated that a machinist could then build the entire project. The second semester is dedicated to the project build.
"With the old model, students were pressed to design and build just to get the project finished in one semester," reflected Hansen. "The new model lets students spend an entire semester building, testing, making adjustments and testing again, which is what they will be doing in their careers."

Students have all the tools for success with a full array of industrial machining tools in the Student Prototype Laboratory, as well as two professional machinists on hand to assist in the builds. And of course, students are expected to draw from the knowledge and experience offered by Hansen and Wood, though sometimes a slightly hands-off approach is best.

“We try and never tell them what they should do,” said Hansen. “We want them to discover.”

At the end of the course, teams demonstrate the success of the projects to their peers. For the creeper project, who better to exhibit the ability of the end product than La Bounty himself? Using his own truck for the product demo, La Bounty used the creeper to its full capacity. He seamlessly moved from his wheelchair to the device and then was able to lower himself to the mechanics’ creeper — wrench in hand — and move under his truck like any seasoned grease monkey.

“He was in heaven,” remembered Hansen. “That project really did make a difference.”

For information about sponsoring a project for the design capstone class, please contact Steve Hansen, steve.hansen@usu.edu

Wind Tunnel Research at USU Helps to Improve Models

Hidden in the back of the College of Engineering’s Student Prototype Laboratory is a white door, easily mistaken for a janitor’s closet. However, the machinery housed in the enormous room on the other side of the door is not brooms and mops. The room houses a transient mixed convection wind tunnel, a one-of-a-kind purpose built wind tunnel, unique to USU’s Department of Mechanical and Aerospace Engineering’s Experimental Fluid Dynamics Laboratory.

The wind tunnel facility rotates 180 degrees.

Delivered in July 2010, the wind tunnel has made its home with the Aggies and may hold the key to a major energy concern: spent nuclear fuel storage.

Recently, concerns with spent nuclear fuel storage have surfaced since the earthquake in Japan and the subsequent Fukushima Nuclear Power Plant disaster. The Fukushima event was partly so problematic because of the spent fuel that was being stored on-site.

Professor Barton Smith heads up the wind tunnel research and explains that after nuclear fuel has been removed from a reactor it sits in a cooling pool for at least five years, when it is then capable of being transferred into dry cask storage, which can be stored away from the reactor. Natural convection is sufficient to keep the spent fuel cool while in dry cask storage. The fuel does not require any external influence to remain safe. Most nuclear catastrophes, as was partially the case in Fukushima, happen when the water pumps used to cool the spent fuel fail.

"People are now interested in getting spent fuel out of the plants as quickly as possible,” said Smith. “In the case of an accident, that is another hazard you just don’t want to deal with. Though our facility wasn’t built with the spent fuel model in mind, the tunnel can and likely will be used to address spent fuel.”

However, removing spent fuel from the pools sooner than five years...
is problematic. The current designs for dry cask storage aren’t optimized for heat transfer, so the spent fuel is still too hot to be cooled by natural convection alone.

Using the wind tunnel, Smith and his team of students can measure heat transfer by forced convection (e.g., a blower creating wind) or natural convection, including the transition from one regime to the other. The combination of the two convections is called mixed convection.

“In the application of spent fuel, this facility will provide detailed velocity and heat transfer data to compare a model to,” said Smith. “It will provide data for the switch from forced through mixed, to natural convection as a plant’s flow slows down, such as when the main pumps fail.”

The actual test area of the facility is a one-foot square, two-meter long rectangular box that runs through the center of the structure. One side of the box is a mirrored plate regulated with heaters and sensors, capable of 190°C. The other three sides of the test area are transparent, for laser-based velocity measurements.

However, the facility is capable of much more than data for spent fuel models. In fact, data collected for spent fuel models doesn’t even require the use of the wind tunnel’s most unique features.

“What makes our wind tunnel unique is the capability to rotate the entire facility 180 degrees,” explained Smith. “Natural convection is affected by gravity. We can manipulate the influence of buoyancy in the tunnel by rotating the facility.”

