ECE 2008

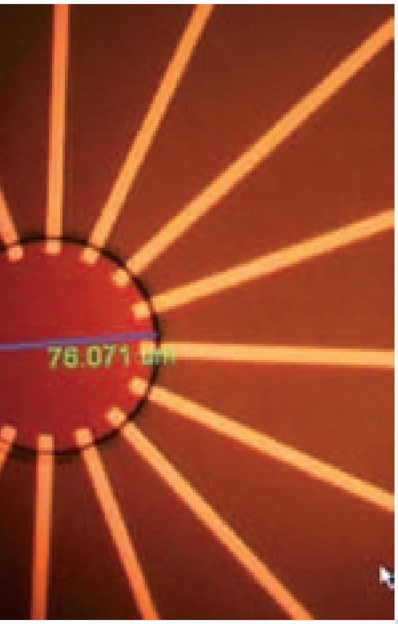
The Bradley Department of Electrical and Computer Engineering

Virginia Tech
Invent the Future

This report was produced with funds from the Harry Lynde Bradley Foundation.

BEHIND THE COVER: The MANIAC Challenge, organized by an ECE team, generated the first large multi-hop mobile ad hoc network in November 2007 (p. 9). This was one of many activities in the department related to networks — from cognitive radio to power distribution to gene networks. The underlying graphic is based on a work by abstract artist Ja' Ski, called "Futuristic Network."
Cover illustration by Christina O'Connor.

WHAT'S INSIDE



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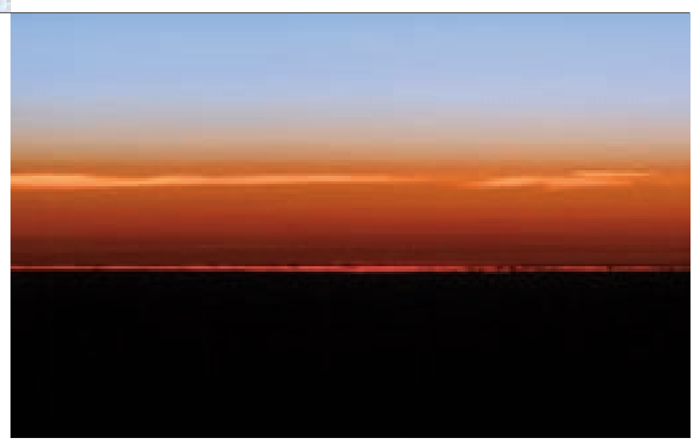
UNDERGRADUATE RESEARCH

ECE PEOPLE



Photography by Virginia Tech Visual Communications
unless noted otherwise.
Jim Stroup: pp. 2, 3, 4, 5, 6, 7, 8, 12, 13, 14, 15, 38, 39
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Kim Peterson: p. 38

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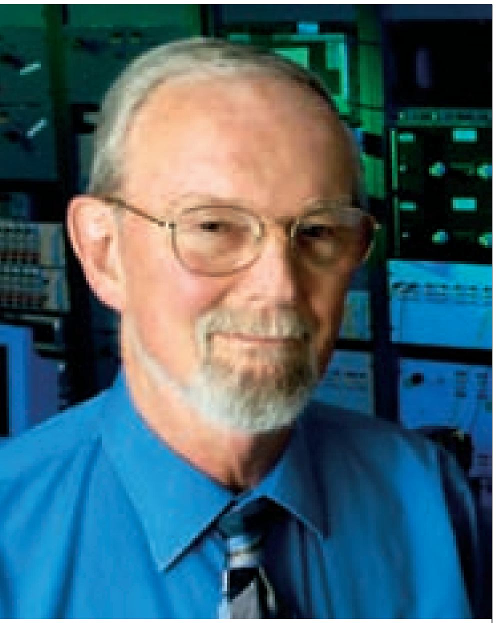
PERSPECTIVES

from the Department Head



James S. Thorp
Department Head

As the world knows, 2007 was a tumultuous time at Virginia Tech. Like the rest of the university community, we in ECE were affected by the horrible events of last April. All of us in the department mourn the senseless deaths of and injuries to our students, faculty, friends, and neighbors. But it hasn't changed who we are: a department passionate about knowledge and education in electrical and computer engineering.

This year, many of our ECE alumni have reconnected with us, reminding us of our strengths and successes. Our alumni are a strong link to both the technology community and to communities around the world. Please keep in touch!

From our alumni, we have heard that the National Science Foundation (NSF) has honored three of our alumni with CAREER awards — its highest award for young faculty leaders. In 2007, Neil Patwari (BSEE '97, MSEE '99) earned an award for his work at the University of Utah. The prior year, two Ph.D. graduates, Robert Adams ('98) at the University of Kentucky and Greg Durgin ('00) at Georgia Tech both received CAREER awards. This past year, Durgin was also honored with Georgia Tech's highest teaching award.

We have a strong group of alumni who live and work in Virginia. As the state's largest and highest ranked ECE department, we take pride in the latest news that Virginia has the highest technology worker density in the country and is the fifth largest high-tech state. Most of these jobs relate directly to our field, involving computer systems design and service and engineering services. We continue to adapt to serve the needs of the region and the field. We added three new faculty members this year, but will be constrained with the institution of budget cuts that will limit our future hiring.

In the fall, Tamal Bose joined ECE as the associate director of Wireless@VT, coming from Utah State, where he had served as department head and held an endowed chair. Majid Manteghi, an assistant professor in antennas and RF joined the faculty from UCLA. This spring, Marius Orlowski accepted a position here as the VMEC Chair in microelectronics. He came from Freescale Semiconducteur in France.

The new Center for Space Science and Engineering Research Center just completed building our new HokieDARN radar station, that for the first time enables continual mapping of the space weather plasma motions over the northern United States. This and our other space science activities are described beginning on page 16.

Our opening stories describe work being done in cognitive radio networks. This technology draws researchers from many areas and has become a significant activity in our department. Two of our student teams took top honors at the Software Defined Radio Forum's 2007 Smart Radio Design Challenge.

Notable faculty awards include Masoud Agah (see p.13) and Jung-Min Park (see p.6) receiving NSF CAREER awards. G.Q. Lu's development of nanoTach was listed one of the 100 most technologically significant products of 2007 by *R&D Magazine*.

My many thanks to Dan Sable who has continued for a second term as the chair of the advisory board. Dan and the board have been extremely helpful in supporting the initiative in space sciences.

Last year I asked for help in identifying photos of W. A. Murray (1935-56) and B. M. Widener (1956-58) to complete our wall of department heads. I am happy to report we received the photos and the artist is painting both portraits.

from the Advisory Board Chair

It is an honor and a privilege to have been re-elected as chair of ECE's Industrial Advisory Board (IAB) for a second year. The events of last April are still fresh in our memory. The resulting challenges that they have brought to the ECE department and the entire university appeared at first to be insurmountable. We mourn the loss of ECE student Henry Lee, and our other friends and students who were killed. We are encouraged by the determination and healing of those who were injured. Our entire community still is dealing with the emotional fallout. However, in the face of this adversity and the continuing emotional and financial burden that is being placed on Virginia Tech and the ECE department, in fact, we have become stronger.

The Virginia Tech ECE department has truly outstanding undergraduate and graduate programs with excellent faculty world-renowned for teaching and research. I can still remember 25 years ago when Dusan Boroyevich and I were graduate students together taking the first course in Power Electronics offered by Fred Lee. "Dr. B.," as the students call him, is now one of the most well respected lecturers in the ECE department. Boroyevich and Lee are now completing their 10th and final year as a National Science Foundation (NSF) Engineering Research Center (ERC). This puts them into an extremely elite group of only six other universities in the country with graduating NSF ERCs in the electronics area.

The list of ECE accomplishments in the past year continues. The recent Franklin Institute Award to ECE Department Head Jim Thorp, and ECE University Distinguished Professor Emeritus Arun Phadke puts Virginia Tech ECE in a league with Albert Einstein, Thomas Edison, Orville Wright, and Marie and Pierre Curie. ECE graduate students took top honors in the Inaugural Smart Radio Challenge at the 2007 Software Defined Radio Forum conference in November. Tech was the only school with two teams among the final 10 competitors.

ECE assistant professors Jung-Min Park and Masoud Agah were awarded NSF CAREER Awards for their work on improving the security of cognitive radio networks and development of a credit-card sized gas chromatography platform. CAREER awards are NSF's most prestigious award for creative junior faculty members considered to be future leaders in their academic fields.

ECE assistant professor Scott Bailey was the co-principal investigator of the NASA AIM Satellite, which was launched April 25, 2007. He was able to convince NASA at the last minute to place a logo on the rocket in memory of the Virginia Tech victims.

As alumni and members of the Industrial Advisory Board, it is in our own interest to see the ECE department prosper and gain greater reputation. My vision for the IAB is to encourage an active role for the members in several ways:

1. Alumni and IAB member companies can encourage practical experience by sponsoring undergraduate and graduate student interns.

2. Alumni and IAB member companies can participate directly in the classroom through guest lectures. Relating practical problems encountered in industry to the classroom theory goes a long way with student understanding of course material.

3. Alumni and IAB member companies can sponsor research in areas of most concern to them.

4. Alumni and IAB member companies can take an active role in being an advocate for the ECE department at the college and university level. The ECE department has been a traditional strength of the university. It is critical that it continues to receive appropriate priority.

5. Finally, alumni and IAB member companies can support the ECE department through generous financial donations.

The ECE department head, Jim Thorp, has demonstrated remarkable leadership in focusing the Department and the IAB fully supports his efforts. The university is fortunate to have person of his stature, integrity, caliber, and vision as the ECE Department Head.

Great teaching, great research, great students, great alumni, great leadership – what more can one ask for?

Dan Sable
Chair, ECE Advisory Board

Arun Phadke (left) and Jim Thorp (right).

Franklin Medal Winners, Arun Phadke & Jim Thorp

> **Today, their technology and algorithms are used to keep lights on around the world, and they have been honored with the prestigious 2008 Benjamin Franklin Medal in Electrical Engineering.**

BLACKOUT BUSTERS

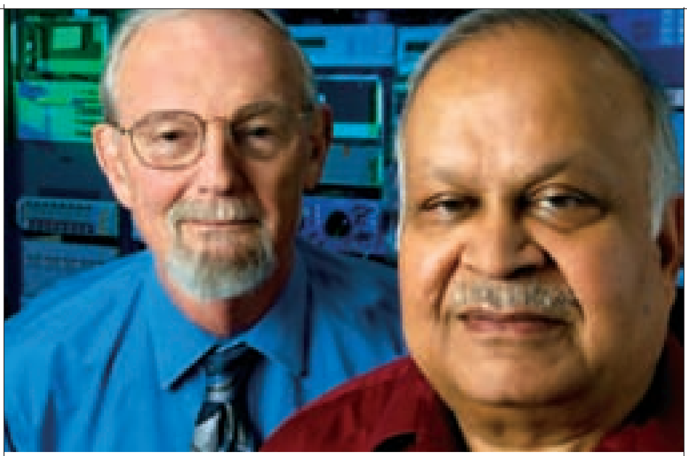
More than 30 years ago, Jim Thorp, ECE department head, and Arun Phadke, a university distinguished professor emeritus, first teamed up to fight power grid blackouts. Today, their technology and algorithms are used to keep lights on around the world, and they have been honored with the prestigious 2008 Benjamin Franklin Medal in Electrical Engineering.

For 184 years, the Franklin Institute has identified men and women from around the world whose contributions have benefited society, advanced science, launched new fields of inquiry, and deepened the understanding of the universe. Previous recipients include Albert Einstein, Nikola Tesla, Max Planck, Enrico Fermi, Thomas Edison, Orville Wright, Marie and Pierre Curie, Guglielmo Marconi, and Jane Goodall.

Phadke and Thorp received the award for "pioneering contribution to the development and application of microprocessor controllers in electric power systems." Their work has made blackouts less frequent, less intense, and easier to recover from.

Their partnership began in 1976 when Thorp was a professor at Cornell and took a sabbatical to study power systems at American Electric Power (AEP) in New York. There he met Phadke. "We were working on introducing computer applications into the power system," Phadke recalls. "Jim had a background in controlling systems and we gave him an assignment in computer applications. He was the perfect fit."

The Ultimate Team



As a team and individually, Thorp (left) and Phadke (right) have been very productive.

