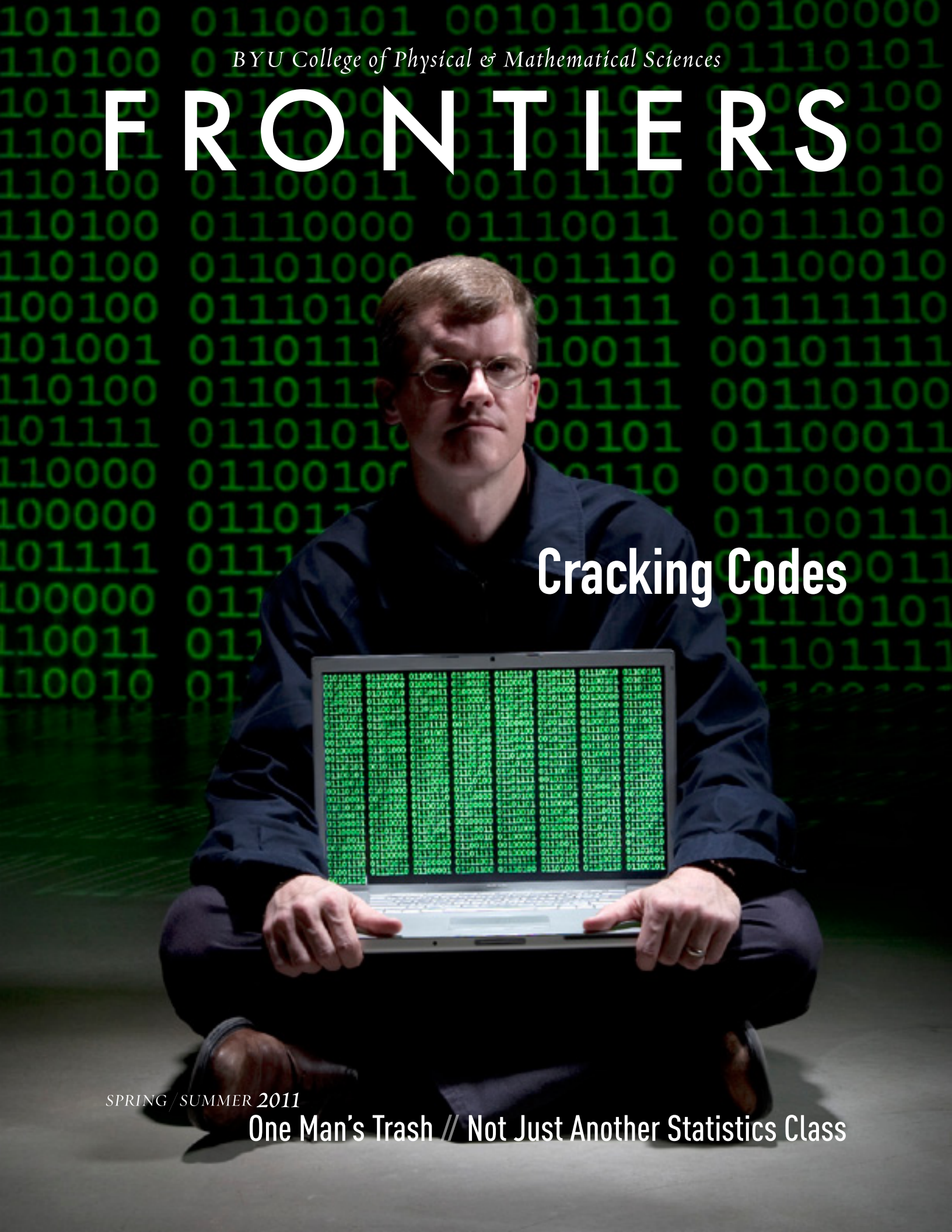
BYU College of Physical & Mathematical Sciences

FRONTIERS



Cracking Codes

SPRING / SUMMER 2011

One Man's Trash // Not Just Another Statistics Class

dean's message

Welcome to another issue of Frontiers! Life here in the college is always exciting. Thanks to the enthusiasm of our students and the ongoing dedication of our faculty members, we are constantly exposed to some of the most cutting-edge research and innovative teaching that our respective fields have to offer.

Our faculty and student research teams are often at the forefront with new ideas and new technologies. This success in research also frequently leads to new and better ways to connect with students in the classroom. We're exceptionally proud of the accomplishments of our faculty and students in both teaching and research. In fact, we'd like you to have a glimpse at some of the great things happening in the college, so we've decided to highlight a few of them in the pages that follow.

In our cover story, Paul Jenkins and Darrin Doud, both faculty members in the Department of Mathematics, are injecting some excitement and mystery into number theory through their cryptography courses. With classes aimed at both traditional math majors and students from other disciplines, these dedicated professors are focused on cracking codes and making complex mathematics a little more engaging.

Meanwhile, Jaron Hansen's recent research efforts may be part of the solution for our country's persistent energy problems. A professor in the Department of Chemistry and Biochemistry, Jaron's work with anaerobic digestion has made it not only possible, but also economical to turn organic waste into renewable energy that can power our lives. Who knew playing with garbage could be so productive?

But Jaron's not the only one working to help solve the world's problems. Faculty member Evan Johnson and his research team are using their knowledge of statistics to make cancer treatment methods more efficient and effective. This is important research that could literally save people's lives and, in so doing, make the world a better, healthier place.

Those are the kinds of great things that are happening here at CPMS, thanks to our wonderful faculty and their students. It's the type of cutting-edge, potentially world-changing research that we hope to continue performing for years to come.

Thankfully, we are fortunate to be part of a remarkable institution that provides us with the means and opportunities to continually expand our understanding of science and mathematics—even in these harsh economic times.

As many of you know, BYU has had a university-wide hiring freeze in place over the last two years to help cope with the financial challenges posed by the recession. While this was certainly a difficult period marked with increased uncertainty, we were fortunate to have a patient and flexible faculty and staff who were willing to fill in and help out whenever necessary. We were able to learn much about our college and our priorities during this time. Thanks to the invaluable contributions of our faculty and staff, we have now weathered the storm, the hiring freeze has recently been lifted, and we are poised to move forward to an even brighter future here in Provo.

All in all, it is truly a wonderful time to be at Brigham Young University. I am thrilled with the outstanding work that is currently taking place in our college, and I am more excited than ever about what we can achieve. It's a journey we look forward to sharing with you—and the rest of our CPMS family—in the months and years ahead.

Thank you for your continued support.

