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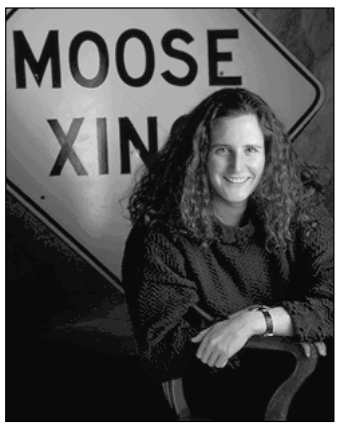
Facilitating undergraduate research reflects professor's project-based learning perspective

Elizabeth Campell
Institute Communications and Public Affairs

While earning her Ph.D. at Massachusetts Institute of Technology (MIT), Amy Bruckman enjoyed supervising undergraduate researchers. When she joined the College of Computing faculty at Georgia Tech in 1997, she missed the involvement of undergraduates in her research that she had experienced at MIT. In addressing this void, she created the Undergraduate Research Opportunities in Computing (UROC) program in 1998, a modified version of a similar MIT program. In effect, faculty seeking assistant researchers may post their research opportunities in a UROC database available to all students. Depending on the project, students may earn either course credit or pay for their research work.

"I think it is important to raise awareness of research and to foster research into the culture at Georgia Tech," says Bruckman, an assistant professor who also directs research at the Electronic Learning Communities (ELC). "I often tell my students that strong research experience can outweigh their grade point average for potential employers."

Mark Gudzial, an associate professor in the College of Computing who has benefited from the use of Bruckman's program, agrees. "I've found that the undergraduate students often become turned on to research through their work," Gudzial said. "[UROC] is the best example of a learning community that I see on campus."



Moose have come to be the symbol of Bruckman's ELC.

Other ways the UROC program encourages undergraduate students to get involved in research is by offering travel grants for students whose papers have been accepted to a conference and by sponsoring an annual symposium. Each spring UROC conducts its annual symposium where students present their research projects in a format similar to academic conferences. Computing faculty select the top research presentations, and winners receive prizes. The symposium recognizes outstanding student research and helps to get the word out to other students to take advantage of research opportunities in the College.

"At the informational meeting the first semester, we had more faculty than students attend," says Bruckman. "A year later we hoped for 30 and got 150-200 students at the information session." The 2001 Symposium is scheduled for April 17.

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Fundamental limit defines future opportunities for silicon nanoelectronics

John Toon
Research News and Publications

Electronics researchers have defined a fundamental limit that will help extend a half-century's progress in producing ever-smaller microelectronic devices for increasingly more powerful and less expensive computerized equipment.

The fundamental limit defines the minimum amount of energy needed to perform the most basic computing operation: binary logic switching that changes a 0 to a 1 or vice-versa. This limit provides the foundation for determining a set of higher-level boundaries on materials, devices, circuits and systems that will define future opportunities for miniaturization advances possible through traditional microelectronics — and its further extension to nanoelectronics.

"Future opportunities for gigascale integration (chips containing up to a billion devices) and even terascale integration (chips containing trillions of devices) will be governed by a hierarchy of physical limits," said James D. Meindl, professor of electrical and computer engineering and director of the Microelectronics Research Center. "We now know the fundamental limit on microelectronics and where we are relative to it."

Photo by Stanley Leary

James Meindl with a silicon wafer. Rather than the theoretical limit, he said, it will be the physical limits that determine future engineering design.

Meindl explained the limits and their implications February 16 in a seminar on nanotechnology held at the 167th annual meeting of the American Association for the Advancement of Science (AAAS) in San Francisco.

Meindl and collaborator Jeffrey A. Davis reported in the October 2000 issue of IEEE Journal of Solid State Circuits that the fundamental limit depends on just a single variable: the absolute temperature. Based on this fundamental limit, however, engineers can

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National Academy of Engineering selects Bruce Ellingwood as new member

Larry Bowie
Institute Communications and Public Affairs

Photo by Stanley Leary

Bruce Ellingwood

Georgia Tech's School of Civil and Environmental Engineering can be doubly confident it made the right choice in selecting Bruce Ellingwood as its new chair. Last month the National Academy of Engineering (NAE) elected Ellingwood for membership in the Academy. The coveted honor is among the top professional distinctions for American and foreign engineers.

Ellingwood, who joined Tech last September following a nationwide search, was selected by the NAE based on his important contributions to engineering theory and practice, said NAE President Wm. A. Wulf. In honoring Ellingwood, the NAE specifically noted his leadership in the use of probability and statistics in the design of structures and in the development of new design procedures in structural engineering.

"I am very pleased and deeply moved to be honored for my work," Ellingwood said. "I have been privileged to collaborate with and be counseled by many outstanding colleagues and students during my career. Much of the credit for my success rests with them."

Membership to the NAE is granted once per year. The organization elected 74 engineers and 8 foreign associates to its membership this year, bringing the total number of U.S. members to 2,061 and foreign associates to 154. The election of Ellingwood in the Academy brings Tech's number of active NAE members to 21.

President Wayne Clough, an NAE member since 1990, said, "It is a pleasure to be joined in the civil engineering contingent of the NAE by a fellow Georgia Tech faculty member. This is a well-deserved honor for Bruce Ellingwood, given his significant professional accomplishments."

Prospective members are not made aware that their names are being considered during the nominating and voting process, which is kept confidential within the Academy until it notifies the newly elected members by mail.

"The joy that I felt after opening the package from the NAE can't be described in words," Ellingwood said. "My friends and colleagues can tell you that rarely am I at a loss for words. This was one of those rare times."

Prior to joining Tech, Ellingwood held the Willard and Lillian Hackerman Chair in Civil Engineering in the Department of Civil Engineering at Johns Hopkins University. He chaired the department from 1990 to 1997. Ellingwood is a two-time recipient of the American Society of Civil Engineers' oldest and most prestigious recognition, the Norman Medal.

Since 1978 his work in the area of probability-based load combinations and natural hazards analysis has been the basis for the treatment of design loads for buildings and other structures in all major codes in the United States.

"As we expected, Bruce has brought strong administrative leadership to the School of Civil and Environmental Engineering," said Jean-Lou Chameau, dean of the College of Engineering. "His scholarly accomplishments and commitment to quality work make him an outstanding role model for our faculty and students."

The NAE will hold an Induction Ceremony for all new members in Washington, D.C., later this year.

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derive a hierarchy of limits that are much less absolute because they depend on assumptions about the operation of devices, circuits and systems.

The researchers studied the fundamental limit from two different perspectives: the minimum energy required to produce a binary transition that can be distinguished, and the minimum energy necessary for sending the resulting signal along a communications channel. The result was the same in both cases.

Though this fundamental limit provides the theoretical stopping point for electrical and computer engineers, Meindl says no future device will ever operate close to it. That's because device designers will first bump into the higher-level limits — and economic realities.

For example, electronic signals can move through interconnects no faster than the speed of light. And quantum mechanical theory introduces uncertainties that would make devices smaller than a certain size impractical.

Beyond that is a more important issue — devices operating at the fundamental limit would be wrong as often as they are right.

"The probability of making an error while operating at this fundamental limit of energy transfer in a binary transition is one-half," Meindl noted. "In other words, if you are operating just above the limit, you'll be right most of the time, but if you are operating just below it, you'd be wrong most of the time."

What does this mean for electronic and computer engineers?

"We can expect another 10 to 15 years of the exponential pace of the past 40 years in reducing cost per function, improving productivity and improving performance," Meindl said. "There will be lots of problems to solve and inventions that will be needed, just as they have over the past four decades."

The outer limits

The theoretical limit, expressed as E(min) = (ln2)kT, was first reported 50 years ago by electrical engineer John von Neumann, who never provided an explanation for its derivation. (In this equation, T represents absolute temperature, k is Boltzmann's constant, and ln2 is the natural log of 2.)

He expects the world's use of silicon will follow the pattern set by its use of steel. During the second half of the 19th century, steel use increased exponentially as the world built its industrial infrastructure. Growth in steel demand fell after that, but it remains the backbone of world economies, though other materials increasingly challenge it.

"In the middle of the 21st century, we are going to be using more silicon than we are now, by far," he predicted. "There will be other materials that will come in to replace it, like plastics and aluminum came in to push steel out of certain applications. But we don't know yet what will replace silicon."

Though the limits provide a final barrier to innovation, Meindl believes economic realities will bring about the real end to advances in microelectronics.

"What has enabled the computer revolution so far is that the cost per function has continued to decrease," he said. "It is likely that after a certain point, we will not be able to continue to increase productivity. We may no longer be able to see investment pay off in reduced cost per function."

Beyond that point, designers will depend on nanotechnology for continuing advances in miniaturization.

"What happens next is what nanotechnology research is trying to answer," he said. "Work that is going on in nanotechnology today is trying to create a discontinuity and jump to a brand new science and technology base. Fundamental physical limits encourage the hypothesis that silicon technology provides a singular opportunity for exploration of nanoelectronics."

The research is sponsored by the Advanced Research Projects Agency under Contract F33615-97-C1132, the Semiconductor Research Corporation under Contract HJ-374 and Georgia Tech.

For more information...

Microelectronics Research Center
http://www.mirc.gatech.edu/

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Stuart Jeff won first place in the 2000 UROC Symposium for his contribution to a Bruckman project called AquaMOOSE, an online community designed to let high school students create their own video games in an environment that rewards mathematical, artistic and computational learning. Jeff, who earned his degree in computer science last year, designed the Avatar construction kit, which creates 3-dimensional characters for use in the AquaMOOSE virtual community. This kit allowed users to customize their characters.

Jeff participated in the UROC Symposium the previous year as well, with the goal of presenting his research and learning how to present his work well. Jeff felt the experience helped him return a year later better prepared, with a better presentation, and more comfortable and confident with his communications skills.

"While working on this research project, I learned so much about graduate school and the academic world, that I felt like I was going to graduate school," he said.

Observing that the graduate students who excelled were the ones who had already focused on an area or a project, he decided to work in the business world after graduation. He plans to pursue graduate school once he's decided on a project. Jeff, who describes himself as an "okay student," had several jobs to choose from after graduation, which he attributes directly to his research experience and the contacts he made while working with Computing faculty.

Bruckman's lead in the UROC program is not coincidental. Much of her teaching and research centers on her project-based learning perspective — motivated by the idea that children and adults learn by doing — whether it is programming on a virtual community or encouraging undergraduates to get hands-on experience through a research internship.

"It's a great program for all concerned," Gudzial said. "The students gain great new opportunities, and the faculty gain new colleagues in having their projects move forward."

For more information...

Undergraduate Research Opportunities in Computing (UROC):
http://www.cc.gatech.edu/program/uroc/

AquaMOOSE 3D:
http://www.cc.gatech.edu/elc/aquamoose/

Photo by Stanley Leary

Architecture students ventured out of their studios February 23 to meet with representatives of more than 20 Atlanta-area architecture firms during the College of Architecture's annual Career Day. Local architects spoke informally with students to discuss the needs and expectations of their profession.

Lane Duncan, a part-time instructor in the College of Architecture, said the event continues to grow each year.

"The firms get a chance to present their work and the things they're interested in," he said. "For the students, it gives them a great opportunity to see the work from some of the top firms in the country."

Faculty elections to be web based

This spring, the campus-wide faculty governance elections will be conducted using a web-based system. The elections are for membership of standing committees of the Academic Senate and of the General Faculty Assembly. In addition, there will be elections to the executive board for certain constituencies.

Each eligible voter will receive an e-mailed message that directs them to a personalized ballot, and will include all the races for which they are eligible to cast a vote. Friday, March 16, has been set as the date for the initial mailing, and responses will be accepted for ten working days thereafter. To preview the races and candidates, refer to http://www.faculty-senate.gatech.edu/zelectionlist2.html. Faculty who are members of the "Services and Central Administration" group will simultaneously receive ballots to select their representatives to the General Faculty Assembly.

The voting system was designed by Andy Fox, Chris Smith and Lori Sundal of OIT. If there are any questions about the conduct of the poll, contact Edward Thomas, secretary of the faculty, who is responsible for conducting the elections. E-mail edward.thomas@physics.gatech.edu or call 894-5249.

Change in long distance services: Tech calling cards to expire

Theresa Harvard Johnson
Office of Information Technology

Effective on or before Wednesday, March 14, the state of Georgia will convert its long distance services from Sprint to Qwest. The immediate impact of this change for state agencies — including Georgia Tech — will be the expiration of Sprint long distance calling cards.

"Georgia Tech's long distance services with Sprint will terminate in mid-March," said Mike Lambert, telecommunications specialist for the Office of Information Technology (OIT). "The impact on Tech will be minimal; however, the changeover will affect faculty and staff who currently use the long distance calling cards, particularly faculty and staff who may travel out of state, or out of the country during the transition period."

The Georgia Technology Authority (GTA) stated in a memorandum to state agency heads that services with Sprint were terminated following a dispute over Sprint's current rate structure.

"We will not see a real change in regular long distance services," Lambert said, adding that the transition would hardly be noticed from a user perspective.

If any member of the faculty or staff find themselves in this category, OIT asks that they contact their department's telecommunications coordinator as soon as possible, said Dewey Baxter, manager of the OIT Operations Center.

"This would be considered an urgent need," he said.

All other staff should contact their department's telecommunication coordinator also to turn in their old cards and arrange for replacements if they have not already received them.

"Every effort is being made to make this as smooth a transition as possible," said Baxter. No date is currently available for when the transition will be completed.

According to a statement from the Georgia Department of Administrative Services (DOAS), Qwest card distribution was scheduled to begin on Thursday, March 1. Currently, 22,000 Sprint calling cards are used by state agencies statewide.