How does a team like this survive 30 years? They say the strength of their collaboration relies on their differences. They describe Phadke as an intuitive problem solver and Thorp as the theoretician with a background in control theory, probability and mathematics.

"Arun knows everything about the power system," Thorp says. "He always has an elegant, direct answer, and I tend to make them more complicated. He has a Richard Feynman-like intuition about things. He's able to bring groups together and makes things happen," he adds.

Phadke says, "Jim is very competent in finding out the math that underlies the issue at hand. Not only does he recognize it, but he solves it. It's remarkable to watch him doing things and realize that, before my eyes, he's doing something that has probably never been done before."

As a team and individually, Phadke and Thorp have been very productive. Phadke holds five patents, has authored more than 150 papers and has written or contributed to 22 books.

Thorp holds two patents has authored more than 200 papers. They are both members of the National Academy of Engineering and Fellows of the IEEE and have been honored with many honors and awards.

Thorp retired from Cornell and came to Virginia Tech in 2004, and the two continue their association in closer contact. They have projects and contracts that extend several years into the future.

"There are many more problems to solve," Thorp says, noting that much of the equipment is more than 40 years old. "As a society, we've got to modernize the power system and these measurements are part of the story."

Protection Technology

For eight years, Thorp commuted one day a week from Ithaca to New York, working on different projects. At that time, power relays — that shut down local power systems to protect the equipment — were made of electromechanical and solid state components. Thorp and Phadke developed the algorithms needed to replace the bulky machines with microprocessors.

"Many people in the industry said that computers couldn't do such a heavy, dangerous job — that it couldn't happen," says Thorp. "But, of course it has. Today you can't buy anything but computer relays." All of today's power protection systems use Phadke and Thorp's algorithms in some way.

One of the biggest problems in protecting the power flow along the grid has been getting information from each of the 3,000 power companies involved. "The power companies could tell the voltage and the location of a disturbance, but there was no commonality when we tried to study large blackouts, like along the East Coast in 1965 and 2003, and 1996 on the West Coast," Phadke explains.

The common measure was time. When the GPS system was being established, Phadke realized it could be used to time stamp all the data in different power systems. "This was a huge idea," says Thorp. They worked on the concept along with Stan Horowitz of AEP. "We developed the algorithms and proved it could be done theoretically, but AEP did not want to pursue it. 'Who would want it?' we were asked?"

Soon after, Phadke came to Virginia Tech and with his students — including Virgilio Centeno, who is now on the ECE faculty — built the first device, which they called a synchronized phasor measurement unit (PMU). "Our goal was to make very accurate measurements on the power system, no matter how big the network," Phadke says. The device measures voltages and currents and identifies a precise time and location based on GPS signals.

The first units were installed at several power companies around the country and by 1993, about two dozen firms manufactured the instruments. "The next step was computerizing them in a large network. Hundreds have been installed in this country and maybe a thousand in China, Mexico, Brazil, and Europe."

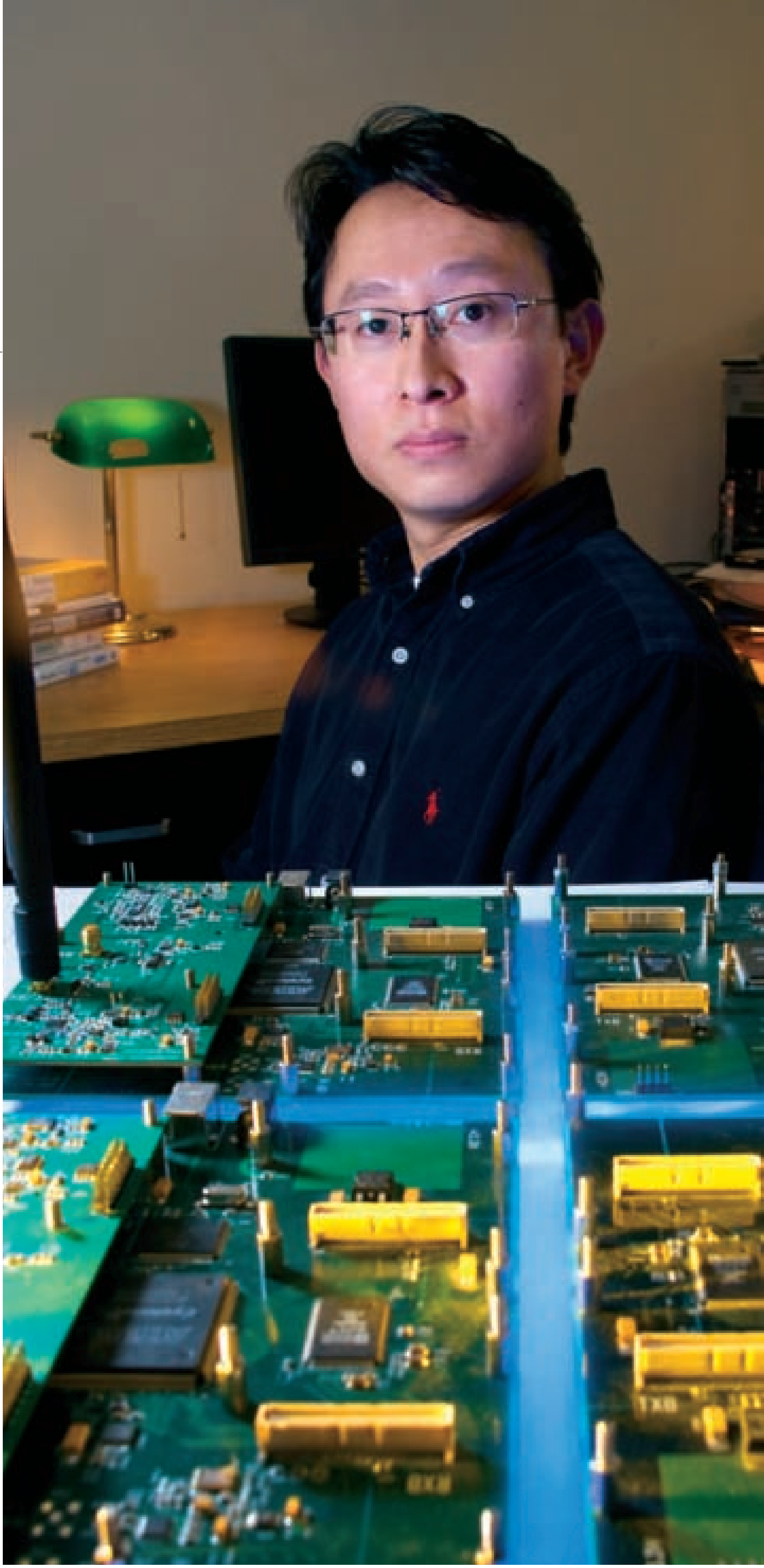
Once a critical mass was installed, they started observing new phenomena along the power grid, Thorp says. "We learned that disturbances spread through the system like waves. Here we had a man-made system behaving like earthquakes and tidal waves!"

The big disturbances can have an early warning system along the grid. "They come at hundreds of miles a second. That's fast, but it's not the speed of light. Computerized equipment can react quickly enough. This makes it possible to protect the system differently," Thorp says.

SECURING THE AIRWAVES

SO YOU DON'T HAVE TO

Seeking a Secure Cognitive Network

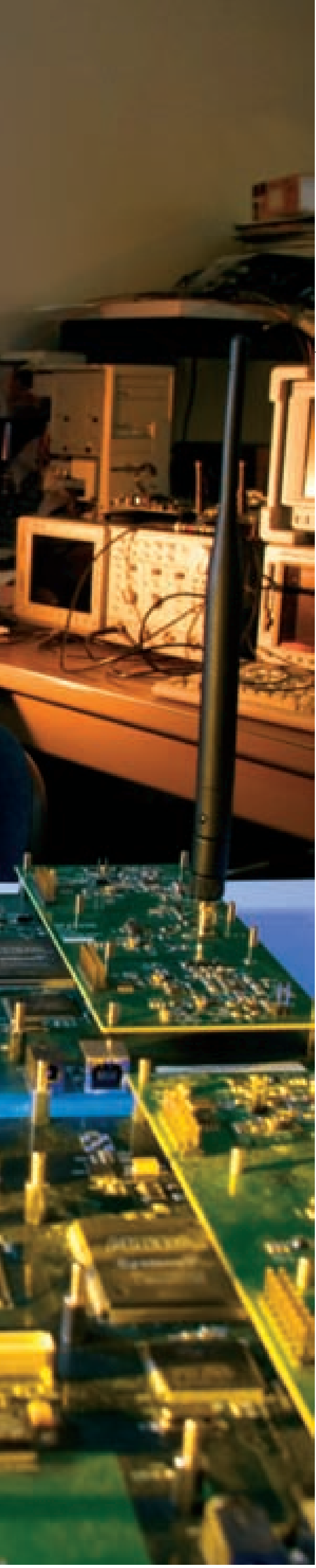


The looming spectrum shortage created by the boom in wireless applications is gaining attention nationwide.

General news media covered the recent Federal Communications Commission (FCC) auction. Google has submitted a proposal to allow wireless broadband in the TV white spaces — those unused areas in the spectrum. Meanwhile, engineers are racing to perfect cognitive radio technology that is expected to play a large role in more efficient spectrum sharing.

ECE's Jung-Min Park supports efforts to deal with the overcrowded unlicensed bands, but he wants to avoid security problems that plague other networks, such as the Internet. The best way to ensure security, he says, is to design for it from the very beginning.

Park has received a $430,000 National Science Foundation (NSF) CAREER Award to head the first major effort to explore non-conventional security issues in cognitive, spectrum-sharing networks. The five-year CAREER



Jung-Min Park has an NSF CAREER award for cognitive network security

grants are NSF's most prestigious awards for junior faculty.

"The spectrum shortage is hampering the development and deployment of new wireless applications and technologies," Park explains. "But, most of the spectrum has been already allocated for licensed use, and the FCC cannot allocate more bands for these emerging applications using the current regulatory paradigms. So, the FCC is considering opening up licensed bands — such as the TV bands — to unlicensed, secondary operations on a non-interference basis with the licensed users, who are typically called incumbents.

In such a scenario, the secondary operators would carry the burden of using the bands when available and ensuring they do not interfere with the licensed incumbents. The incumbents would not have to alter their operation or technology. "This is a hard problem," Park says. "It's like living in somebody's house at the same time as the owner – without ever providing any clue that you are there."

"It's like living in somebody's house at the same time as the owner — without ever providing any clue that you are there."

One of the more promising technologies for these secondary operators is cognitive radios, which can sense and understand their environment and actively change their mode of operation, including frequency, modulation, and transmission power. Researchers — including teams at Virginia Tech — have developed working prototypes of cognitive radios and now are working on high performance networks

"We expect that cognitive radio technology will be used for two-way communications in a wide range of applications, such as communication systems for tactical military forces and emergency responders."

The other major arena for the technology is the development of wireless access networks that can provide Internet services to rural areas, he notes. The world's first standard (IEEE 802.22) for wireless access networks based on cognitive radio technology is currently being developed for rural wireless access.

The advantages of this technology, however can be offset by new security threats that have not been considered previously. "In a civilian cognitive radio network, the motive of a malicious user might be to simply cause mayhem to other users to receive notoriety. This would be the equivalent of computer hackers," he adds.

Malicious users also could try to extort money from providers who operate cognitive radio networks and services. In a military setting, an adversary could try to bring down a network or interfere with its communications to gain a tactical advantage.

"If you think of security after everything is finished, it's too late," Park says. "First developing a functioning network, then guaranteeing security doesn't work. The Internet is the perfect example, with its problems of spam, denial-of-service attacks, viruses, and Trojan horses. Let's break that paradigm. This time, let's think about security at the design stage."