Best wishes,

Scott Sommerfeldt, Dean

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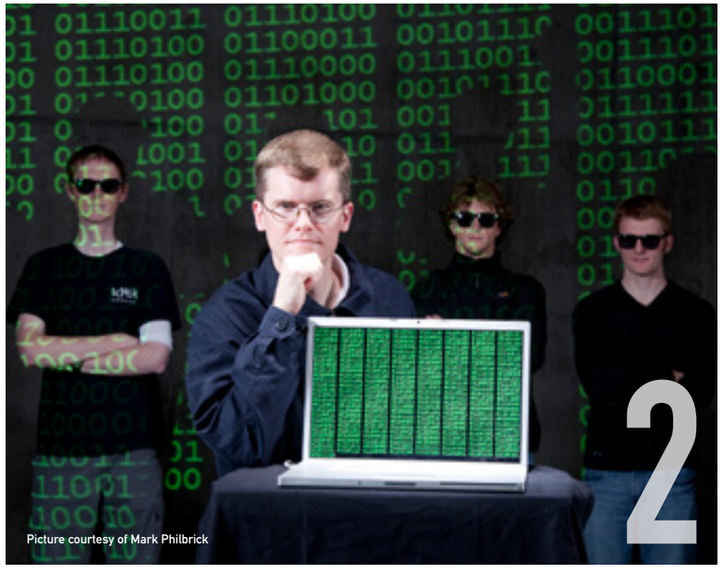

Picture courtesy of Mark Philbrick

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departments

features

Cracking Codes:
Teaching Number Theory Through
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C R Y P T O G R A P H Y

By Steve Pierce

Top-secret codes. Carefully encrypted information. Cutting-edge security techniques protecting valuable intelligence. If this sounds like a Hollywood blockbuster revolving around Cold War-era spies and a hefty dose of international espionage, it's not. Nevertheless, even though this tale of cryptographic intrigue may not be playing at a theater near you anytime soon, it is coming to a BYU mathematics classroom. In fact, it's already here.

For professors Paul Jenkins and Darrin Doud, complicated codes and classified messages aren't just fun plot devices in a James Bond movie—they are vehicles for in-depth classroom study of some fairly complex mathematics.

"When I was an undergraduate, I was a math major, and I started studying number theory—and one of the major applications of number theory, if you want to apply it, is cryptography," Doud said.

> In a world where so many of our financial transactions and social interactions take place online, cryptographic methods like those Jenkins and Doud teach have become increasingly vital.

But what does cracking codes have to do with mathematics? In the modern world, everything—but it wasn't always that way.

"Historically, there have been many ways of sending secure messages," Jenkins said. "The first methods were much simpler. You had things like, 'Well, just shift the alphabet by a few letters.' From there, things got steadily more sophisticated and, by the 19th Century, there were some fairly sophisticated ways of encrypting messages that nowadays don't seem very sophisticated, but were quite good for the time."

In the 1970s, encryption methods took a more mathematically complex turn with the introduction of public key cryptography—a method that allows any individual to use a widely known algorithmic process to encrypt messages that can only be read by the intended receiver.

"Previously, if you wanted someone to be able to send you a message, they had to have a machine identical to the one that you had or they had to have some kind of a key that they had to keep secret. With public key cryptography, that's not the case," Jenkins said. "There are mathematical ways where you can say, 'If you want to send me a message, transform your message into a number in some standard way and then perform these operations on that number, you'll get another number, send that to me.' Everyone knows exactly what operations you performed on that number but the mathematical operations are such that, to undo them, you have to have some extra knowledge."

The most popular public key method involves choosing two large prime numbers and multiplying these numbers together to get an even larger product. The message is then encrypted using the large product in such a way that it can only be decrypted by someone who knows the original two numbers. Anyone can know the original encrypter multiplied two numbers together, but it would be nearly impossible for a potential interceptor (even with the help of modern computers) to factor the product and discover the identity of those original numbers—at least not any time soon.

"You could try to do it, but the universe will die a slow heat death before you do—and that isn't very helpful," Jenkins said, playfully. "Essentially, we believe the problems [presented by public key-encrypted messages] are difficult enough that people won't be able to factor that number in any reasonable amount of time and, because of that, we believe the message is secure."

And we had better hope it's secure, Doud said. The safety of Internet commerce depends on it.

"When you click 'purchase,' packets of data go out over the Internet with your information and credit card number in them, and they go through any number of servers before they reach [the seller's] servers," Jenkins explained. "If [the packets] were not encrypted, any one of these servers could skim through them, pull out the credit card number and e-mail it somewhere where bad things will happen."

In a world where so many of our financial transactions and social interactions take place online, cryptographic methods like those Jenkins and Doud teach to BYU students have become increasingly vital to the functioning of modern society—and will undoubtedly only become more crucial in the future.

Dr. Darrin Doud became interested in cryptography as an undergraduate student studying mathematics. "One of the major applications of number theory, if you want to apply it, is cryptography," he said. Picture courtesy of Bradley Slade

The Department of Mathematics has intermittently taught classes in cryptography on an ad-hoc basis throughout the years. However, when Jenkins joined the department in 2009, he was asked to use his previous experience to help start a more permanent class at BYU.

"When I arrived here, the department was in the process of actually adding [Mathematics] 485 as a course on the books, and I was asked to help with that," Jenkins said. "I had taught an upper-division elective cryptography class when I was a post-doc at UCLA. Since I had that experience, they asked me to help write the course description and then assigned me to teach the course in Fall 2009, which was a lot of fun and seemed to go very well."

Dr. Paul Jenkins (front right) has been teaching upper-level cryptography classes since his time as a post-doc at UCLA. "It's great that we get to talk about some exciting mathematics and do it in a way people are interested in," he said. Picture courtesy of Mark Philbrick

Since that point, Jenkins and Doud have been responsible for creating and teaching multiple courses on cryptography, all of which have been very well received by a variety of students.

Jenkins has taught Mathematics 485 every fall semester since its inception. The course provides math majors and others interested in an in-depth study of cryptography with an opportunity to delve deep into both the history of the field and the most modern mathematical methods available.

> "NSA is the largest employer of mathematicians in the country, and they seem to really like BYU students because they speak foreign languages and pass their background checks."
> – Paul Jenkins

However, Jenkins doesn't want the 400-level course number to scare off potential students—in fact, Mathematics 485 was designed to engage individuals who might never otherwise consider taking such an advanced math course.

"We set the pre-requisite [for the course] at just Linear Algebra, a course that pretty much all of the students in the engineering college take," Jenkins said. "About a third of the classes have been non-math majors the last two times I've taught it, which I think is a good thing. It's great that we get to talk about some exciting mathematics and do it in a way that people are interested in."

Jenkins said some Mathematics 485 students have become so interested in the subject matter that they are looking into pursuing careers in cryptography and related security fields. One former student participated in the National Security Agency's (NSA) summer internship program in 2010 and several others have expressed interest in potentially working with the agency in the future.

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One Man's Trash

A tale of bacteria, garbage, and sustainable energy.

By Steve Pierce

Could playing around with garbage and bacteria lead to a solution for our nation's energy problems?

Jaron Hansen thinks it just might help. For several years, Hansen, the son of a university professor and now a professor of chemistry himself at BYU, has actively pursued the creation of sustainable energy sources from trash—a passion he traces back to his father.

"My interest goes back a couple of years," Hansen said. "In fairness, the reason I've really become interested in this is because my father, who is a professor at Utah State University and an engineer, has been researching anaerobic digestion for about 40 years now."

Anaerobic bacteria are the key. These tiny organisms live and grow in dark, oxygen-poor, inhospitable environments where other living things can't survive. Following in his father's footsteps, much of the younger Hansen's research now focuses on developing a method to naturally create a lot of energy using these bacteria.

"The idea behind anaerobic digestion is that you take a bunch of different types of bacteria, they interact together and, if you feed them food, then these anaerobic bacteria are really good at breaking down that food and producing methane gas," Hansen explained, citing garbage as a real treat for the bacteria. "That methane gas can then be compressed and used to create electricity or biodiesel, which can power our homes, cars and several other things that we use every day."

The Hansen family by no means has a monopoly on this potentially promising idea. Scientists around the world have been trying to develop an efficient, effective way of generating fuel via anaerobic digestion for decades and, if you listen to the way Hansen talks about the potential benefits associated with such a breakthrough, it's not hard to see why.

"If we can improve the anaerobic digestion process," Hansen said, "humans could essentially be able to [begin to] power their lives—*with their garbage*."

> "If we can improve the anaerobic digestion process, humans could essentially be able to power their lives — with their garbage." – Jaron Hansen

Turning Garbage Into Gas

Anaerobic digestion is, in its simplest form, a three-part process that can transform ordinary, organic waste into useful forms of energy for public consumption. Americans have plenty of trash and other waste, which means there's potential for plenty of relatively inexpensive energy.

The abundance of these necessary source materials is a big reason why anaerobic digestion is so appealing, Hansen said.

"The reason this has been on people's minds for so long is that the kind of waste you can feed into these bacteria ranges from manure from a confined animal operation all the way to garbage that goes into a landfill," he said. "About 70 percent of what goes into a landfill is organic—grass clippings, leaves, newspaper, food scraps, etc. These are things that anaerobic bacteria can operate on."

However, the bacteria don't necessarily work their magic on everything. Some materials—including leaves, grass clippings and algae, among others—are not broken down very efficiently by the bacteria, a problem which has traditionally limited input sources.

To combat this inefficiency, Hansen and his research team have developed a new method to pre-treat difficult organic materials by "roughing up their molecular backbone" and thus making them more susceptible to anaerobic digestion.

"If you look at a tree that has fallen down in the forest, is that tree there the next year?" Hansen asked. "If the tree falls down and you walk by the next year, the tree will still be there. If you walk by 10 years later, that tree will still be there. Nature has made it so that these things are very hard to break down, but we've found a way to expedite [this process] so bacteria can break them down very rapidly."

After all the waste materials are sufficiently pre-treated and prepared (if necessary), the digestion process begins when those organic materials are fed into an Induced Bed Reactor (IBR), which is essentially a digestor comprised of a large cylindrical, heated tank filled with anaerobic bacteria. These bacteria interact and consume the waste, producing a stream of valuable methane gas as a result.

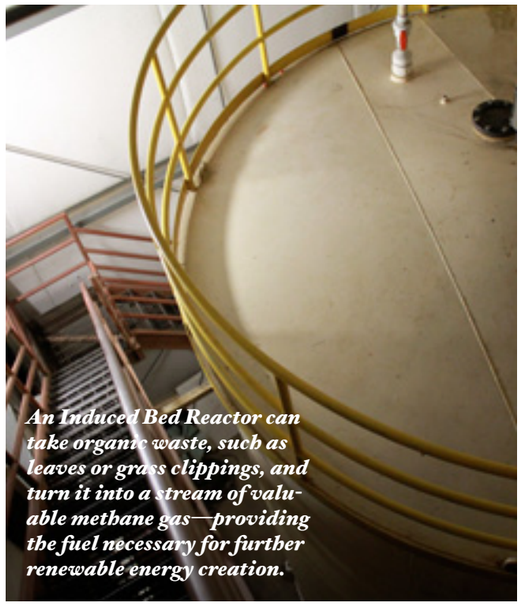
Unfortunately, methane is not the only by-product of this process. Although methane constitutes roughly 75 percent of the resulting stream, a hefty portion of carbon dioxide is also present, as well as some hydrogen sulfide and water vapor. The presence of these other substances is problematic for energy production.

"You won't be able to drive your car as far or heat your home as efficiently if you just use this kind of biogas because of the carbon dioxide—and that's a sad thing, but the thing that really kills [anaerobic digestion] as a renewable energy technique is the fact that it's got hydrogen sulfide and water in it," Hansen said.

Dr. Jaron Hansen (left) works on a biogas conditioning unit on a dairy farm in Ogden, Utah. One of Hansen's systems retails for around $50,000—approximately one-tenth the price of previous models.

The presence of hydrogen sulfide in the gas causes expensive generators to corrode at an accelerated pace, making it difficult to produce electricity at a reasonable price. With these generators running upwards of $100,000 per unit, it makes little economic sense for a potential energy producer to purchase one just to watch it become a useless heap of scrap metal in a few months' time.

Or as Hansen puts it: "If you went down to a car dealership and said, 'I'm willing to buy the finest Cadillac you have on the lot. I'm willing to give you $100,000 for that car.' And if the salesperson then said, 'Yeah, it'll work for three months,' that's not something that you would consider a good idea—and that's basically what you're dealing with on these generators."



An Induced Bed Reactor can take organic waste, such as leaves or grass clippings, and turn it into a stream of valuable methane gas—providing the fuel necessary for further renewable energy creation.

Improving the Purification Process

To remedy this problem, Hansen and his colleagues created the third step in the three-part anaerobic digestion process—biogas conditioning. By feeding the contaminated gas mixture into a special conditioning system, Hansen and his research partner—emeritus BYU professor Lee Hansen (no relation)—can strip unwanted elements out of the biogas mixture and create a purer stream that is more agreeable to energy production.

> "We're getting to the point where we can start producing profit by breaking down waste that is otherwise just going to sit on somebody's field or go into a landfill. We're actually using waste to produce energy. That's very exciting." – Jaron Hansen

Scientists and engineers have been building different biogas conditioning units for years. However, no one has ever been able to produce a cost-effective machine, and Hansen estimates most previous systems have cost around $500,000 apiece. The Hansens' new conditioner sells for about $50,000.

At one-tenth the price of earlier models, the system becomes much more than a research toy—it can now produce methane gas at a competitive price, and help to eliminate garbage at the same time. Not only is the start-up cost much lower than older systems, but the new biogas conditioning system developed by the Hansens is cheaper to operate—doing the same job for less by utilizing innovative heat management systems to remove hydrogen sulfide and water vapor from the mix entirely, while also significantly reducing the presence of carbon dioxide. The result is a more efficient, more marketable gas product—comprised of 98 percent pure methane—that solves many of the problems traditionally associated with anaerobic digestion.

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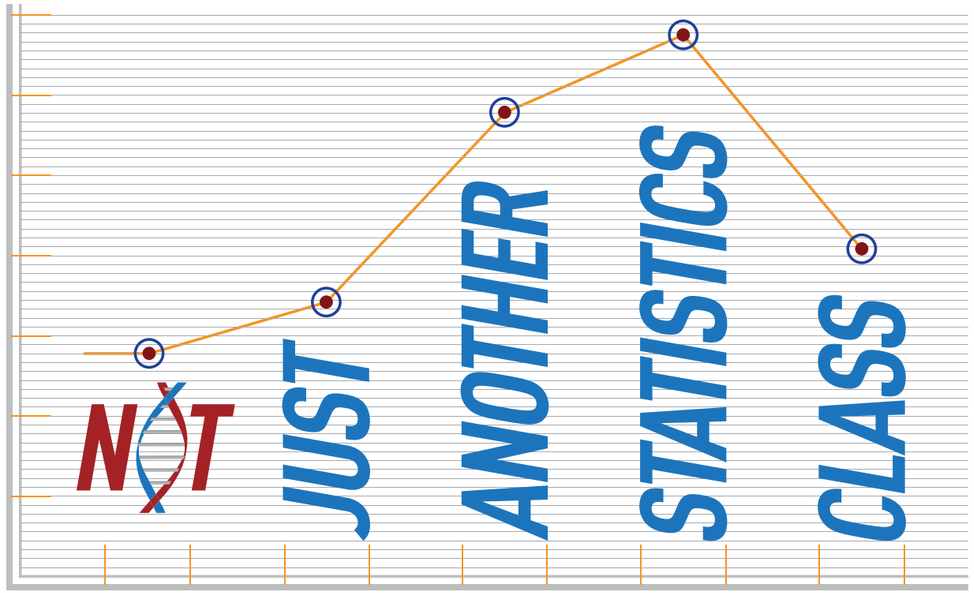


At the Huntsman Cancer Institute (HCI) in Salt Lake City, Utah, every cancer patient is treated as a unique human being, not a statistic. But when it comes down to a genetic level, it actually is statistics that is making personalized treatment a future possibility.

By Katie Pitts

Dr. Evan Johnson, a professor in the BYU Department of Statistics, and his students are using statistics to analyze genetic data from the HCI. Johnson spends one day a week up at the Institute collaborating with the researchers there. He said that this working relationship is perfect for a statistician —and for students.

"One problem with statistics is that the science might get a little disconnected from the applied problems," he said. "Actually being up there gives us a chance to see where this is all going. We can really better apply and be directly helpful. It also improves communication. This is the best thing for students."

By being on-site, Johnson has become familiar with the processes the HCI is using to better understand cancer at a molecular and a genetic level —the science of genomics.

Johnson explained that before they use statistics, they have to run DNA samples through a sequencer. This allows the researchers to see the unique combination of DNA bases, commonly abbreviated as A, C, G, and T. Different combinations make up different genes, resulting in an infinite number of physical effects. By comparing the sequenced DNA with data from the Human Genome Project, they can begin identifying genes that might be causing problems. The difference between having the sequence ACGT versus ACGG in a particular gene, for example, might be the determining factor in whether or not you have a high risk of developing cancer.

"What we really care about is where you are different from everybody else because that's where the problem is," Johnson said of the process. "It's like trying to put a puzzle together, only the pieces don't fit—they only kind of fit."

These misfit pieces occur because long chains of DNA are cut up when they are run through the sequencer. Scientists have to figure out if they are looking at one complete gene, a section of one, or even the beginning of one gene and the end of another.

This is where statistics come in. Johnson uses a mathematical algorithm to determine the possibility of certain sequences appearing in different places.

Johnson developed this algorithm through collaboration with Mark Clement and Quinn Snell, of BYU's Computer Science Department, and Nathan Clement, a former student.

The innovative aspect of their work is that the algorithm can be used for many applications beyond cancer research, including a host of other diseases and bioterrorism.

"We've built a basic algorithm to do other applications," Johnson said. "The ability to do that wasn't really there before now. Having our own approach allows us to tweak it for many different applications. We have a lot of flexibility to adapt to answering questions of all kinds."

"This isn't just statistics students learning a stats program; this is a real experience with real impact. We have students making a notable difference in people's lives."

Since there are so many questions to address, students in Johnson's lab come from all areas and skill levels—but all of them end up with an outstanding experience.

"The great thing about [the lab] is it gives them a real chance to apply what they learn in class," Johnson said. "This isn't just statistics students learning a stats program; this is a real experience with real impact. We have students making a notable difference in people's lives. They do it at varying levels, but there really is a problem here for everybody."

Check out a video interview with Dr. Johnson online at cpms.byu.edu/frontiers

Interview With One Individual Behind Individualized Medicine

The current form of chemotherapy involves administering a cocktail of drugs in the hopes the patient will respond positively to one. Michelle Withers, a graduate student in Johnson's lab, is working to change that. She's applying the lab's algorithm to predict what drugs will work best and for whom—a developing idea called individualized medicine. Withers recently presented her research at this year's Student Research Conference. She talked with Frontiers *about what this project means to her.*

Q: ***How has your research impacted your educational experience?***

A: Working with Dr. Johnson on individualized medicine has really helped round out my educational experience and give it purpose. It has provided me an opportunity to see how to apply what I've learned in my coursework, and just knowing I am contributing, even in a small way, to cancer research is so much more fulfilling than just doing an assignment. I also feel like my research experience has taught me a lot of analytical and critical thinking skills that cannot be taught in a classroom, and it has allowed me to be able to synthesize what I've learned and apply it in new and interesting ways.

Q: ***Why are you interested in individualized medicine?***

A: I've always wanted to work in a career that I felt was directly helping people, and when I chose statistics, it wasn't quite clear to me how I could do that. Working with the statistical side of individualized medicine has helped me accomplish this. I feel like individualized medicine is a very worthwhile pursuit; the research I am doing could help save lives.

Q: ***Does this field have any special personal appeal for you?***

A: When I was eight, my mom had cancer. I remember my siblings and I went to live with my uncle for a week when she had her radiation treatment. It wasn't a particularly traumatic experience for me, but I do remember it was a hard time for our entire family. Her treatment was successful, and she fully recovered, but I know there are many times when that doesn't happen. I have had many friends and distant family members that have had cancer, and it's always hard to see all of the heartbreak associated with it. Knowing that there are other options that would be a lot easier on the patient and on the patient's family is a comforting thought.

Alumnus Gives Back To Help CS Students Graduate Debt-Free

By Steve Pierce

Picture courtesy of Mark Philbrick

Left: Dr. Dan Olsen works with students in his Interactive Computing Everywhere (ICE) Lab. Through donations from generous alumni and friends of the college, Olsen and other CPMS professors are able to help students like Bret Ahlstrom work their way through school while gaining valuable experience in their chosen field.

It's no secret how expensive a college education can be for students—particularly if you're planning to earn an advanced degree.

Many students leave school with tens of thousands of dollars in student loan debt, and as soon as they walk across the stage and receive that all-important diploma, a small mountain of interest also begins to build. The result? Years upon years of seemingly never-ending loan payments that can place an unwelcome strain on a family's finances.

Bret Ahlstrom has seen the long-term costs of student debt—and he's glad he didn't have to deal with any of that.

Ahlstrom, who graduated from BYU with a bachelor's degree in computer science in 1993 and a master's degree in the same discipline in 1995, was able to complete his education debt-free—a fact he largely attributes to an on-campus mentorship opportunity with Dr. Dan Olson that allowed him to work his way through school while also gaining experience in his chosen field.

"Although [my wife and I] lived very frugally, the main reason that we were able to graduate debt-free was the generosity of Dr. Dan Olsen," Ahlstrom wrote in a recent e-mail to fellow BYU alumni. "[Olson] has always excelled at obtaining good grants and external funding, which he has used to employ graduate and undergraduate student researchers. His support enabled me to focus on my education while working in my area of study and being paid for it."

"Although [my wife and I] lived very frugally, the main reason that we were able to graduate debt-free was the generosity of Dr. Dan Olsen."
—Bret Ahlstrom

Without the added support offered by his paid mentorship with Olson, Ahlstrom—who now works as a program and release manager with worldwide software leader Microsoft—admits his financial situation would have been quite different following graduation.

"We were able to get into a house within a year of starting full-time at Microsoft," he explained. "Had we had loans, that would not have been possible for a few more years, or maybe longer."

Now that Ahlstrom has moved on to a stable career, he wants to help give others the same opportunities he received. He has chosen to do that by contributing to the BYU Microsoft Scholarship Fund. The fund, which several dedicated university alumni and friends contribute to every year, allows Microsoft employees to donate matched dollars that sponsor multiple scholarships for BYU computer science students.

Ahlstrom said he appreciates the many opportunities he received at BYU, and he sees the Microsoft Scholarship Fund as a great way to give back and help others.

"I support the fund because I feel grateful for the start BYU gave me, and I know how beneficial it can be to get non-loan financial assistance in college," he said. "Especially in a challenging economy, increasing debt—even for a good cause like education—is not a good idea. I'm happy to help out in a small way to reduce that for someone else."

Pictures courtesy of Mark Philbrick

Changing the World With Math and Science

By Steve Pierce

For 25 years, CPMS has proudly featured our students' cutting-edge research at our annual Student Research Conference. 2011 will be no different. The following students—some of our best and brightest—will be showcased at this year's event on March 19.

Chemistry and Biochemistry At first glance, fruit flies and human birth defects may not have much in common—but that's not how Brandon Gassaway sees it. A senior biochemistry major from Vancouver, Wash., Brandon is studying cell development in the common fruit fly to get a glimpse into how certain cells mutate and, thus, gain greater insight into how birth defects and tumors develop in humans.

Computer Science No one likes to go under the knife, but many medical procedures require such invasive procedures to detect potential problems. Rob Smith, a Ph.D. candidate in computer science from Reisterstown, Md., is working to change that. Using BYU's Fulton supercomputer, some complex math formulas, and a few well-placed external microphones, Rob is developing a method that can successfully diagnose heart disease without costly and inconvenient surgical procedures.

Geological Sciences Everybody needs water, but where that water comes from varies from place to place. Maria Asay, a geology graduate student from Rapid City, S.D., is researching glaciers in the Himalayas that store large quantities of water as ice; these glaciers provide water for several major rivers, including the Indus. Maria's work focuses on determining just how much water they have accumulated and how they affect the future water needs in the region.

Mathematics Most people know the shortest distance between two points is a straight line. But what is the shortest path connecting three or four points? What about connecting n points? How about connecting those points on a surface of revolution? Ryan Jensen, a senior math major from Burlington, Wyo., is working to answer these questions—often called the Steiner Problem. His solutions could have several far-reaching, real-world applications in solving complex problems.

Mathematics Education In a math class, there are often unspoken rules about how a teacher and a student are expected to interact. Unfortunately, these roles can inhibit a student's ability to learn effectively. Kelly Campbell, a graduate student from Aurora, Colo., who is pursuing a master's degree in mathematics education, is researching the use of new instructional designs to assign students new, more productive roles that can facilitate learning and improve our nation's education system.

Physics and Astronomy In modern society, we always want the newest, fastest and smallest devices—and Lauren Richey's work with photonic crystals may just help us in that quest. Photonic crystals are microscopic periodic structures that have the ability to power devices with light rather than electricity. Lauren, a senior physics major from Mapleton, Utah, hopes to create a usable photonic crystal from synthetic materials that can manipulate visible light and propel our technology into a smaller, faster future.

Statistics When it comes to diagnosing and treating cancer, it is essential patients receive the most effective treatments possible. However, because cancer is such a complex disease, each case is different. Michelle Withers, a graduate student in statistics from Bozeman, Mont., is using statistical models to develop biological profiles that will identify individuals who will respond to specific treatments. This will enable the most effective treatments to be given as soon as possible, improving the odds of cancer recovery.

Above: Brandon Gassaway seeks to understand birth defects using fruit fly samples. **Below:** From left to right: Maria Asay hopes her study of Himalayan glaciers will help solve the region's future water needs; Kelly Campbell aims to reshape the way we teach mathematics by changing students' classroom roles; In her quest to create a synthetic photonic crystal, Lauren Richey is looking to beetles for natural occurrences of the structure.

Left: Five faculty and staff members were honored with College Awards in January (from left to right): Kim Christensen, Dr. Paul Farnsworth, Dr. Kent Gee, Dr. Tim Leishman , and Dr. Jennifer Nielson.
Below: Nine administrative/staff members received University Service Awards at the College Awards Dinner in January (from left to right): Scott Daniel, Mark Erickson, Wayne Peterson, Wes Lifferth, Janet Fonoimoana, Gordon Billings, and Wayne Anderson. (Not pictured: Keith Kling and Bruce Jackson.)

Retired Faculty News

Chemistry & Biochemistry—One way of judging researchers' work is by looking at how often other researchers quote and cite them. Twenty researchers at three Utah universities, including Department of Chemistry and Biochemistry emeritus faculty members Jerald S. Bradshaw and Reed M. Izatt, ranked in the top 250 cited researchers in their disciplines, according to the website ISIHighlyCited.com.

Chemistry & Biochemistry—Dr. Douglas J. Henderson has been awarded the title "Doctor honoris causa" (honored doctor) of the Institute for Condensed Matter Physics (ICMP) of the National Academy of Sciences of Ukraine.

Chemistry & Biochemistry—Dr. Reed M. Izatt was selected as a recipient for the 2010 Special Recognition Award from the Brigham Young University Emeriti Alumni Association. The award was presented to him at an awards ceremony and luncheon on March 6, 2010, by the association's president, Stanley Peterson.

Physics & Astronomy—Dr. Robert Clark, along with his colleagues in the Physics Teaching Resource Agents, was awarded the 2011 Excellence in Physics Education Award by the American Physical Society. The award was established to recognize and honor a team or group of individuals who have exhibited a sustained commitment to excellence in physics education. The group was cited for "providing peer-led professional development for 25 years to more than 5,000 physical science teachers nationwide through a network of more than 500 master teachers."

Faculty & Staff News

Chemistry & Biochemistry—Dr. Paul B. Savage received the Reed M. Izatt and James J. Christensen Faculty Excellence in Research Award.

Chemistry & Biochemistry—Dr. Juliana Boerio-Goates was presented with the Utah Award in Chemistry by Tom Richmond of the American Chemical Society's Salt Lake section at an awards banquet, August 2010.

Chemistry & Biochemistry—Dr. Barry Willardson received the Sponsored Research Recognition Award at the recent Annual University Conference, recognizing his outstanding achievements in scholarly activities funded by external resources. Willardson's work has focused on important research problems in medicine and health.

Chemistry & Biochemistry—Dr. Daniel Ess, the newest member of the Department of Chemistry and Biochemistry faculty, was recently appointed to the Center for Catalytic Hydrocarbon Functionalization (CCHF), a prestigious energy frontier research center funded by the U.S. Department of Energy.

Geological Sciences—Dr. Summer Rupper has been invited to participate as a session speaker in the 4th annual Indo-American Kavli Frontiers of Science Symposium, co-sponsored by the U.S. National Academy of Sciences. This is the Academy's premier activity for distinguished young scientists. Dr. Rupper will present results of her work on glacial systems in the Himalayas at the April 17-20 meeting to be held in Irvine, Calif.

Geological Sciences—Dr. Ron Harris was recently invited to participate in the Penrose Conference in Manizales, Colombia, which brought together an international group of scientists to discuss neotectonics and seismic hazards of shallow slab subduction. Ron presented his research on neotectonics of the Banda arc.

Mathematics—Dr. Vianey Villamizar has been called to serve as president of the Venezuela Caracas Mission by the LDS Church, and will be taking a temporary leave of absence in order to do so. He will begin his service on July 1.

Physics & Astronomy—Wayne Peterson won a 2010 Apparatus Competition Award at the Summer Meeting of the American Association of Physics Teachers in Portland, Oregon last July. His entry in this physics demonstration competition shows the dramatic expansion of volume that occurs when a liquid evaporates and becomes a gas at atmospheric pressure.

Physics & Astronomy—Dr. Karine Chesnel and her student Joseph Nelson (BS, 2010) won best paper in the physical sciences division from the Utah Academy of Sciences, Arts and Letters in 2010 for their paper entitled "Persistence of Magnetic Domain Memory Through Field Cycling in Exchange Bias Thin Films." Joseph Nelson is now attending Baylor Medical School in Houston, Texas.

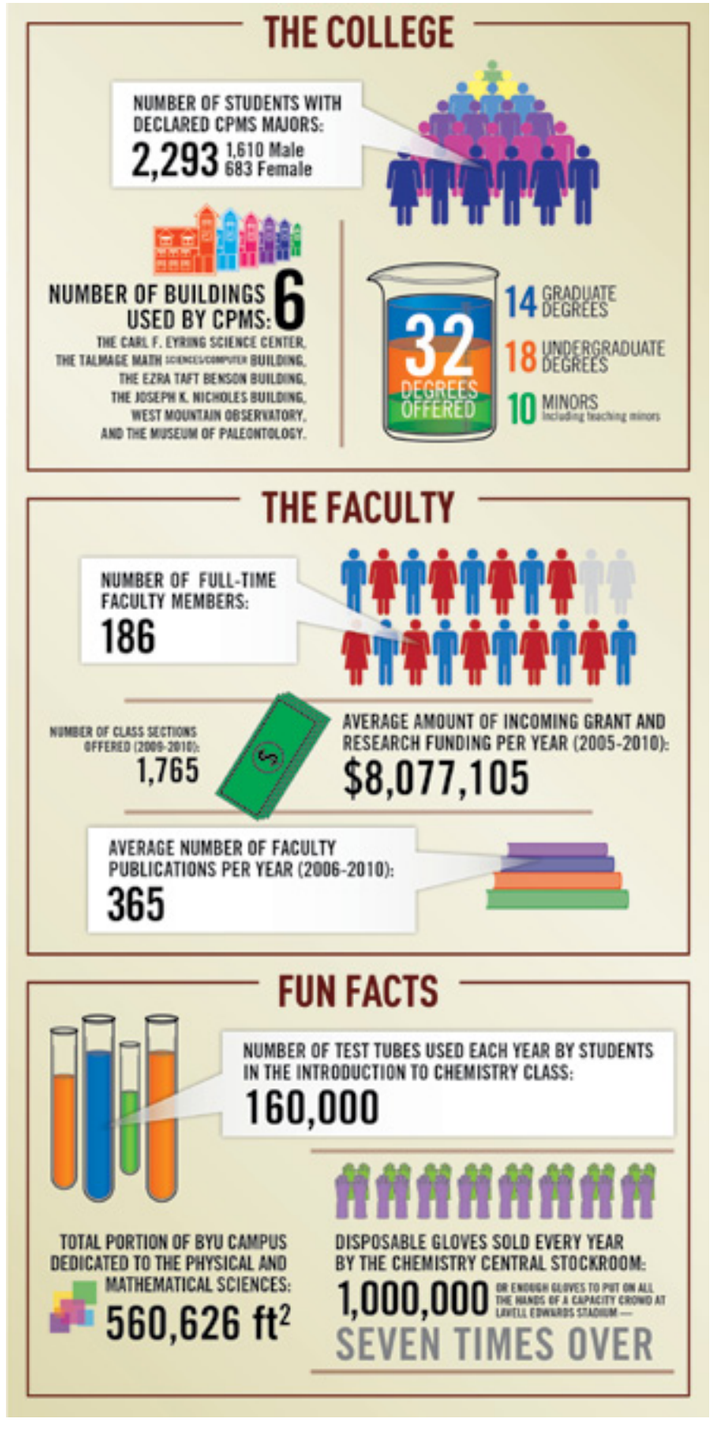
Physics & Astronomy—Duane Merrell received the Benjamin Cluff Award from the McKay School of Education at BYU for his distinguished work in training science teachers in secondary education. Duane is nationally recognized for his creative, dedicated, and personal work with his students.

Statistics—Ruth Dauwalder, administrative assistant in the Department of Statistics, graduated with a B.S. in Home and Family Living from BYU in April 2010.

College Awards

At the College Awards Dinner in January, Kim Christensen received the Outstanding Staff/Administrative Employee award, Dr. Kent Gee received the Faculty Young Scholar award, Dr. Jennifer Nielson received the Excellence in Teaching award for faculty with 3-10 years of service, Dr. Tim Leishman received the Excellence in Teaching award for faculty with 10 or more years of service, and Dr. Paul Farnsworth was awarded the Distinguished Faculty Citizenship award.

In addition, the following received University Service Awards: Gordon Billings (5 years), Janet Fonoimoana (5), Mark Erickson (10), Wayne Anderson (15), Keith Kling (25), Bruce Jackson (30), Wes Lifferth (30), Scott Daniel (35), and Wayne Peterson (35).



1980 |

David Ward, *Mathematics*, has more than 30 years of actuarial and consulting experience, including health and life insurance product development and administration. Today he is the director of actuarial services and works as a consulting actuary at The Angell Pension Group, Inc., in East Providence, R.I.

1982 |

Gerald Morton, *Geological Sciences*, and his family live in Texas, where he is currently General Counsel and VP for Business Development for Carrizo Oil in Houston. Gerry also currently serves on our College Volunteer Leadership Council.

1985 |

D. Clark Turner, *Chemistry & Biochemistry*, President and CEO of Aribex Inc., was awarded the Utah Governor's Medal for Science and Technology in a recent ceremony at Discovery Gateway. Utah Gov. Gary Herbert made the presentation to Clark and six others for providing distinguished service that has benefited the State of Utah. Clark also currently serves on our College Volunteer Leadership Council.

1988 |

Steve Lyon, *Mathematics Education*, taught high school mathematics in Morgan, Utah, for ten years. In 2000, Steve accepted an offer from General Electric to work on software quality, then on their database administration team. Following his time at GE, he worked on Intermountain Healthcare's database administration team, and later on their Enterprise Data Warehouse team. For the past five years, he has enjoyed working with an organization that is committed to improving healthcare through accurate data analysis.

Clifford W. Hansen, *Mathematics* received his M.S. from Northwestern University in 1989 and Ph.D. in Mathematics from The George Washington University in 2000. In 2008, he was named a Distinguished Member of the Technical Staff of Sandia National Laboratories. His service with Sandia is notable in that he has been the technical lead for the risk assessments for both the West Isolation Plant in New Mexico, and the proposed Yucca Mountain repository in Nevada.

1993 |

Jered Skousen, *Computer Science,* works for National Instruments as the Area Sales Manager in Phoenix, Ariz. He is also on the board of directors for Cynergy Advertising and AADI, a Houston, Texas, fuel-injection company. Jered also serves on our College Volunteer Leadership Council.

Rachel (Carroll) Rahman, M.D., a double-major in *Physics & Astronomy* and *Chemistry & Biochemistry*, is currently a rural family physician in Nauvoo, Ill. She was recently voted Nauvoo's Country Doctor of the Year. She has cared for thousands of children, delivering over 400 babies so far.

Clark Goble, *Physics & Astronomy*, and his partner Art Pollard were recently featured in a story about their award-winning Amano Artisan Chocolate company in *Physics Today*. When asked how physics fits into making chocolate, Goble stated, "We ended up finding antique equipment and hand restoring it ourselves. And we built a lot of electronics. That is where the lab work in physics comes in."

1994 |

Greg Hebertson, *Geological Sciences*, General Manager at Anadarko Petroleum, has been an exploration geologist and manager for Anadarko for the past 16 years, and is well acquainted with the concept of risk management. Greg recently shared his expertise on the business side of geology with Geological Sciences majors during a two-day seminar conducted at the Eyring Science Center.

Norman Jarvis, a double-major in *Mathematics* and *Computer Science,* published "Dense Admissible Sequences" in March 2001 in the journal *Mathematics of Computation* as a result of his master's thesis in mathematics. He has worked as a software engineer at Corel Inc., Novell Inc., the Canopy Group and the LDS Church. He is currently employed at Goldman Sachs. Norman also serves on our College Volunteer Leadership Council.

Frank Wilson, *Mathematics,* went to work as an officer in the U.S. Air Force from 1994-2000, culminating in a two-year teaching assignment at the U.S. Air Force Academy. Frank taught college math for five years in Auburn, Wash., before accepting his current tenured faculty position at Chandler-Gilbert Community College in Arizona in 2005. Frank is an award-winning author of six math textbooks, and a children's book on measurement. In 2008, Frank co-founded Make It Real Learning Company, which creates learning activities to address the question, "When am I ever going to use this?"

1995 |

Jim Loveland, *Computer Science*, is President and CEO of Xactware, a leading provider of innovative tools, services and data for the property insurance and construction industries.

1996 |

Lee Loveridge, *Physics & Astronomy,* received a master's degree from the University of California-Berkeley and was one of two winners of the PAAL Graduate Student of the Year Award at UCLA for 2004-2005, where he received his Ph.D. in 2005. He is now an Assistant Professor at Pierce College, and is married to Staci Reynolds Loveridge.

Greg Thompson, *Physics & Astronomy,* is a professor of material science at the University of Alabama-Tuscaloosa. His lab has one of the country's few atom probes, where he works with magnetic materials. Greg received M.S. and Ph.D. degrees from The Ohio State University in 1998 and 2003, respectively.

1997 |

Keyne and Kirsten (Liechty) Monson, *Statistics,* are co-founders of Elevita, a non-profit organization whose mission is to alleviate poverty worldwide by helping artisans in developing countries find a greater world market for their products. They use 100 percent of the profits from these sales to fund meaningful humanitarian projects, especially in education.

1998 |

David R. Miller, *Physics & Astronomy*: Founder and owner of DRMiller Engineering, a research and development consulting firm that specializes in various forms of spectroscopy to non-invasively evaluate and characterize in-vivo blood and tissue samples. Additionally, David continues to actively pursue medical device-directed photoplethysmographic and NIR spectroscopic research and development interests as a visiting Research Fellow at LG Electronics. He and his wife Paula currently reside in Morgan, Utah.

Adam Fennimore, *Physics & Astronomy,* received his Ph.D. in Physics from the University of California-Berkeley. He won a coveted R&D 100 Award from *R&D Magazine* in 2004, for a tiny rotational motor using carbon nanotubes he developed at Berkeley. Adam is now a scientist at E.I. Du Pont de Nemours and Co. in Wilmington, Del. He is married to Jennette Smith Fennimore and they have three children.

2001 |

Cort Johnson, *Physics & Astronomy*, earned a Ph.D. in Physics at MIT in 2008 and is now at Sandia National Laboratory. He is working on studying neural currents in the brain by detecting the tiny magnetic fields that they create. He and his family live in Albuquerque, N.Mex.

Brent Wacaser, *Physics & Astronomy,* earned a Ph.D. in Physics at the University of Lund in Sweden in 2007, and is now working on concentrated solar energy and nanowires as a research staff member at IBM Watson Research Center in Yorktown Heights, N.Y. He and his family live in Garrison, N.Y.

2002 |

Paul Jensen, *Geological Sciences*: After several years of working in the petroleum industry in Texas and Colorado, Paul has moved to Mount Pleasant, Utah, to take a position as a mine geologist with Arch Coal at Skyline Mine. He is looking forward to new challenges and opportunities.

2004 |

Nick Webb, *Physics & Astronomy*, a Postdoctoral Fellow at Los Alamos National Laboratory since 2009, is working on Laser Chemical Vapor Deposition and hyperbaric CVD. He is married to Jenny Jones Webb and has one child.

2008 |

Elisabeth Strein, *Physics & Astronomy*, is currently in a chemistry Ph.D. program at the University of Washington.

We want to keep in touch with our alumni! Please share your latest adventures with us by e-mailing Lynn Patten at lynn_patten@byu.edu.

Cracking Codes (Cont. Page 3)

"NSA is the largest employer of mathematicians in the country, and they seem to really like BYU students because they speak foreign languages and pass their background checks for some reason," Jenkins added, with a knowing smile.

Doud is now taking cryptography to an even wider range of students by partnering with the BYU Honors Department to develop Honors 250—a general interest course that provides students in less technical majors with an opportunity to explore cryptography. It was first offered in the fall of 2010.

"[The course] is primarily for non-math majors," Doud explained. "When the class began, I did not have a single math major in the course. I [eventually had] one math major and a few computer science people, but it's mostly humanities majors and others who are interested in learning about mathematical cryptography."

That's not to say all the students immediately grasped the somewhat complex mathematics associated with even the most rudimentary modern cryptographic methods, but Doud said he was happy to help them get their feet wet.

"The students were a little skeptical about learning math [at first]," he said. "On the first day of class, I asked them, 'How many of you haven't had a math class in many years?' and many of them raised their hands with very few exceptions. But I led them into it gently—we did a lot of introductory work, and I think they did very well."

Both Jenkins and Doud said they have enjoyed teaching classes that students really want to take—not because they have to fulfill a graduation requirement, but because they possess a genuine interest in the subject matter.

"It's a pleasure to teach students who are enjoying the material for its own sake—they ask great questions; they're motivated; they go out and find other resources and bring things into class that help other students. It's a really great thing to experience," Jenkins said.

Even homework, the dreaded scourge of students of all ages, takes on a new, fun twist in BYU's cryptography courses—for both the students and the teachers.

"I try to put codes to break on as many of the homework assignments as I can, because the people who take this class seem to think this is a fun thing to do," Jenkins said, pointing to an assignment comprised of 15 seemingly nonsensical number combinations hanging on his office door. "The students work together in teams trying to figure out what it is, and the answer to one gives you the hint for another one, and things like that. It's a lot of fun—both for me making them and for all of them solving them as well."

Or sometimes, as Doud notes, it might just be fun for the professors.

"My students tell me I have too much fun making the homework," he said with a grin.

One Man's Trash (Cont. Page 5)

Usable, Consumable Product

Once the biogas is satisfactorily purified, it's time to put it to use by converting it to energy that consumers can use to power their homes or drive their cars. Currently, one of the immediately profitable avenues for biogas is the generation of electricity. With hydrogen sulfide having been removed via biogas conditioning, the generator can now run for tens of thousands of hours without corrosion problems and produce large quantities of electricity. This electricity can either be used to power homes or could even be sold back to a power company for profit.

The Church of Jesus Christ of Latter-day Saints sees a potential benefit in this system—they have contacted Hansen about possibly installing one on its large dairy farm in Elberta, Utah, which houses about 5,000 head of cattle. The Church hopes to use manure to produce enough electricity to partially or totally offset the dairy's $800,000 annual power bill.

But electricity isn't the only option—Hansen is also working with other BYU research groups to help pioneer the conversion of methane into biodiesel, which works almost exactly like traditional diesel fuel but is made from biological sources.

Hansen is already experimenting with biodiesel production at a dairy farm in Ogden, Utah. The system uses an on-site biogas generation and conditioning system and manure from the farm's cows to create pure methane gas, which is then turned into biodiesel by a Salt Lake City-based company named Ceramatec. So far, the process has been successful—the Ogden operation yielded its first batch of biodiesel in January 2011.

The key to these great advancements in fuel technology, Hansen said, lies in the ability to condition and purify biogas at a significantly reduced cost.

"Because we can now cheaply clean up the gas, we can start to make electricity for a price that begins to compete with what you can get off the grid [from the power company]," he said. "The fact that we can also make biodiesel now, this is a game-changer. Now we have a liquid fuel, something tangible we can charge somebody three dollars a gallon for. This is a marvelous thing."

Powering Our Future

Though some research and development still remains, Hansen believes these most recent advancements have the potential to make anaerobic digestion a legitimate player in the renewable energy game—helping to finally provide some workable solutions to the energy problem that has persistently plagued our fuel-dependent modern world.

Furthermore, Hansen sees these steps forward as a win-win situation for all involved—for consumers, for policymakers, for farmers, for the environment, and even for the American economy.

"The United States will be a big developing market for this technology in the future," Hansen said. "We're getting to the point where we can start producing profit by breaking down waste that is otherwise just going to sit on somebody's field or go into a landfill. We're actually using waste to produce energy. That's very exciting."

Check out a video interview with Dr. Hansen online at cpms.byu.edu/frontiers

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WHY DANI IS "INEXPRESSIBLY GRATEFUL"
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For Dani Mendel, the *X* factor is her scholarship.

A senior from Sandy, Utah, majoring in mathematics education, Dani says, "My scholarship has allowed me to expand my learning opportunities and take advantage of my BYU education."

Dani took full advantage by becoming a research assistant and cofounding BYU's Mathematics Education Association, which recently was accepted as a student affiliate of the National Council for Teachers of Mathematics. Dani believes that this organization will benefit future mathematics education majors by helping them connect and learn from each other. "It was only possible through the generous support I received from donors," she says. "I am inexpressibly grateful."

After graduation, Dani plans to teach. "Working with students and giving them the tools they need to succeed in life is what I want to do," she says.

We invite you to help students take full advantage of their BYU education. Add your gift online at give.byu.edu/cpms.

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