The capabilities of the facility are catching national attention. After Smith and his peer Robert Spall submitted a Nuclear Energy University Programs proposal, the Department of Energy offered USU $635,860 to support university-led nuclear energy research and development. With multiple other proposals already submitted, Smith is hopeful that he, his team and his peers, will be making headlines soon.
Science, Technology, Engineering and Mathematics Education is commonly referred to as “STEM” education, among educators and policy makers alike. These are the subjects that give students the tools to solve today’s pressing issues and problems, and it has been made clear by educators and leaders nationwide that STEM subjects are a priority in today’s classrooms.

Dr. Kurt Becker, Department Head of Engineering and Technology Education (ETE), researches topics involving STEM education in high schools and retention of engineering majors at universities. His current research, in partnership with Purdue University and funded by the National Science Foundation, focuses on the engineering design continuum that ranges from novice to expert, comparing how high school students in engineering courses approach and execute design, versus the approach and design used by college engineering majors and professional engineers. Obviously there are differences along the spectrum, and Becker’s research will identify these gaps.

“One of the research goals in the ETE Department is to determine how to optimally teach and prepare students to make them better engineers,” explained Becker.

In his study, high school students were asked to design a playground — a familiar and open-ended, but complex design problem — and given three hours to complete their plans. Each student was videotaped by a research observer, and students were prompted to think aloud as they worked through the problem.
They were also asked to prioritize 26 different design activities and rate them in order of importance to the design process. “What’s interesting is the fact that what students chose as most important didn’t match what they actually did,” Becker said. “They all rated ‘planning’ as most important and then didn’t spend as much time on that when they carried out the project. Also, expert engineers ranked ‘understanding the problem’ as the most important design activity, so clearly there is gap in how these students are approaching the design process.”

Becker also noted that high school students don’t typically do well with generating ideas when presented with a problem. “Students will fixate on one idea, and then they’ll come up with several more because they know that’s what’s expected of them for the assignment, but they only really focus on and give attention to their initial idea. On the other hand, professional engineers continually keep the big picture in mind, which makes them better problem solvers and designers because they aren’t limited by this fixation.” This conclusion is further supported by the fact that the students often neglected to consider aspects such as budgeting and city code requirements, issues that a professional engineer would never omit.

The long-term goal of these studies is to redesign high school curriculum and potentially college engineering education, so that students develop and adopt these expert skills and ways of thinking earlier. Becker believes high schools and universities across the nation could do better at exposing students to real-life problems earlier on in their education instead of focusing solely on theoretical problems.

“These young students are enthusiastic. They want to change the world, make people’s lives better, improve the environment and solve real problems, all issues that can be approached from the engineering-design perspective. The problem is that students aren’t given exposure to these kinds of projects early enough, so they get bored and we lose them.”

The results of this ongoing study will be communicated to high school curriculum developers, and potentially to universities, with the intent of changes being implemented in the classroom in time to benefit the current generation of youth. These curricular improvements will excite more students about engineering design and help them better understand how science, technology, engineering and mathematics subjects play an important role in design, and the process professional engineers follow in approaching engineering design.

USU Flight Students Take to Virtual Skies

The Aviation Professional Pilot program boasts a sleek flight simulator as the newest addition to its training equipment. The Redbird All-Glass Cockpit Flight Simulator is housed at the Logan-Cache airport, and it’s hard to miss its shiny red-and-white siding and impressive size. The Redbird is definitely eye catching, especially compared to the drab old simulator that still sits in another corner of the building.

“This simulator is heads and heals over the old one,” says Tom Davis, a flight instructor in the Professional Pilot Program. “It’s as close to flying a real airplane as you can get.” Specifically, the
Thinking about Thinking: Metacognition Applied to Engineering Design

Utah State University’s Dr. Oenardi Lawanto is head deep in unprecedented research that could improve the way students approach engineering design. Lawanto is working with a concept called metacognition, which he describes as “thinking about thinking.” Metacognition involves awareness of one’s thought processes and various stages of problem-solving strategies.

Lawanto has completed pilot studies in metacognition with high school students and college freshmen, and recently received NSF CAREER funding for a five-year study on metacognition and engineering design.

This was one of the main requirements when Nolan Clifford, director of Aviation, decided on which simulator the program should purchase. The other was certification from the Federal Aviation Administration, which is crucial to quality pilot training and corresponds with the main goals of USU’s program, which are to promote professionalism, and above all, safety.

The Redbird certainly promotes safe flying practices. It can replicate any airport in the world, night and day, under all weather conditions, recreating virtually every possible scenario that students could encounter as pilots. Each student flight is recorded so students and instructors can review the flight afterward, which gives students clear instruction on how to improve and become better pilots.

“It’s great because we can take students into some pretty scary situations that we would never actually let them get into in real life,” says Davis. Because students can log hours with these virtual, dangerous flights, they are able to hone their skills as safe pilots.

Students can also get more experience and flight hours for their money with the Redbird. In order to log the flight hours needed for licensing in the program, students must rent time on the actual aircraft or the simulator. To rent time in the planes, students have to pay $170 per hour, while the simulator flights cost only $83 per hour.

Always the frugal crowd, students are pretty excited about this. Especially when they compare its capabilities to the old simulator, which had a few personality quirks that made flying it more a hindrance than a help. “The old simulator was touchy and nonresponsive,” explains Clifford. “Students were spending more time learning how to maneuver around its quirks than actually learning how to fly.”

Davis laughs about the old simulator as well. “I went through the program as a student before I became an instructor, so I’ve been here about 10 years, and compared to the resources I had, this new simulator is incredible.”

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Research has been conducted on metacognition in the past, but mostly in other fields like reading comprehension, training, science, and mathematics education. Lawanto is among the first to apply research in metacognition to the field of engineering design. “Engineering design is all about solving complex and ill-structured problems. Metacognition is concerned with planning, monitoring, and regulating, which is crucial to successful engineering design.”

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EnginEERING AND TECHNOLOGY EDUCATION PROFILE

- USU is home to one of only three Ph.D. programs in the nation in the emerging discipline of engineering education. USU’s first Ph.D. graduate will finish the program in December 2011.
- Students in the engineering and technology education undergraduate teacher education program have 100 percent job placement in teaching positions after graduation.
- The Engineering and Technology Education Department is a leader in research of metacognition in engineering education.
- Students in the department participate with the VEX Robotics team that consistently
self-regulated learning for engineering design students.

Thinking about thinking is a confusing concept, and researching thinking about thinking can be even more confusing. In addition, assessing students’ metacognition requires rigorous tools and methods. “It’s what I call a dirty job,” Lawanto says about his research. “It’s really muddy because students come to the table with various background knowledge and different understandings of what is expected of them, and since no one has ever researched this before, there will be a lot of double and triple checking to make sure I collect valid data. In fact, I see this as a never-ending project, because we can always go back and learn more and keep improving.”

The long-term goal of Lawanto’s research is to improve students’ design skills through self-regulated learning and metacognition. He hopes to use his findings to improve classroom education for students, because if they can be taught to develop these skills, their potential in engineering design could be much greater.

“I plan to develop a teaching guide for educators so this research can be put into practical use,” he says, “because otherwise, you just put your research on the shelf and what good does it do if you don’t apply it to improving teaching and learning?”

Dr. Ning Fang was the first professor in the College of Engineering to use wireless clickers in the classroom back in 2006. Clickers are classroom response systems that allow students to anonymously respond to multiple-choice questions. Student responses are immediately displayed on a projector screen, so the professor and the class can see exactly what percentage of the class answered correctly.

The value of using clickers in the classroom is that they provide immediate feedback and real-time evaluation of student learning. Fang has specifically focused his research with clickers in college-wide fundamental engineering courses he teaches, including engineering dynamics, a large and difficult class typically taught in the traditional lecture style.

“If I see that a significant portion of the class has gotten a question wrong, I can adjust my lecture to make sure the students understand how to get the correct answer. It allows us to stop and answer questions students may have in that particular area, which I might not have anticipated when I planned my lecture.”

Clickers are also useful for housekeeping purposes in teaching, such as keeping track of attendance and seeing if students have completed their assigned readings. “These kinds of things are fundamentals to classroom success,” Fang says. “And the clicker is an efficient way to monitor them and motivate students to succeed.”

Fang’s work with clickers has sparked interest in the College of Engineering and clickers have now been implemented in other engineering courses. Along with his colleague Laurie McNeill, Fang has also recently given a lecture in a college-wide seminar on how to effectively use clickers to improve teaching and learning.

Sometimes Engineering Courses Just Click