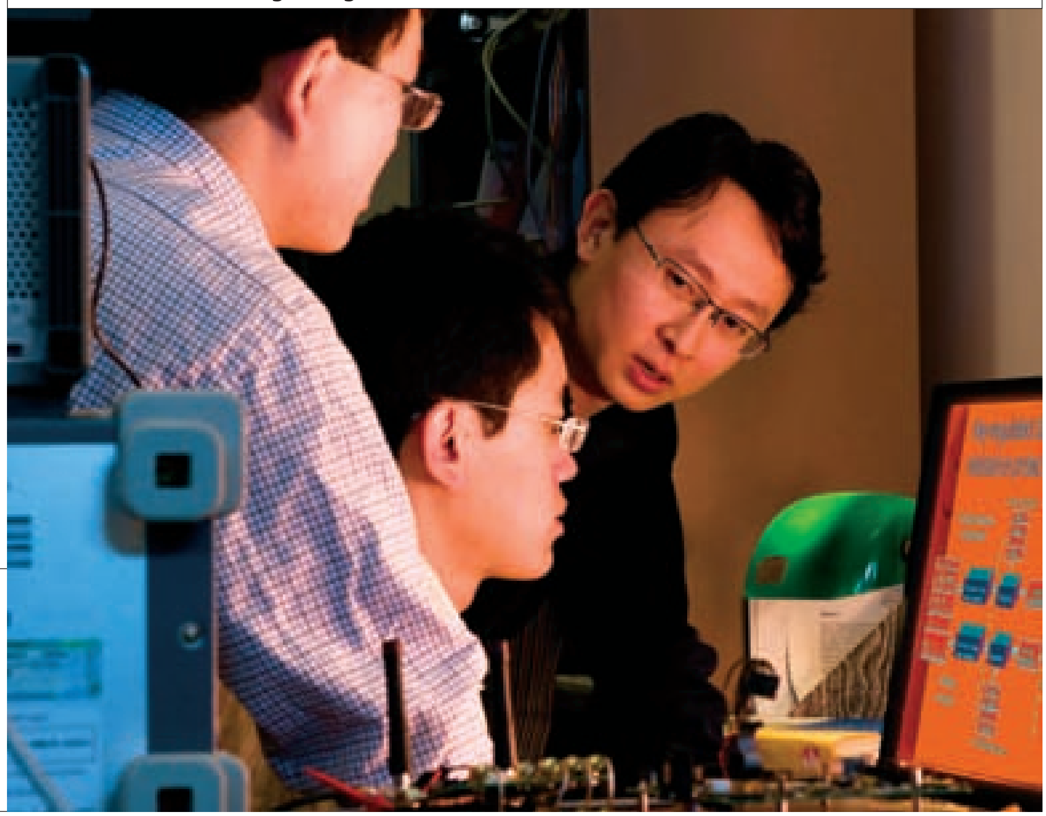
Security is possible to implement from the beginning, according to Park. "These are policy-based radios. They all follow human rules written in software. They are not self intelligent."

Park and his students are focusing on non-conventional threats. He defines conventional security threats as those elements that threaten the confidentiality, authentication, or integrity of the data within the network. "Conventional security threats can be countered using off-the-shelf cryptographic solutions, such as encryption and authentication schemes," he explains. "We use the term 'non-conventional security threats' to denote threats that cannot be thwarted with cryptosystems alone."

The team has identified three different security problems to explore and develop countermeasures against: incumbent emulation; Byzantine failures in cooperative spectrum sensing; and vulnerabilities in cognitive radio network self-coexistence.

"If you think of security after everything is finished, it's too late."

Jung-Min Park (right), Shucai Xiao (left), and Kaigui Bian want to secure cognitive networks at the design stage.



Incumbent emulation would involve modifying the radio's software to change its emission characteristics to appear to other users as an incumbent. This possibility stems from the inherent programmability of cognitive radios and would undermine the spectrum utilization rules, ultimately reducing a network's throughput.

Byzantine failures would appear when incorrect sensing data is sent to the network from rogue terminals run by adversaries or faulty radios with malfunctioning software or hardware. "This problem involves determining how a network can make accurate estimations or predictions in spite of bad information. Can you come up with a scheme that maximizes the network's ability to make accurate predictions, even in a hostile environment where some of the nodes have turned bad?" Park queries.

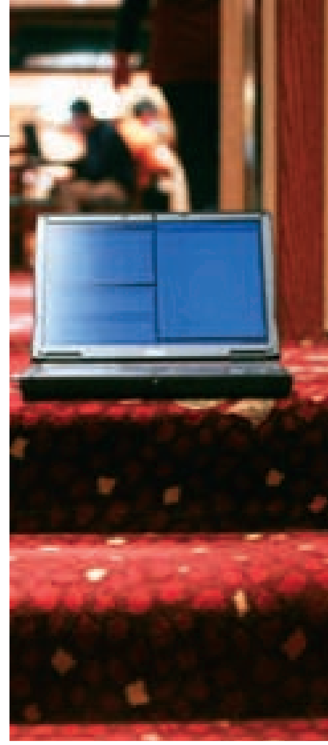
The third major problem involves overlapping cognitive radio networks trying to operate in the same spectrum. He explains that this problem can only happen with multiple secondary user networks. Because cognitive radios are flexible and can easily switch bands – or even support each other's traffic in a friendly manner — there will be interference issues. "How will the radios change their modulation, power, and frequency in those situations?" The problem is called network self-coexistence. "It turns out that there are inherent weaknesses in the current 802.22 protocols for self coexistence. This is something that must be addressed before networks can safely operate in this mode," he says.

Probing a network before it exists introduces unique hurdles. Park foresees a big challenge in quantifying the security threats. "Finding and discussing these threats qualitatively is easier," he says, "but we need to define exactly how severe each threat is. We want to identify those issues that have the most practical significance so that we can prioritize them. For that, we need to be able to quantify the threats. We will also want to quantify the effectiveness of our countermeasures."

He anticipates that the most exciting aspect of the project will be evaluating the countermeasures and solutions. "We would like to do some partial implementation of our solutions. This is a novel problem that nobody has looked into yet." Finding the solutions now, he says, will make cognitive radio networks more robust and more reliable from the start.

For more information, visit *www.arias.ece.vt.edu*.

—*with Liz Crumbley*



HUNTING IN THE WILD MANET

Armed only with laptops, intrepid student explorers hunted this past November in what was possibly the world's most uncooperative ad hoc network — and still managed to bag an elusive, quarry: a six-hop route.

Undergraduate and graduate student teams gathered from seven universities to generate a first-of-its-kind mobile ad hoc network (MANET) and to compete for glory in its uncharted territory. The Mobile Ad Hoc Networking Interoperability And Cooperation (MANIAC) Challenge was organized by ECE's Luiz DaSilva and Allen MacKenzie and held in conjunction with the IEEE Globecom 2007 in Washington, D.C. It was the first of at least two such competitions, funded with a three-year grant from the National Science Foundation (NSF).

Teams competed from Auburn University, Bucknell University, The George Washington University (GW), the Technical University of Kosice in the Slovak Republic, the University of North Carolina at Charlotte (UNCC), the University of Puerto Rico at Mayaguez, and Virginia Tech.

Seeking a natural habitat

The goal of the competition was to generate interest in the field among students, while also providing one-of-a-kind opportunities to study actual, uncontrolled, ad hoc networks where users make their own decisions regarding tradeoffs between self-interest and common network goals.

Although the technology is imminent, MANETs do not cur-

Photos by Christina O'Connor

A key goal of the MANIAC Challenge is to spur interest in the field among graduate and undergraduate students.

rently exist outside of tightly controlled laboratory environment and military deployments, according to MacKenzie. "Questions linger about how well MANETs will work in the wild. Are simulation results reported in the literature too optimistic about performance that can be achieved in these networks?" he said.

The MANIAC Challenge was the first large, multi-hop MANET that was spontaneously formed in a natural habitat, according to DaSilva. "We have a need in this field for data from an ad hoc network that is not controlled by any single research group. We want to see what happens when we don't control every node, and the different nodes may have different, and probably conflicting, interests," he said.

Strategic selfishness

The November competition focused on cooperation in routing and packet forwarding.Cooperation is one of the biggest issues surrounding MANETs, DaSilva said. For a stable MANET to exist, all nodes must cooperate, but still retain some selfish behavior in order to achieve their own goals. "Will users of wireless ad hoc networks trade off bandwidth, signal strength, or speed to ensure system effectiveness? If so, how? What incentives will get users to provide services — such as forwarding and routing — to other nodes?"

Each team controlled two laptop nodes on the network. MANETs are based on the premise of users sporting different hardware and software, so the only requirements were that the laptops have 802.11 capabilities and run the MANIAC API and OLSR as the routing protocol.

Strategy played a large role in the competition and teams were evaluated on the creativity of the strategy employed. As a group, the participants wanted to create a robust MANET and hoped to spot elaborate, multi-hop routes. However, each individual team wanted to acquire the highest number of intended packets.

To encourage both cooperative and selfish behavior, MANIAC teams were awarded 10 points for every packet they received that was intended for them, but every packet they forwarded for another team cost them a point. Source nodes for each team were not part of the cooperative network, but issued packets and sniffed the network to capture its topology.

The strategies were predominantly selfish and ranged from extremely simple to very sophisticated. Most teams tried to drop packets that would give other teams points, but maintain their reputation so that other nodes would still send them packets.

Other strategies included physically positioning their nodes close to sources, limiting the proportion of packets sent to any sin-

"We were evil. We dropped every packet with a final destination for the next node."

gle node, and being unfriendly to nodes not in their direct path from the sources. "This was probably the unfriendliest ad hoc network in the world," commented DaSilva at the conclusion of the contest.

"We were evil," admitted a member of the Auburn team. "We dropped every packet with a final destination for the next node. Dropping next-node packets was a popular strategy with the other teams as well.

"Live and let live" wins for creativity

The team from Kosice won first place in creativity for their "live and let live" strategy. "Their strategy was ingenious," commented MacKenzie. The Kosice strategy included manipulating the routing protocol itself to prevent traffic for other teams from being directed towards the Kosice devices at all.

"We were hoping to see the teams come up with fairly simple strategies that when you put it all together would lead to reasonably efficient outcomes for the whole," MacKenzie said. "They didn't do the things we expected, but that is part of the fun of it."

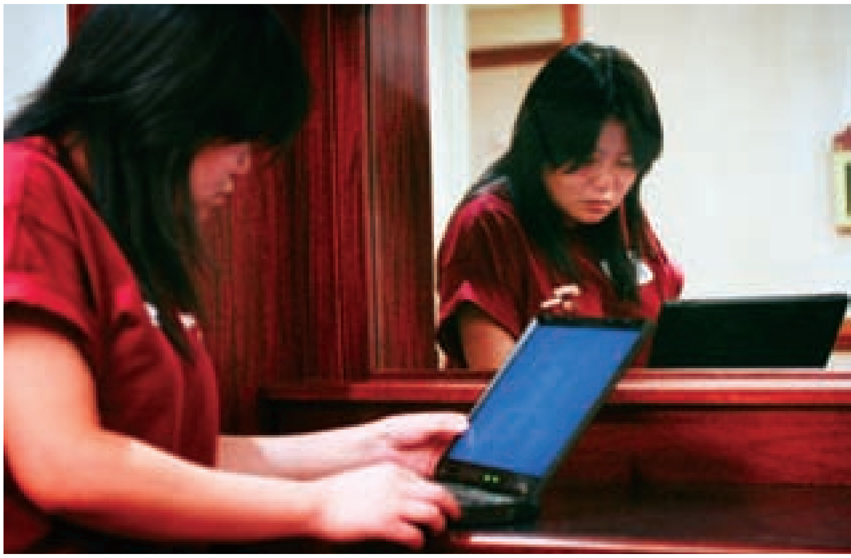
"Everybody decided to be a bad guy," DaSilva said. "This confirms the prisoner's dilemma." The prisoner's dilemma is a classical game theory situation in which two players who may cooperate for gain or betray the other to go free typically choose to betray each other, even though this result is inefficient for both parties.

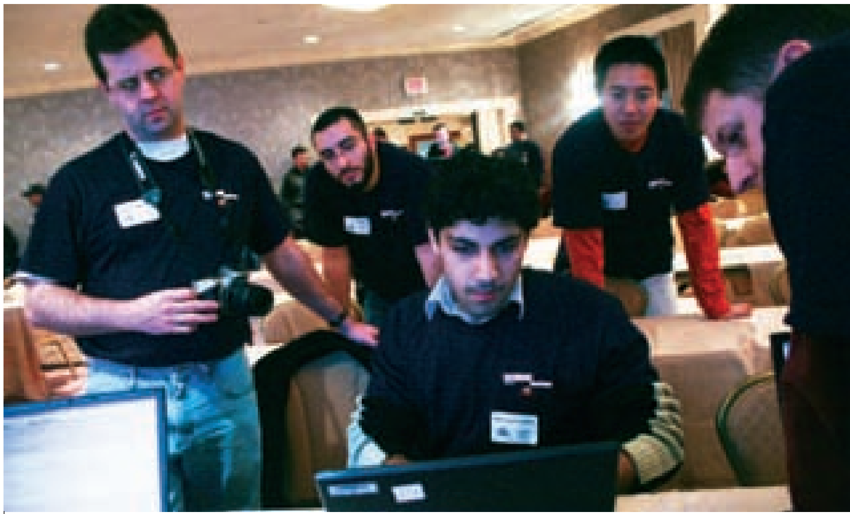
But did it work?

During the competition runs, teams roamed throughout the lower two floors of the Washington Hilton, while the non-network source nodes remained stationary. Many teams roamed, attempting to be near certain sources or just for better network placement.

The network had the common stresses of any wireless network, with interference and non-users trying to gain access. In spite of the hostility of the nodes, a complex topology appeared, with the greatest hops measured at 6 — extremely rare.

"I'm surprised it worked," DaSilva said. "So many things can go wrong — these networks are pretty fragile. This was less fragile than I expected. This doesn't mean they are robust networks, however."





Allen MacKenzie (left) and the MANIAC Challenge organizing team were looking to encourage student interest while creating and studying a live MANET testbed.

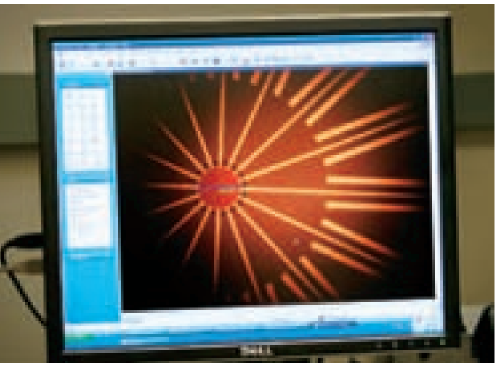
The UNCC team was almost always the multipoint routing node and took first place in the performance runs. The Bucknell team — the only team of undergraduates — came in second.

"The most fun was to see people actually enjoying participating in an experiment of this type," said DaSilva. "Getting students and faculty excited about something like this is an intangible, but it's very important in moving the research forward."

He cited evidence of growing enthusiasm among the participants. "We had undergraduates here, and their advisor reports there is now a higher probability they will continue in the field and perhaps get a higher degree." Also, the Kosice team has written a conference paper on their strategy and participation.

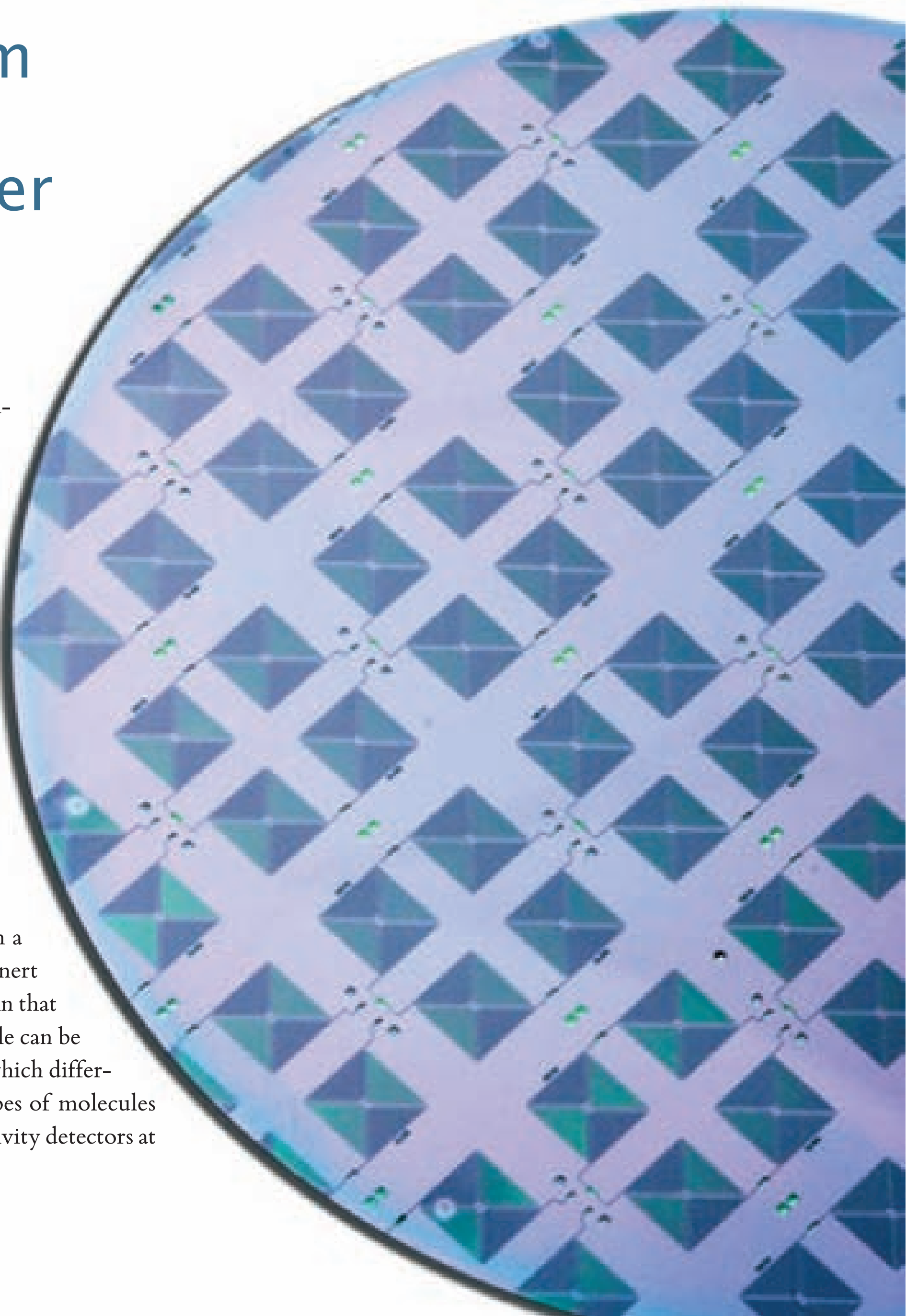
DaSilva and MacKenzie are preparing for MANIAC Challenge II, which will focus on power control and spectrum usage.

Data from both events will be available to researchers at *www.maniacchallenge.org*.



SHRINKING LAB EQUIPMENT ONTO A CHIP

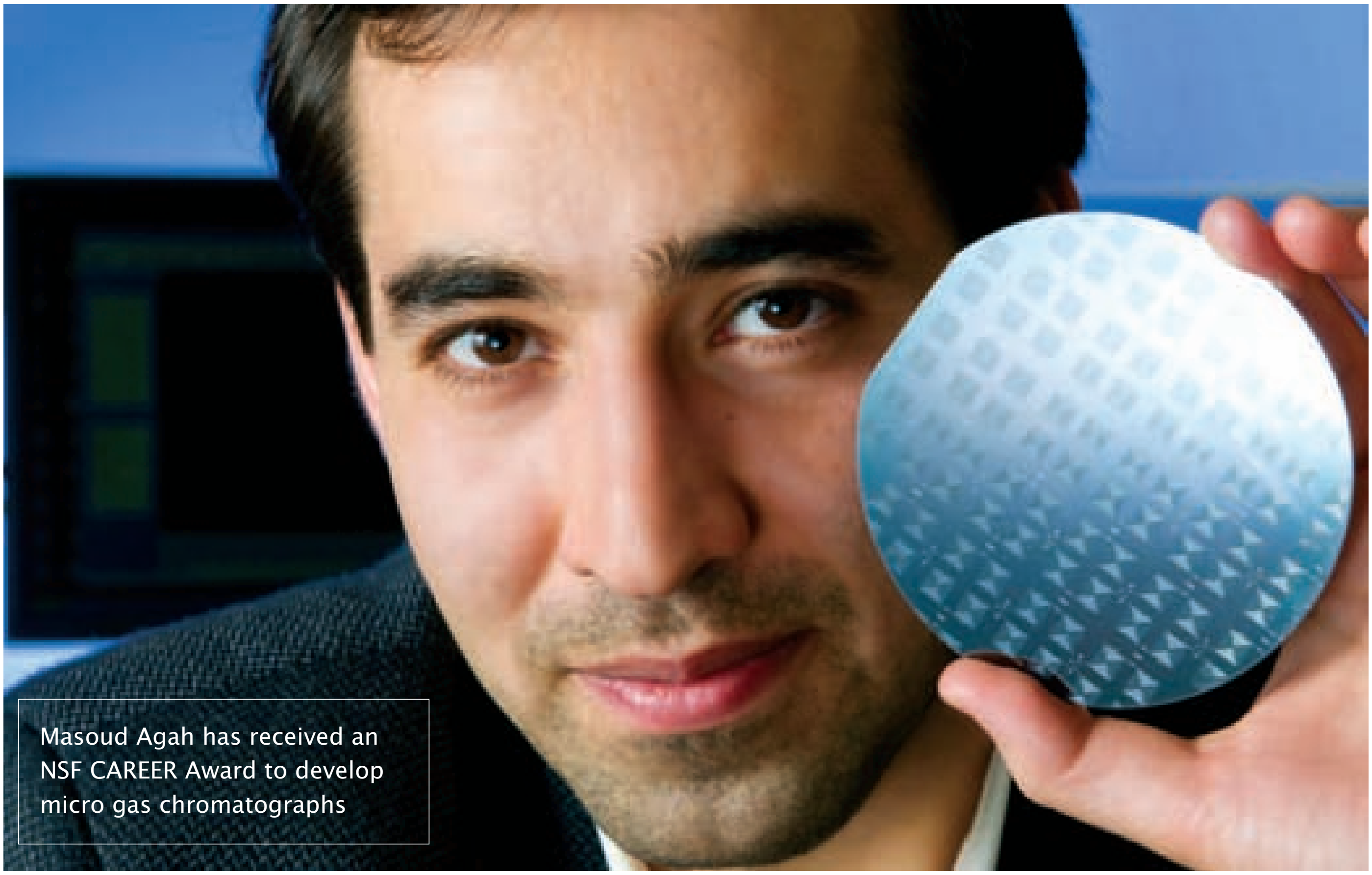
GC Matrix System tackles faster analysis and lower cost with micro design.



Masoud Agah has developed a microchip etching process and a multi-column architecture that he hopes to use to push gas chromatography (GC) out of its traditional laboratory setting and into the field. He wants to shrink GC units from their present table-top size to a credit-card size so they can be carried easily for instant analysis of hundreds of elements.

Gas chromatography is the primary technique used in scientific, medical and industrial laboratories for separating and analyzing volatile compounds. Portable microGC units would have many uses, ranging from doctors using breath analysis for diagnosing disease, to environmental monitoring of air and water contaminants to testing for chemical warfare agents.

Gas chromatography separates chemicals from a compound sample that has been gasified. Using an inert carrier gas, the sample is propelled through a column that has coated interior walls. Molecules from the sample can be absorbed by the coating, which affects the rate at which different chemicals exit the column. Since different types of molecules exit the column at different times, thermal conductivity detectors at



Masoud Agah has received an NSF CAREER Award to develop micro gas chromatographs

The single-pass, multi-depth etching process developed by Masoud Agah's research team may change how university students in many fields study MEMS.

the end of the column can identify the chemicals in the sample. In practice, several runs are used to confirm results and the time spent in the column can sometimes run more than an hour.

"It can often take four days to send a sample to the lab and get firm results using gas chromatography or mass spectrometry," Agah says. "There are many applications that can't wait that long. So the separation and detection times become critical."

A number of research teams worldwide are working to develop fast, accurate microGC units, but Agah's concept focuses on low-cost production methods and a novel, multi-column architecture. His etching process may also help change how students in many fields study microsystems.

His team's preliminary results are encouraging and the National Science Foundation (NSF) has awarded him a $400,000 CAREER Award to support the effort. CAREER grants are NSF's most prestigious awards for junior faculty members who are considered likely to become academic leaders.

Agah's plan involves at least two critical advances — employing an array of microtubes instead of the single tube that is conventionally used in gas chromatography and developing a single-pass etching process for multiple channel depths.

Matrix approach

Most microGC systems use a similar structure to the large, table-top systems, employing a single, long column. While tabletop systems use columns about 10 meters long, Agah describes the current trend in microGC systems is to use 3-meter-long columns. "These systems cannot separate more than 20-30 compounds and have separation times measured in several minutes," he explains. Faster analysis has been achieved by reducing the column length to less than 50cm and using rapid temperature programming. "These systems have separated multi-component mixtures in a few seconds. But there is a tradeoff between speed and resolution. They can only separate fewer than 10 compounds. They can go fast and few, but not complex," he adds.

Agah's goal is to separate complex mixtures – more than 100 compounds — in a few seconds. He is tackling the speed/resolution tradeoff by using a novel architecture he calls GC Matrix. The GC Matrix will consist of short microGC columns less than 30 centimeters long, with on-chip heaters, temperature sensors, micro flow meters, and thermal conductivity detectors. The columns will be integrated into a matrix configuration, with each row responsible for certain boiling points. Within each row, different columns will have different polarities and even different coatings.

Agah's goal is to separate more than 100 compounds — in seconds. He is tackling the speed/resolution tradeoff by using a novel architecture he calls GC Matrix.

"At the end of each row, we'll be spitting out results," he describes. "That's how we can get speed. We have independent rows, but also get the needed complexity because we'll have different polarities in each row." The performance of each mGC column will still depend on a tradeoff between speed and resolution, he says, "but the GC Matrix will enable us to tune these attributes independently on a system level." Agah already has developed columns that can separate a limited number of volatile compounds in less than 10 seconds.

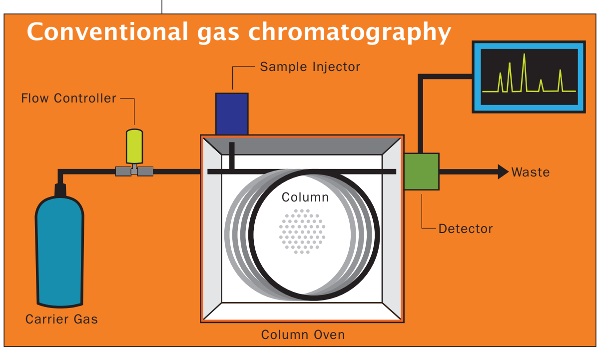
First-ever integration

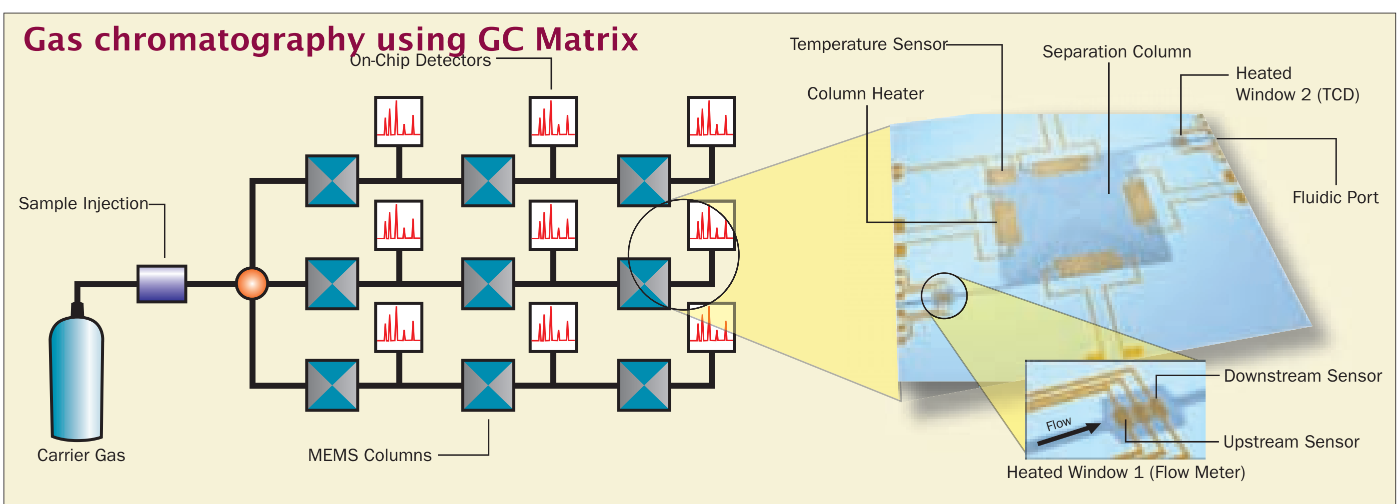
A GC Matrix system would integrate all the sensors on a column for the first time. "We're talking about a very compact microchip with integrated pressure, flow, thermal conductivity, and temperature sensors, with columns and heaters."

"For easy commercialization, we want to develop technology that is simple, reliable, low-cost and robust," he explains. "With this kind of compactness, it's important to minimize the fabrication complexity. As you increase production steps, your yield goes down, because every additional step introduces more opportunity for problems, such as contamination."

Instead of the typical silicon glass, Agah's team is using a silicon base employing a new fabrication technology they call the CMOS-Compatible Predictable 3D Buried-Channel Process. "For our integrated columns to work, we will need to etch to four or five different depths from 10 to 120 microns." He explains that the team wants to fabricate the system using a single pass for etching and a single pass for deposition with no bonding.

The team has eliminated a bonding process for both power consumption and production reasons. "If we use bonding, we will increase the total mass of the chip," Agah says. "When we increase the mass of a chip, it needs more power to heat it up. By getting rid of bonding and its thick pyrex substrate, we reduce mass. Then our columns can be floating structures connected with thin dielectric layers. We can heat it up rapidly, because it is isolated and the power consumption goes down. We cannot do this with silicon glass. We'll be able to keep the processing temperature during fabrication less than 300°C, which makes it compatible with conventional IC manufacturing."





"The beauty of research is we don't know what will happen until we do it."

Single-pass etching process

The team has recently tested a new method of etching silicon to different depths in one pass by maximizing a reactive ion etching (RIE) lag. "We have concluded that with a structure that has wider openings, the etch is deeper. Based on the holes in the array and the dimensions of the holes and spacing between them, we can control the depth and width of these channels."

Since the technology allows different depths and widths, even a single channel can have varying dimensions, according to Agah. "We can even make nozzles with this," he says. "This is just not achievable in pyrex."

The single-pass etching technique is not only useful for Agah's microGC system, but holds promise for other microfluidic uses in life sciences and chemical analysis and in engineering education (see sidebar).

Although he has demonstrated the new, single-pass, multi-depth etching process and modeled the GC Matrix, there are many challenges facing Agah's team. Several hurdles include tuning Virginia Tech's existing equipment to accommodate the required sensitivity or even acquiring new deposition capability.

Other hurdles are technical. Once the etching technology is perfected, the team will develop the microcolumn with all the microsensors on it. "To do that," Agah says, "we first must fabricate the individual components to make sure we can get the sensitivity we need for each component, then integrate it on a chip. That seems routine, but a least one part might become troublesome — coating the columns. We can use typical coating techniques or use nanotechnology.

"Then, we'll need to make the 30 cm columns coated with different polymers that separate different components. Since all of these sensors are integrated, will the coating affect the performance? Will there be any deficiency in sensitivity and detectability?" he wonders.

"The beauty of research," he says, "is that we don't know what will happen until we do it. What makes it fun is that we see so many challenges in front of us, and we know there will be more as we move forward."

For more information: *www.ece.vt.edu/mems*.

Etching process may impact engineering education

The single-pass, multi-depth etching process developed by Masoud Agah's research team may change how students in many fields study microelectromechanical systems (MEMS). As microsystems become more common, students in many disciplines, including ECE, mechanical engineering, engineering science and mechanics, chemical engineering, and biosciences are being introduced to the technology. As part of Agah's CAREER project, he will be incorporating the process in a laboratory course for students from these disciplines.

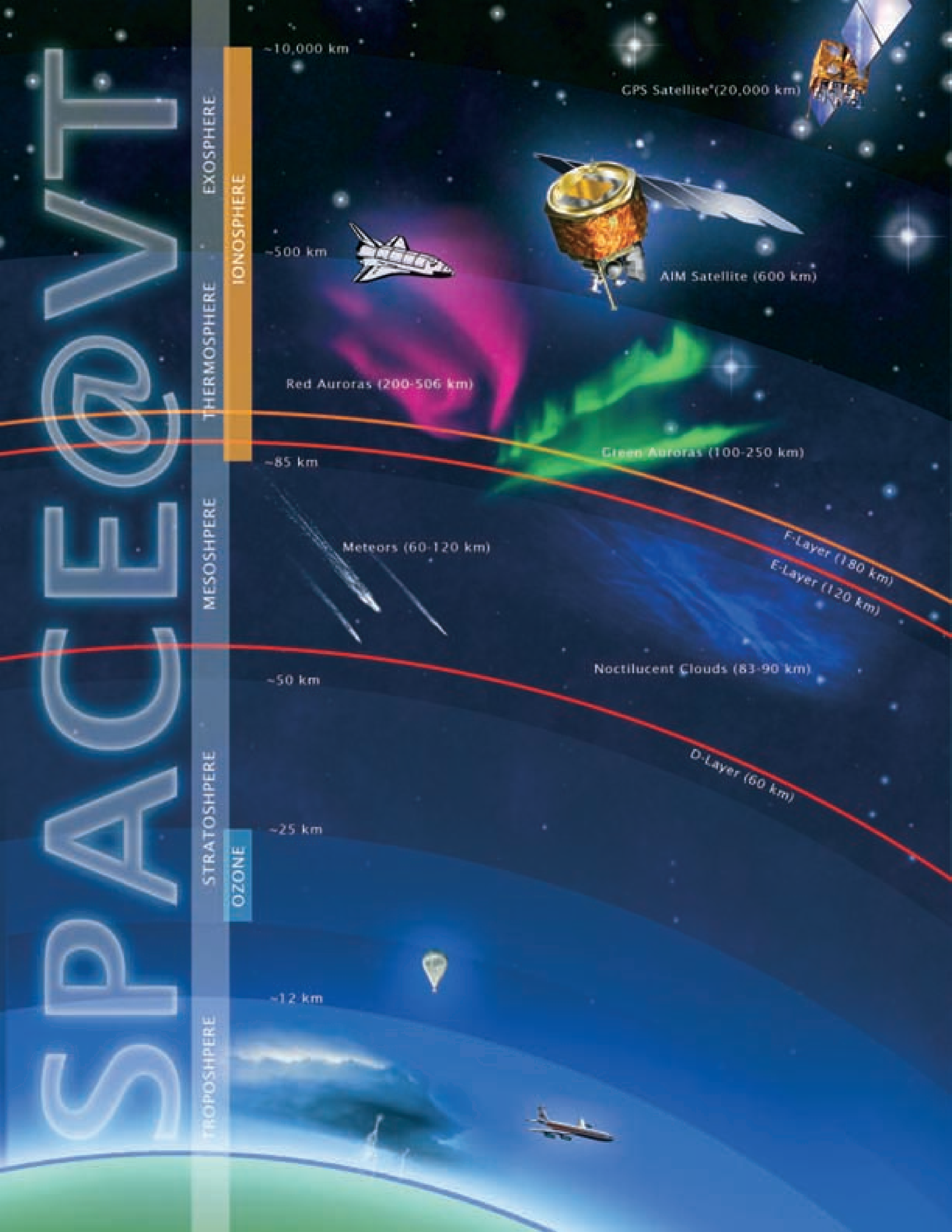
The new etching process is expected to make fabrication inexpensive and speedy enough for classroom use in real applications. "We'll be able to give students a deep, hands-on education in microsystems from design to fabrication to applications. Equally important, we'll be able to have them work in truly interdisciplinary teams while in school," he says.

"With this etching technology, we can make many different systems, such as pressure sensors, micro mixers, particle (cell) separators, gas analyzers and more," he adds. In the course, each multidisciplinary team will design a device based on the technology. "They can design whatever they are interested in. It can be a sensor. It can be a microfluidic device."

Once they determine the overall design and the depth and width of their channels, they will have access to the software Agah's team is developing for the gas chromatography project to determine the layout. "We'll be able to put all the designs onto one photo mask and have them all fabricated simultaneously using the single-pass process. Everybody will get trained on the different tools and fabrication processes and will contribute to the fabrication of class microchips."

With the chips fabricated, the teams will be able to analyze and test their systems, and determine what design changes would be needed.

Teams of up to three students will work together for the design, with each student taking the responsibility of his or her own discipline. The students will learn to communicate about their discipline at the level of students from other fields. "MEMS is by nature interdisciplinary," he says. "Learning to communicate to professionals outside their field and learning to work on a multidisciplinary team will make our students more valuable to employers."Micron Technology is helping develop the course. "Getting the perspective from an IC company is very valuable," Agah says. "Micron will help ensure that our students learn skills that are state-of-the-art."


SPACE@VT
EXOSPHERE
IONOSPHERE
THERMOSPHERE
MESOSHPERE
STRATOSHPERE
OZONE
TROPOSHPERE
~10,000 km
GPS Satellite*(20,000 km)
~500 km
AIM Satellite (600 km)
Red Auroras (200-506 km)
Green Auroras (100-250 km)
~85 km
Meteors (60-120 km)
F-Layer (180 km)
E-Layer (120 km)
Noctilucent Clouds (83-90 km)
~50 km
D-Layer (60 km)
~25 km
~12 km

SPACE WEATHER

The interaction between the solar wind and Earth's magnetic field and upper atmosphere can negatively impact the technology we rely on today — and engineers and scientists at Virginia Tech want to do something about it.

Space weather creates the beautiful auroras and striking night-shining clouds, but it can also interfere with communications and GPS systems or generate electromagnetic impulses that disrupt the power grid. It is possible that space weather may also contribute to the destruction of the earth's protective ozone layer and have a relationship to global climate change.

Last year, Virginia Tech formed the Center for Space Science and Engineering Research, directed by ECE Professor Wayne Scales, for further understanding of fundamental space science, to help develop technologies to mitigate the impact of space weather, and to educate and train students in the field.

The group, referred to as Space@VT, is studying the upper atmosphere and beyond with ground-based and space-based equipment as well as with computer simulations using advanced computational physics methods. This past year alone, graduate student Lyndell Hockersmith traveled to Antarctica for the installation of a magnetometer near the South Pole; the HokieDARN radar array joined an international system observing the ionospheric electric field; an ECE professor served as deputy principal investigator for NASA's AIM mission; and Virginia Tech students became the first U.S. university students to study Global Navigation Satellite Systems (GNSS) with the first in-house Galileo (European GPS) simulator at a U.S. university.

"We want to understand the physical processes of the interactions, but we're an engineering department; we want to know how it affects technology."

In two years, the center grew from a proposal by Scales and Joseph J. Wang, an associate professor of aerospace and ocean engineering (AOE), to an active group of eight faculty members with international reputations and two dozen graduate students and postdoctoral fellows. The center has more than $5 million in funding from the National Science Foundation (NSF), NASA, and various Department of Defense (DoD) agencies. Space@VT has an enthusiastic Industrial Advisory Board chaired by Dan Sable ('85, Ph.D. '91) that has greatly contributed to its rapid growth.

Three tenure-track and two research faculty members have joined ECE since 2006. That year, Robert Clauer came from the University of Michigan and is stationed at the National Institute of Aerospace (NIA) at Hampton, Va.; Scott Bailey came from the University of Alaska, Fairbanks; and Brent Ledvina came from a postdoctoral position at the University of Texas at Austin.

The new research professors include Daniel Weimer, from Solana Scientific, Inc., and Ray Greenwald, who is retired from JHU/APL. Weimer, stationed at NIA at Hampton, is the developer of the model that has become the international standard of global electric fields and potentials. Greenwald is the chief architect of the international SuperDARN radar concept.

A major focus of the space science team is educating and training undergraduate and graduate students in the field, according to Scales. "We are pursuing a holistic approach to space research and space mission development by combining theory, modeling, observation, data analysis, and education," he says. "Our goal is to prepare students to become leaders in the field and to make important contributions to society as a whole."

The center encourages undergraduate students to get involved in its projects. Undergraduates can make a serious contribution through both building and analysis activities, according to Bailey. "The educational benefits are great," he says, "but the truth is, it's just plain fun."

The team has also been developing courses in space and atmospheric science to introduce students to the field. "One of the beautiful things about this field is you have to be just as competent at science as engineering," says Scales. "We want to understand the physical processes of the interactions, but we're an engineering department; we want to know how it affects technology. We don't want to be doing science for science's sake. It's a means to an end to understand how it affects our technology."

For more information, visit: *www.space.vt.edu*.

AERONOMY OF ICE

TOM ELKLUND

Scott Bailey is interested in the interactions of space weather with the Earth's atmosphere. Why did noctilucent (night shining) clouds appear at about the same time as industrialization? Do the auroras play a part in ozone destruction?

To get the data to study such questions, he has been active in building satellites, spacecraft, and equipment.

Why do noctilucent clouds form?

Bailey currently serves as deputy principal investigator of NASA's Aeronomy of Ice in the Mesosphere (AIM) mission, working with James Russell (BSEE '62), a professor at Hampton University. The AIM satellite is the first mission ever to study noctilucent clouds, which are called Polar Mesospheric Clouds (PMCs) when viewed from space. The clouds, when viewed from the ground, are seen as very bright clouds reflecting the sun at twilight.

"These clouds form about 50 miles high – at the edge of space," Bailey explains. "The density of water molecules is one in a million. This is less than the Sahara desert, yet the clouds form – always in summer and always in the polar region. What makes these clouds interesting is not just their striking beauty, but they did not appear until about 120 years ago. "Because their rise coincides with industrialization, there is a suggestion of a link."

Over time, the clouds have become brighter, have been seen more often, and appear to be occurring at lower latitudes. "We've never studied these clouds except as serendipitous satellite and ground observation. How do they form with so little water vapor? How does this work? We have a lot of theories. Once we understand how they form, we will be able to go back and determine if they have anything to do with global warming or human activity.

Do auroras take part in destroying the ozone layer?

Bailey is also involved with studying if and how the auroras impact Earth's protective ozone layer. "There is a large and growing body of evidence showing that solar energetic particles from the aurora lead to production of nitric oxide (NO)," he describes. "We know that there is an abundance of nitric oxide in the thermosphere (in the region of the auroras). When we get to polar winter, the night is so long, the nitric oxide may flow downwards. Then, when it comes down, it's a catalytic destroyer of ozone. It's not responsible for the ozone hole, but may have a part in the destruction of ozone.

These particles may form a coupling between the highest and lowest part of the atmosphere, according to Bailey. "The problem is, we can't measure nitric oxide at night. It's never been done." Bailey and Chris Hall, an aerospace professor, are working with researchers at the University of Colorado. The team has developed a method to look at how the atmosphere attenuates at night, and using that to calculate NO levels.

They are preparing a 5-minute sounding rocket flight in January 2010 from Poker Flat, Alaska. A large telescope payload (being built by Virginia Tech faculty and students) bolted to the rocket will focus on a bright UV star in occultation – as it is being covered by Earth's atmosphere.

After the sounding rocket, the team hopes to expand the effort to include measurements on the same star, but from a satellite.

EXPLORING SPACE FROM ANTARCTICA

Bob Clauer's data analysis work has taken his team to the very edges of the planet.

Bob Clauer wants to understand how Earth's electromagnetic fields respond to solar activity. He explores the solar wind/magnetosphere interaction from the ground.

He describes the space environment as an electrodynamic system that involves plasma physics. "The solar wind interacts with Earth's magnetic field in a manner similar to a fluid, but an electrically conducting fluid."

A consequence of this interaction is that electric currents are generated and flow to the ionosphere. "It's a large, coupled system." Variations in the magnetic field and the energization of electrically charged particles are the items that comprise space weather.

The energy that is coupled to the magnetosphere from the solar wind and dissipated through electric currents in the upper atmosphere and the precipitation of energetic particles into the upper atmosphere (producing the aurora) — adds up to about 1012 W. "That's the same energy as a typical hurricane, but spread over a much larger area."

"It seems that if you drive the magnetosphere strongly, it goes into a periodic oscillation. Why does it do that?"

Scientists and engineers study the space environment using magnetometers to look at electric currents, radar to measure the drift of plasma and infer the electric fields. Particle detectors, various radio remote sensing instruments and optical instruments are also used.

Clauer investigates the global type phenomena using global arrays of instruments. He has helped to establish an ionospheric HF radar at Virginia Tech, and also is principal investigator on a project to develop an array of magnetometer platforms in the southern hemisphere. The first platform was installed in Antarctica in January. The goal is to install a chain of seven to eight stations over the next three to four years

The chain is being installed along the 40° magnetic meridian — magnetically conjugate (reciprocal) to a chain of magnetometers on the west coast of Greenland. The chain reacts rapidly to changes in the solar wind. With the Greenland chain, researchers have been able to identify differences in the electrical coupling between the solar wind, magnetosphere and ionosphere during the summer and winter.

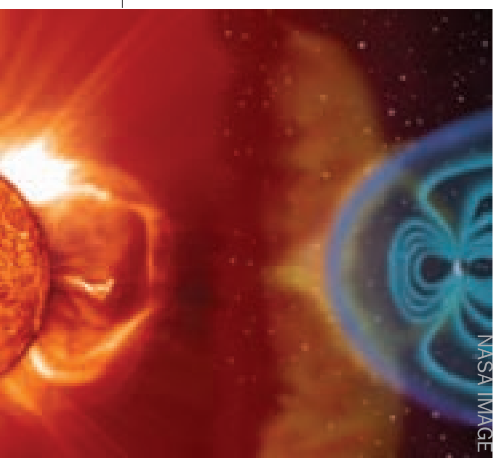
"We don't believe that it's changing due to time of year," Clauer says. "We think it's probably the difference in conductivity in the hemisphere." The research has been hampered by only having data from one pole. With the Antarctic chain, they will be able to study polar winter and polar summer simultaneously. The array will also be used to help understand a phenomenon first observed during magnetic storms only about 10 years ago. "It seems that if you drive the magnetosphere strongly, it goes into a periodic oscillation. Why does it do that?"

Even with a single station at the South Pole, the team is getting data that helps the investigations, Clauer says. "I'm a data analyst. The art is in assembling data in ways that allow you to see things. I manipulate data to reveal different kinds of behaviors. We can't control things in this lab, so we do it by trying to control the various variables through a statistical analysis."

Graduate student Lyndell Hockersmith near McMurdo, Antarctica

The effects of space weather on

SATELLITE NAVIGATION



The solar wind interacting with Earth's magentic field and upper atmosphere can disrupt satellite navigation systems. Brent Ledvina studies these effects to develop the technology to predict and avoid these disruptions.

Brent Ledvina studies the effect of space weather phenomena on satellite navigation systems. "The primary science," he says, "is looking at radio wave propagation issues and how the chaotic ionosphere (the ionized part of the Earth's upper atmosphere) can disturb radio waves via refraction, reflection, diffraction, and absorption."

His work recently focused on the mid-latitudes between 22° and 60° latitude. "Previously, that part of the ionosphere was considered absolutely boring. Nothing was happening there. Or so we thought," he says. Historically, the interesting phenomena occurred at the equator and near the poles, he explained. Then, public data from surveyed GPS receivers started to reveal some eccentricities of the ionosphere in the mid-latitudes.

"We didn't see it until we had the GPS data from all over the U.S. It is not only interesting scientifically, but potentially has an impact on society and the technologies we rely on," he says.

One of the main eccentricities is the occurrence and dynamics of large plasma densities in the ionosphere, he explained. Plasma is the fourth state of matter – an ionized gas where the electrons in an atom or molecule separate from the nucleus. On a grand scale this leaves a soup of positively charged ions and negatively charge electrons in the upper atmosphere. The large plasma densities generate instabilities, which in turn can cause errors in the received signals from the GPS.

"Above the Midwest, for example, there is essentially a very benign low-density ionosphere, then during a space weather event, a wall of density can form and flow through Canada towards the North Pole. We do not understand these plasma flow dynamics. They cause perturbations to the position solution output by our GPS receivers. The real problem is, the GPS receivers weren't designed to deal with such a large gradient in electron density," Ledvina says.

Why does position matter? The Federal Aviation Administration (FAA) has a mandate to allow commercial planes to land using GPS. "Getting an incorrect position could be devastating."

Another interesting phenomenon being studied is solar radio bursts. "These can cause noise in the GPS transmission band, making the signal-to-noise ratio go down, thus making a GPS signal difficult to track. It's like the noise on your TV set when your cable is out and somebody turns on the microwave or blender," Ledvina explains.

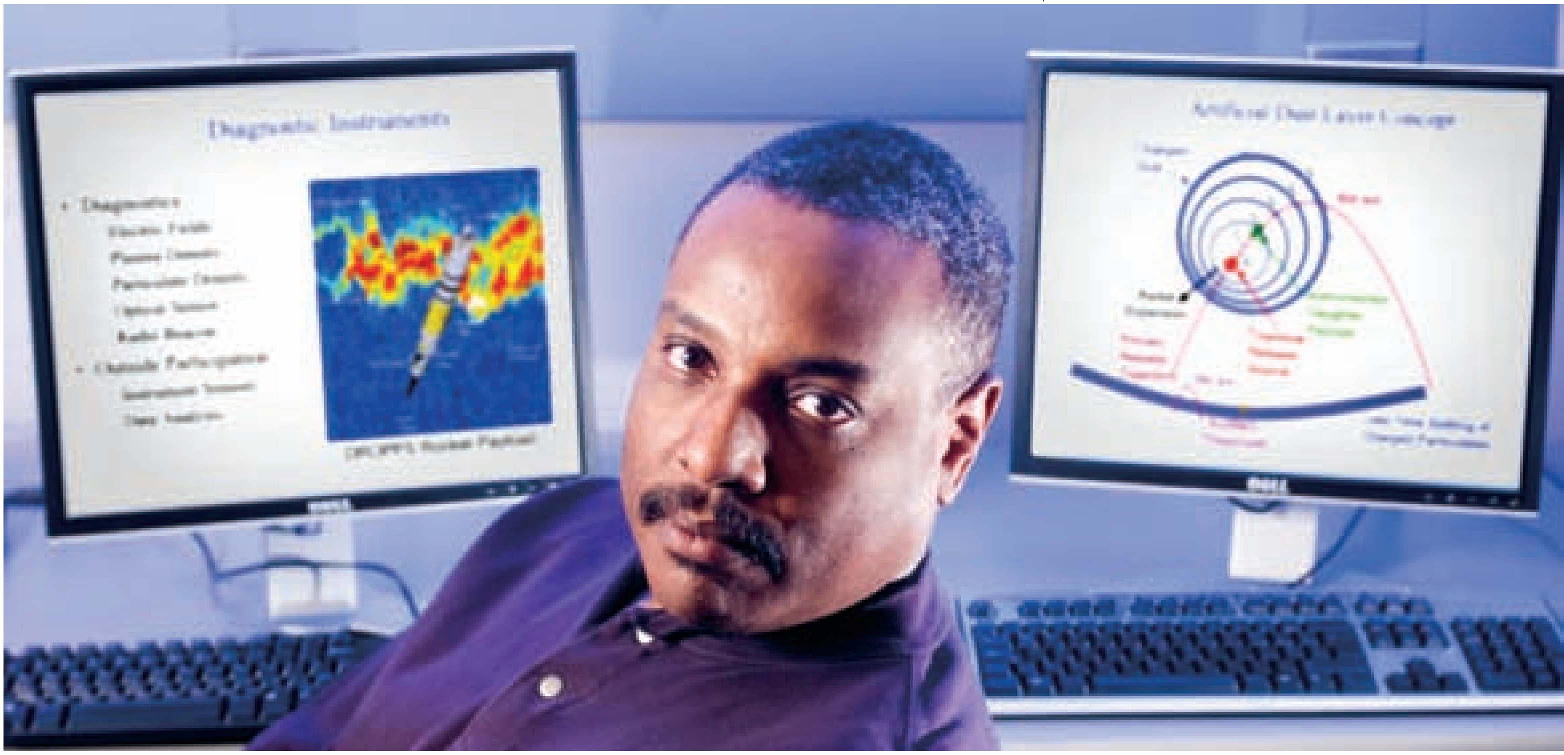
A solar radio burst in the fall of 2006 was an order of magnitude larger in strength than ever predicted. "It knocked out a large percentage of the science-grade GPS receivers on the daylight side of the U.S. for several minutes. We assumed we understood the worst case and it turned out we had no clue," he says.

To study these effects, Ledvina builds instrumentation to collect and analyze the data. GPS is used to measure the line-of-sight integrated plasma density from a receiver on the ground to a GPS satellite. Using arrays of receivers, he is involved in mapping the ionospheric content.

One project involves putting GPS receivers in Chile and Colombia to understand the conjugate effects of the Rayleigh-Taylor instability on the plasma densities of the equatorial ionosphere. A simple explanation of the Rayleigh-Taylor instability is the situation in which a heavier fluid is on top of a lighter fluid, an obviously unstable situation, which typically results in chaotic mixing of the two fluids. By observing from two locations on opposite sides of the Earth's magnetic equator, the team will be able to study the instability's effects as they propagate down the geomagnetic field lines.

Another project involves building a commercial-grade GPS receiver based on software-radio technology. "The GPS receivers we build will be able to work easily with the European, Russian, Chinese and other satellite navigation systems. The commercial market doesn't produce receivers that operate well during challenging space weather events," he says. With more robust receivers, the team will be better able to measure the extremes of space weather.

Ledvina is also upgrading and developing ECE's GPS course and laboratory. Virginia Tech is the first U.S. university to have a simulator for Galileo — the European GPS system that will go online in the next 4-7 years.



Wayne Scales, director of the new Center for Space Science and Engineering Research

CREATING WAVES

Being an expert in computational space plasma physics has involved Wayne Scales in projects from analyzing the effects of high-altitude nuclear detonations to creating and perturbing charged dust clouds in space.

In a multi-university effort funded by the Department of Defense, Scales and Joseph Wang, an aerospace professor, are developing a model to mitigate the impact of the earth's radiation belts on space assets. "This is part of a multi-university effort to counteract a high-altitude nuclear detonation (HAND). Such a detonation won't affect the people on earth, but the radioactive particles are predicted to destroy the electronics on spacecraft and basically wipe out most of the low-earth orbiting satellites in about a week," he says.

The project's goal is to develop novel techniques of generating electromagnetic waves that interact with the radioactive particles and scatters them out of the radiation belt, he says. "One way to do that is to use a big, high-power transmitter on the ground that sends a high power radio wave. Another option would be to use a satellite that has a high-power transmitter, he says"

The Virginia Tech team is involved in a third option: using a spacecraft that ejects chemicals that photo-ionize and create electromagnetic waves which then interact with the radioactive particles to scatter them out of the radiation belts. Scales' and Wang's model addresses the effects within seven days of a high altitude detonation. "We're trying to determine what is the most efficient and quickest way to counteract this threat. How much chemical do we dump? How much wave energy do we need to create for the scattering to be effective? If we dump a certain amount of chemicals, how much wave energy will be involved?"

Another project in space computation involves noctilucent clouds that form at the edge of space, shine at dusk, and are believed to be related to global climate change. Over the past several years, the team has developed a comprehensive computation model for investigating the interaction of high power radio waves on these charged clouds for diagnostic purposes.

"We've gone as far as we can with the theory; now we want to do experiments to validate our theory;" Scales says. The team is building a radar receiver to use in Alaska at the high frequency active auroral research program (HAARP) facilities

The team not only studies natural clouds, but is involved in a Naval Research Laboratory project to create an artificial noctilucent cloud. Called the charged aerosol release experiment (CARE), the project entails sending a sounding rocket from Wallops Island, Va., to create a large dust cloud over the East Coast.

The Virginia Tech team will be involved in developing a theoretical and computational model to study the turbulence generated in the charged dust cloud. "Radars will be used to bounce signals off the dust cloud to see if the turbulence, which is linked to global change, is the same as a natural noctilucent cloud," Scales says. The sounding rocket project principal investigator is Paul Bernhardt of the Naval Research Laboratory. "We're working to see if the new Blackstone SuperDARN radar will be able to contribute to the project as well."

SUPERDARN

iSTOCK PHOTO

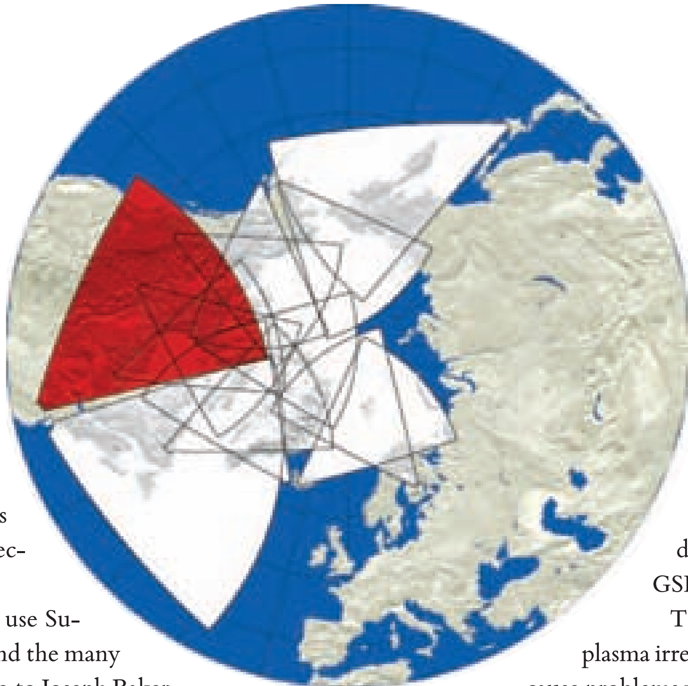
IT'S RAINING PLASMA

Those ionospheric plasma winds are blowing up a storm

ECE's newest laboratory stretches thousands of kilometers into the ionosphere from a field near Blackstone, Va.. The HokieDARN radar enables first-time-ever, continual mapping of space weather plasma motions over the northern United States and southern Canada.

HokieDARN is the newest part of the Super Dual Auroral Radar Network (SuperDARN) which is an international collaboration involving a dozen countries. High frequency radars are positioned around the world and operated continuously to provide the only method of obtaining global, instantaneous maps of plasma convection.

"The ionosphere is like a CRT; it projects a picture of what is happening in Earth's near-space environment," explains Michael Ruohoniemi, who is on the SuperDARN project. "We can see motions in the plasma in the ionosphere that re-



The Blackstone SuperDARN field-of-view plot.

semble winds. When we combine the measurements from all the radars, we generate something that looks like a familiar weather map, only the speeds reach thousands of miles per hour and change in a few seconds.

Scientists around the world use SuperDARN data to help understand the many effects of space weather, according to Joseph Baker, who is also a SuperDARN team member. "The Earth's magnetic field is like wires that transfer the energy from the solar wind into the upper atmosphere," he explains. "When the near-Earth space environment (or magnetosphere) gets stressed, it corrects by dumping energy into the atmosphere via the auroras and heating from powerful electric currents."

SuperDARN was first built in the 1990s as a chain of radars ringing the auroral latitudes and pointing towards the poles. "We wanted to study the auroral processes that occur daily and their connection to the solar wind," Ruohoniemi says. The SuperDARN efforts succeeded in producing the first-ever direct two-dimensional images of convection on global spatial scales. The resulting discoveries touched on the complementary nature of convection in the northern and southern hemispheres, the occurrence of hurricane-like vortices in the plasma flow, and the rapid response of convection to change in the solar wind

Until recently the mapping was available only for the far northern and southern latitudes. This is sufficient for studying such phenomena as the magnetospheric substorm, which occurs frequently and is mostly confined to auroral latitudes. Powerful magnetic storms, however, which occur much less often but have more serious effects, trigger very large disturbances in the space environment and can even cause auroras to be seen as far south as Texas.

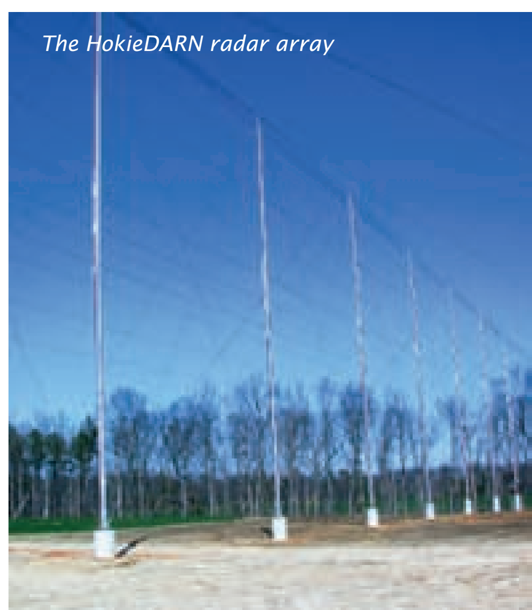
"These events are big and dramatic — and can be dangerous for people flying over the poles in aircraft, for astronauts, for GPS and other communication and radar systems," Ruohoniemi says. "The impacts get even more significant at the mid-latitudes since more people live there and the density of vulnerable technology is greater.

The original SuperDARN radars were pointed towards the poles and were missing the expansion of such large events. The SuperDARN collaborators decided to begin installation of a chain of mid-latitude radars, which is sometimes referred to as StormDARN, to study the magnetic storm electric fields. The first mid-latitude system was built in 2005 at Wallops Island, Va., by the Johns Hopkins Applied Physics Laboratory (JHU/APL) and NASA Goddard Space Flight Center (NASA/GSFC).

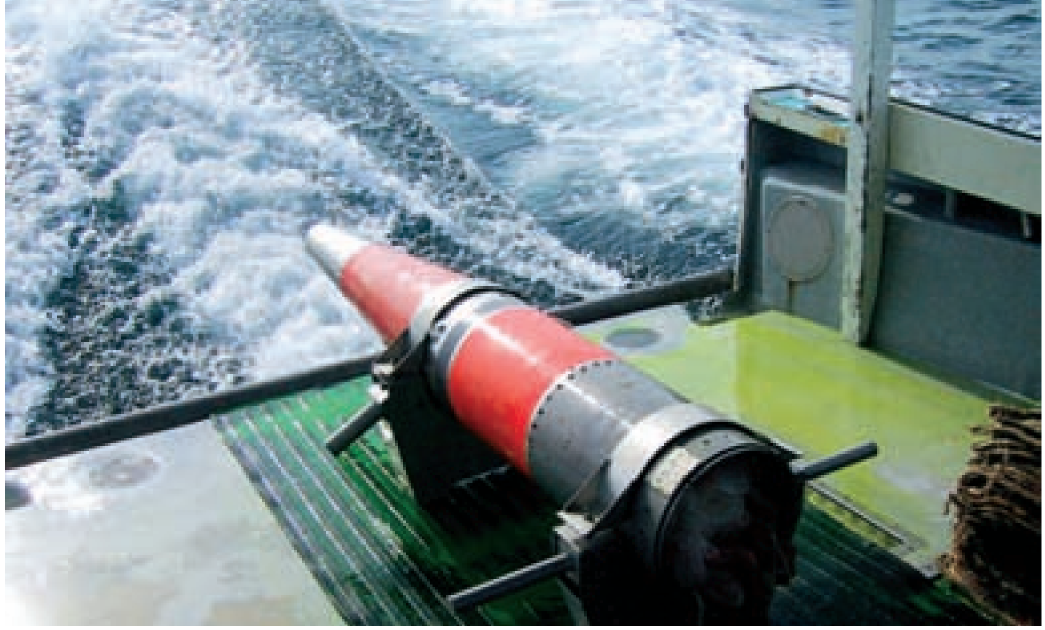
The targets for the radar system are plasma irregularities in the ionosphere that often cause problems with other systems, such as GPS, surveillance radars, and HF communications. "It is a case of one guy's noise becoming another guy's signal," describes Baker. With the mid-latitude data, scientists were able to continuously monitor both storm and quiet time activity over a larger area. "We quickly mapped the expansion of storm-time electric fields from the auroral zone to mid-latitudes with the Wallops radar and discovered a new type of irregularity that populates the ionosphere just equatorward of the auroral zone every night."

The HokieDARN radar is the second mid-latitude system built in the United States and the third in the world, after the Wallops radar and a Japanese radar operated on the island of Hokkaido. It was turned on in February of this year, just in time to contribute 'ground-truth' to a major NASA satellite mission (THEMIS) that is studying the causes of the auroral substorm. The radar was built with funding from the National Science Foundation (NSF) as a collaboration between Virginia Tech, JHU/APL and Leicester University in the United Kingdom.

HokieDARN was raised by a team of scientists and engineers from the collaborating institutions lead by the new arrivals to ECE, i.e., Ruohoniemi, Baker, and Ray Greenwald, who has joined as a research professor. Greenwald pioneered the use of HF radar for ionospheric studies and is the primary founder of SuperDARN.



The HokieDARN radar array



The HokieSat is one of three in NASA's Ionospheric Observation Nanosatellite Formation mission. Above right: A sounding rocket was collected after flight for its payload of particles from the mesosphere

HANDS-ON SPACECRAFT

Chris Hall, a professor of aerospace and ocean engineering, is an expert in spacecraft dynamics and control. He is involved in modeling and simulation of complex spacecraft systems and hands-on student projects.

A couple of recent projects started as student design projects, including HokieSat, one of three satellites that comprised the Ionospheric Observation Nanosatellite Formation mission, funded by the U.S. Air Force Office of Scientific Research and NASA.

A sounding rocket mission, which launched from Wallops Island in 2005, carried a Naval Research Laboratory payload to collect mesospheric particles. His students are currently building a scramjet payload for a two-stage sounding rocket, which will launch in 2010.

His modeling and simulation of complex spacecraft systems ranges from high-altitude balloon payloads to small satellites. In a recent study for NASA Goddard, his team completed a control system analysis for a tethered satellite system. They are currently modeling electrodynamic tether systems with rigid end bodies that use internal and external torques for attitude control. The current study is aimed at understanding the interactions of the tether's motions with the motions of the end bodies.

PROBLEMS WITH MOON DUST

NASA PHOTO

Joseph Wang, an associate professor of aerospace and ocean engineering, is an expert in advanced plasma propulsion systems, spacecraft-environmental interactions, and computational physics.

He describes his work as interdisciplinary, concerning both spacecraft engineering and space science and combining theoretical studies, experimental studies, large-scale simulations, and modeling. Ongoing work in his group ranges from ion thruster plume interactions with spacecraft and spacecraft charging on lunar surface, to plasma micro-instabilities relevant to radiation belt remediation experiments.

One ongoing study in Wang's lab concerns charged dust interactions on lunar surface. Dust clouds suspended above the lunar surface were first observed by the Surveyor spacecraft and later by Apollo astronauts.

It is well documented that lunar dusts can cause a wide range of significant problems for both spacecraft and astronauts on extra-vehicular activities. Currently no technology exists that can effectively mitigate the effects of lunar dusts. Utilizing computer particle simulations and vacuum chamber experiments, Wang and his students are trying to understand the dynamic processes that levitate and transport lunar dust grains and develop a technology to actively control and mitigate the dust environment surrounding lunar spacecraft.

New space science courses cover planetary physics and the perils of space weather

How does the sun's atmosphere and magnetic field interact with the earth's atmosphere and magnetic field? How does this interaction impact modern electrical technologies?

Why does Jupiter look so different from Earth? Why is Earth's atmosphere different from that of Mars and Venus? What electrical engineering principles are used to observe such differences?

With the knowledge students have from sophomore and junior engineering and physics classes, they can work through and calculate the answers to these questions, according to ECE's Scott Bailey and Bob Clauer. Bailey and Clauer used these questions and solutions as the framework for new courses taught last academic year.

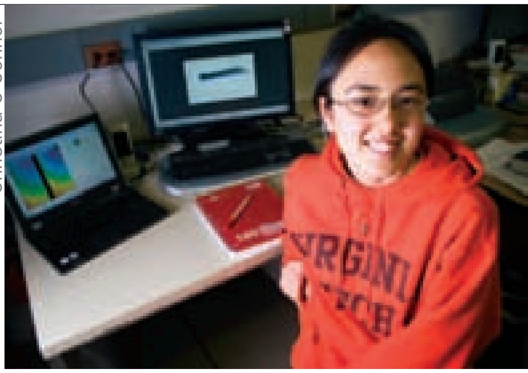
Bailey's course, "Introduction to Space Science II," concentrates on the upper atmosphere and gives a quantitative treatment of ionospheric physics and aeronomy (the science of the upper atmosphere), based on our solar system. "If you think about the physics and work through the questions, you can get a long way towards understanding why the planets have their characteristics. We all started the same, but have different locations relative to the sun," he says.

Location from the sun determines a planet's temperature, which leads to different evolutions, he explains. The planets then develop different atmospheres; Mars developed a thin atmosphere, Venus developed a thick one, and Earth developed an atmosphere with oxygen. "My goal in the class, was to show students that with the mathematics and engineering and physics courses they had already taken, they could reason out these differences."

The course covers ion and neutral chemistry, ionization by solar Extreme Ultraviolet (EUV) photons and charged particle radiation, heating and cooling processes, diffusion, neutral upper atmospheres, exospheres and ionospheres, and solar wind/ionosphere interactions. "We are trying to teach the students problem-solving and at the same time get them fired up about space science and engineering," Bailey says. Although it's a graduate-level course, it is open to the best undergraduates. "We are trying to get undergraduates more confident about their own ability and be able to jump in and try their hand in this field," he said.

Two other new courses in the series, "Introduction to Space Science I" and 'The Perils of Space: An Introduction to Space Weather', were developed by Bob Clauer. The introduction course covers the electrodynamics, plasma physics, and chemistry of the near-earth space environment from the sun to the earth's upper atmosphere. The space weather course is a 4000-level course emphasizing the practical consequences of space weather on modern electrical technologies, such as solid state devices, satellite technology, communication, and global navigation systems.

Undergraduate reaches for the edge of space



Christina O'Connor

An instrument designed and built to observe polar mesospheric clouds (night shining clouds) from space can also measure ozone, according to results verified by the research of undergraduate Heather Hunter (ECE '08). Hunter is working in the Aeronomy and Remote Sensing Laboratory, analyzing data from the NASA AIM satellite that launched last April.

She presented her results in a poster session at the American Geophysical Union conference in San Francisco, Calif., in December 2007.

The cloud imaging and particle size (CIPS) instrument is observing the clouds and determining particle sizes and the proportion of the incident light that is reflected. "When the clouds are not present," she explains, "CIPS observes only the sunlit Rayleigh-scattered background brightness, which is controlled by ozone present above 40 km from the earth's surface."

She created a model of the atmosphere from existing data and compared it to the satellite data, following a technique developed for solar backscattered ultraviolet instruments. "Our results show that CIPS can reasonably measure ozone column density and the ratio of the ozone and neutral air scale heights."

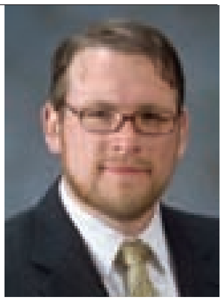
Hunter, who started working in the laboratory last May, says she was initially surprised by the amount of space science research and the complexity of the projects. "I was also very surprised that there were so many opportunities emerging in space science research for students. I'm glad to see the department encouraging students in this area."

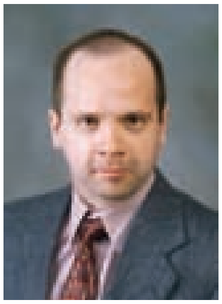
Before joining the laboratory, she had decided she most enjoyed the area of electromagnetics. She had a strong interest, but no previous course work in space or atmospheric science and had much to learn. Her experience has convinced her to follow a career in the field. She wants to work in RF propagation engineering, then return to school for more education in atmospheric science. "This is an exciting area of study with a very promising future. This isn't 'mainstream EE', but I'm eager to see more students get involved."

2007 2008 BRADLEY FELLOWS

11 alumni Bradley Fellows serve as facultymembers at universities across the country

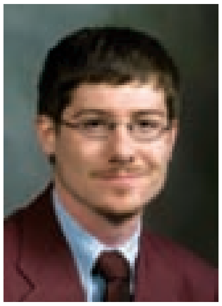
Robert M. Gardner
BSEE '03, MSEE '05, Ph.D. '08, Virginia Tech
Advisor: Yilu Liu
Research: Wide area monitoring and control of large-scale, complex networks, such as power systems. He is working on frequency data analysis and conditioning, power system event detection, and power system event location using the FNET wide area frequency monitoring network developed at Tech.

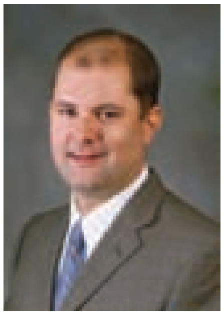




Mark W. Baldwin
BSEE '93, MSEE '05, Ph.D. '08, