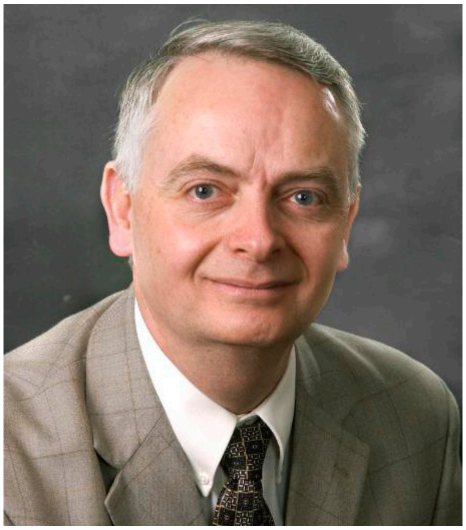
may 2010

FACULTY newsletter

CPMS Physical and Mathematical Sciences



ABOVE Tom Sederberg received the Karl G. Maeser Distinguished Faculty Lecturer Award in August 2009.

Sederberg delivers university forum address

In August 2009, Thomas W. Sederberg, an Associate Dean in the College of Physical and Mathematical Sciences, received the Karl G. Maeser Distinguished Faculty Lecturer Award -- BYU's most prestigious faculty award.

On May 18, 2010, Sederberg delivered the forum address traditionally given by the award recipient.

Entitled "Computer Graphics and Mentoring," Sederberg's address emphasized the importance of undergraduate mentoring — students working closely with a professor or staff member on large projects — and the benefits a student may gain from this experience.

"Many potential benefits can arise from a mentored learning experience, such as greater depth of learning, academic maturity, and self confidence. There are also practical benefits. For example, when the time comes for you to seek letters of recommendation, a professor who has mentored you will be in a better position to write such a letter," he said.

While highlighting many interesting computer science projects recently accomplished through mentoring, Sederberg closed his lecture by stressing the need we all have for the ultimate mentor: our Heavenly Father.

"A mentor is a 'wise and trusted counselor or teacher.' By that definition, our Heavenly Father and his Son, Jesus Christ qualify, above all others, to be called our mentors," he said.

We may pursue many courses in our pursuit of education and perhaps studying under a professional mentor in our field is not in our plans – and that is fine, said Sederberg. But learning from the Spirit is not optional; it is vital.

"The Spirit is a wise and caring mentor. The Spirit will lead us to a balanced life. The Spirit will lead us to an abundant life," Sederberg concluded.

To view the entire forum address, please visit CPMS-TV.

by: Natalie Wilson

ABOVE Dennis Eggett worked with Bryan Hopkins of BYU's Department of Plant and Wildlife Sciences to increase potato yield using stastistics.

Eggett uses stats to increase potato yield

The study of statistics influences various fields, though usually behind the scenes. Its role in farming is particularly important. Dennis Eggett, an associate professor in the Department of Statistics, recently analyzed the yields of russet potatoes in relation to the amount of fertilizer used.

Bryan Hopkins, a faculty member in BYU's Department of Plant and Wildlife Sciences, headed this study on the effects of phosphorous-based fertilizer on potato production while Eggett provided the statistical analysis.

To ensure the accuracy of their findings, the authors took several precautions. First, they ran the same experiment using many different plots of land in various areas because each plot has a different soil compostion and different access to water and sunlight. This insured that the results would not be biased by the location and plot of ground. Second, they divided each plot of ground into several sections, applying different amounts of fertilizer to each section.

In every crop harvested, the potatoes were separated into two groups: US No. 1, and small. US No. 1 potatoes meet superior size and quality requirements; small potatoes don't. The results showed that, up to a certain optimal level, as the amount of phosphorous-based fertilizer increased on a plot of land, the poundage of the US No. 1 crop increased and the poundage of the small potatoes decreased. Commenting on this trend, Eggett explained that potatoes that otherwise would have been small can grow to US No. 1 size as long as there is adequate nutrients available. Because the market prefers these large potatoes, the profitability of the crop increases with more fertilizer.

Though fertilizer does increase production, a farmer also must be cautious

Continued on next page

COLLEGE PUBLICATIONS

Chemistry and Biochemistry

* , G., Jensen, D.S., Wiest, L.A., Vail, M.A., Dadson, A., Lee, M.L., Shutthanandan, V., Linford, M.R., Analytical Chemistry,2010, 82 (11), 4448-4456. Core-Shell Diamond as a Support for Solid-Phase Extraction and High-Performance Liquid Chromotography.

Yung, W., Woolley, A.T., JALA, 2010, 15, 198-209. Integrated Multiprocess Microfluidic Systems for Automating Analysis.

Physics and Astronomy

Hicks, B., Getty, S., Allred, D., (2010). Diode properties of nanotube networks. Thin Solid Films 518, pp. 5014-5017.

Nathan John Steiger and Jean-Francois S. Van Huele, "Quantifying Incompatibility: Ramifications of Extending Angular Momentum Uncertainty Relations", The Journal of Utah Academy of Sciences, Arts, & Letters, Volume 86, p. 197, 2009.

Daniel Merrill, Christopher Erickson, Dallin Durfee, "Creating an Ultra-Stable, High Power Diode Laser at 657 nm by Injection Locking", The Journal of Utah Academy of Sciences, Arts, & Letters, Volume 86, p. 247, 2009.

C. J. Erickson, J. L. Archibald, D. S. Durfee, "An Ultra-Stable 657 nm Diode Laser", The Journal of Utah Academy of Sciences, Arts, & Letters, Volume 86, p. 257, 2009.

R. Steven Turley, David Alllred, Anthony Willey, Joseph Muhlestein and Zephne Larsen, "Effective Medium Theory, Rough Surfaces, and Moth's Eyes", The Journal of Utah Academy of Sciences, Arts, & Letters, Volume 86, p. 273, 2009.

Statistics

Lawson, J. *Design and Analysis of Experiments with SAS*. CRC Press, 2010.
*** Professor Lawson would be happy to consult or collaborate with any faculty who would like to use Experimental Design in their research work.*

Eggett *continued*

not to over-apply it. If applied too liberally the fertilizer may actually serve the opposite purpose and decrease the fertility of a piece of land.

"With too much fertilizer, you may start to burn the leaves," Eggett said. "And without the nutrition from the leaves, the potatoes will not develop."

Though this study was carefully executed and produced much information, it would have been impossible to come to any clear conclusions or understand the results without Eggett's statistical analysis. Statisticians bring all the information together, analyze it, and identify the patterns in a study.

Many times we do not notice the affect statistics have on our lives, but Eggett's work demonstrates why statistical analysis is so important in many scientific studies. In this case, Eggett is helping farmers understand how to increase their income by improved farming methods. With a growing population, effective use of the land is becoming increasingly important and these types of studies are increasingly more important.

by: Natalie Wilson

Williams researches teaching and telling


Steve Williams

At the front of the class, demonstrations are given and tough problems are solved—but this time it's the students that are doing the explaining. Steven Williams, a faculty member in the Department of Mathematics Education, has published research on how these classrooms still incorporate traditional teaching methods.

Williams' publication is all about how the student can benefit from being more involved in the learning process. Along with a colleague from the University of Oregon, Williams studied classroom interactions at schools who had implemented a new approach to teaching math.

Under the direction of university and college professionals in their area, these schools implemented a reformed teaching method where students work towards solutions together and then share their solutions with the class. The teacher makes specific suggestions that guide students toward the correct methods. This concept is referred to as "scaffolding," where understanding is initiated as the teacher helps to point out connections.

This approach seeks to avoid one drawback of the traditional classroom setup, where students are told the answers in a rigid, formalized lecture.

"When students get used to a teacher telling them everything they need to know, they begin to tune out until they get to what they think is the important part," Williams said.

So, when do teachers tell? Through his research, Williams found that the dilemma of telling is two-sided. In the reformed approach, how and when teachers choose to tell is still vital to learning. His research shows that teachers were able to scaffold student-led discussion by having clear expectations and keeping a high level of involvement in the classroom.

"We observed that these teachers removed themselves as the single mathematical authority in the classroom and allowed students to explain and justify the mathematics they were doing using their own reasoning," said Williams. "In order to pull this off, teachers need new skills. The term in the field is teachers that have 'withitness,' meaning they are aware of what is going on in the classroom. Good teachers can and should interact. They need a much fuller toolbox than just worksheets and timed tests."

Williams feels the greatest impact of his research is its potential ability to change the poor reputation that has been attached to this kind of teaching. His publication provides support for an improved system that requires students to meet higher expectations by being independent thinkers. The role of teachers is enlarged, not diminished, through increased interaction. His paper acts as a caution towards extreme implementation of either reform or traditional methods.

"I realize that when you describe this kind of teaching, people say this is just discovery teaching and that didn't work in the nineties," he said of the politics involved. "They say it's

Williams *continued*

like turning over the asylum to the inmates, when really it's more subtle than that. It's not a wholesale abandonment of telling. Teachers in our study did break in when necessary. They did in fact tell, and any teacher needs to do that. Neither a pure lecture nor a pure discovery approach will work. Each side has more to give than the other side realizes."

Though not part of his published findings, Williams found that this blended approach did, in fact, work for the school studied. In the case of 8th grade algebra students, they saw a huge jump in the number of students who were able to test into higher math classes, evidence that they were still performing well on standardized tests.

While many concede that talking about history or literature is helpful, many don't see how more than one answer in math can actually be useful. Williams said that such a prejudice comes from not fully understanding the subtleties of mathematics.

"Different answers sometimes serve different purposes," he said. "The ways of thinking about and approaching the problem are more important. If you understand math correctly as being about ideas and making connections, not just memorizing rules and applying them, you can see that [discussion among students] is suited to math."

With the addition of Williams' research to the literature, educators can better evaluate how these teaching methods can work together to create a richer education for math students.

by: Katie Pitts

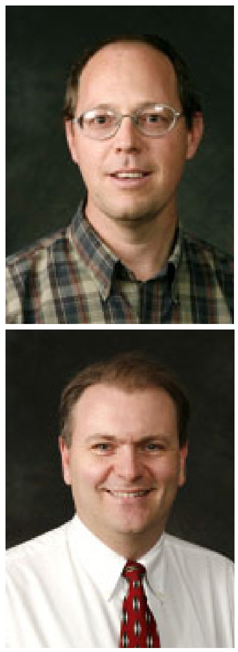
Professors improve wireless Web

The Internet is becoming more and more wireless. We see this in rural, developing countries where the cost of wiring infrastructure is too high, as well as in urban environments where wireless cameras and other devices are streaming information more than ever before. Every time we use an iPhone or laptop to wirelessly access the Internet, we are part of this trend.

Students, professors develop MEMS process

Silicon's status as the sole material for microelectromechanical systems (MEMS) is quickly being challenged by a team of students.

Working with Robert Davis and Richard Vanfleet, faculty members in the Department of Physics and Astronomy, the team is discovering and publishing new methods for constructing these tiny machines.



Robert Davis (top) and Richard Vanfleet

Though often unaware, most of us enjoy using some kind of MEMS on a daily basis. Their microscopic features play a vital role in a number of everyday items, such as the sensors that set off airbags, make Wii remote controls respond, and tell cameraphones which way is up. Until now, these silicon MEMS were limited in size, sensitivity, and the type of conditions they could withstand. However, by using carbon nanotubes, Vanfleet and Davis's research team has opened up a number of fresh possibilities.

"The reason we're excited is that our process gives us an alternate approach to make small structures," Vanfleet said. "Right now, we make them out of silicon. That's about it, which means designs are limited to a few microns tall. Our process gives us ways to make MEMS taller, more sensitive. Silicon can't do that."

This novel method for fabricating MEMS puts to use one unique property of carbon nanotubes. Because of the molecular structure of carbon, the molecules join together and form microscopic tubes. By laying down a catalytic layer, or substrate, a forest of vertically aligned tubes can be grown at a controlled rate.

The 3-D structure is then filled in as it is sprayed with a chemical vapor, comparable to the way in which rebar reinforces a concrete wall. Silicon and silicon nitride, the traditional materials for MEMS, have been proven as adequate materials for solidifying the structure, but many other filling materials could be used. The team is very excited about the wide range of possibilities that this opens up in the field of MEMS fabrication.

"The carbon nanotubes form a framework, which then we can coat with whatever we want," Vanfleet said. "[This new technique] allows us to make MEMS from all kinds of materials, avoiding some of the other limitations of silicon. For example, if we wanted to put a sensor in the exhaust pipe of a car, it would be too hot and too corrosive for silicon."

Vanfleet and Davis are continuing to explore the properties and applications of carbon nanotubes in MEMS. They are currently setting up a facility on campus that will allow them to test more materials. These facilities will also serve several other department research groups as they study their own exciting applications of carbon nanotubes.

"We're going to make lots of things with it," Vanfleet said of the project. "We're pushing into the materials. Looking at how strong the structures are now opens up avenues to what we can do with them."

Vanfleet said his project is now reaching out to involve faculty from the chemistry, chemical engineering, and mechanical engineering departments, in order to make full use of the technology. The research will continue to be led by himself and Davis. He also noted that the pair collaborates on about 80 percent of their projects. He said their partnership is best described as "You made it; I look at it."

As both professors and their mentored students continue their research as applied physicists, carbon nanotubes may soon be improving some of your favorite electronic devices.

by: Katie Pitts

IMPORTANT DATES TO REMEMBER

- *NSF Regional Grants Conference*
  October 25-26
  For more information, click here.

Warnick/Zappala *continued*

Sean Warnick and Daniel Zappala, professors in the Department of Computer Science, are making these wireless networks work better. Funded by an $80,000 grant from the United States Air Force (USAF), they have combined the efforts of their respective research groups to make wireless networks more efficient and fair.

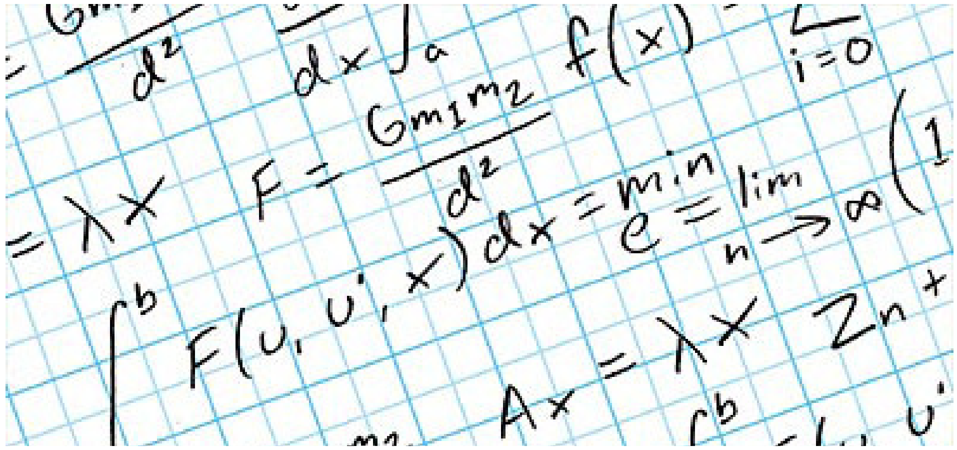
Several important algorithms have been designed for the wired Internet to decide which path data takes as it travels through the network and to decide how fast each application should send. These algorithms don't tend to work as well for wireless networks – the path between two users might not be the fastest, for example. In some cases, two users could be sharing a wireless network, but one of them could be allocated all of the resources while another is left without anything.

Sean Warnick (top) and Daniel Zappala

Warnick and Zappala are developing new algorithms that will provide better performance and fairness for wireless networks. These algorithms are based on mathematical models of the network, so that their performance can be provably guaranteed. Moreover, the team is deploying these algorithms on an actual wireless mesh network in the Talmage building and comparing real performance with the mathematical guarantees.

Zappala leads the Internet Research Lab, which specializes in building software that both extends the reach of the Internet and improves its performance. Warnick leads the Information and Decision Algorithms Laboratories, or IDeA Labs, an interdisciplinary team of students exploring complex systems in Business, the Life Sciences, Government, and Engineering including, of course, the Internet.

by: Natalie Wilson



Professor finds work fun in Number Theory

Roger Baker

While many fields call upon mathematicians to solve real world problems, a large group of these number magicians also find personal enjoyment in playing with complicated relationships between integers. These number theorists concern themselves with pure mathematics, the properties of numbers in general, and often decipher complex puzzles for pleasure. Roger Baker, a faculty member in the Department of Mathematics, is a passionate member of this community.

"The problems I solve are curiosity driven," he said.

In a recent publication, Baker presented his most recent findings related to the Gauss Circle Problem. This problem challenges mathematicians to find the number of lattice points that can fit into any given circle. Extensive amounts of work were required to identify just one method to solve this puzzle.

"It takes dozens of pages of calculations," he explained, producing a 45-page pamphlet of equations that proved his solution.

Realizing the amount of work required to solve just one aspect of a single problem helps one to understand the overwhelming number of problems mathematicians tackle. Publications come out so often and in such various areas of mathematics that one must continually review these works to stay in the mainstream of discoveries. Baker says he must devote a minimum of one hour per week to reading reviews of those papers relevant to his area of interest just to remain current.

Studying and commenting on papers not only helps mathematicians keep up with findings, but also aids in accelerating further discovery. If one researcher cannot find the solution to a problem, for example, he or she may study the advances others have already made and build upon that groundwork.

"I love to read others' findings and then see if I can do it better," Baker said.

Mathematics fosters an extremely intricate and intimate community. Members continually communicate, sharing ideas via the Internet and international conferences. Even war and harsh restrictions could not keep mathematicians from collaboration. When the Iron Curtain was still up, Baker corresponded by mail with fellow researchers who were behind it. These mathematicians' mutual love for their science propelled them to overcome any barriers that would hinder their progression.

"It's a community," he explained. "We love to help each other."

While much of this numerical research is done to fill personal curiosity, practical applications of Number Theory have also emerged in recent years. One especially pertinent example is its prominent role in banking cryptography, the science of writing codes. Because account information can grant access to large amounts of money, banks must be sure to create nearly unbreakable ciphers so as to protect their funds from illegal tapping.

By playing with numbers and understanding their properties, number theorists have established themselves as vital members in the banking world by creating strong, protective codes. While many of these researchers may be in it for the fun, they remain an indispensable tool for maintaining security.

by: Natalie Wilson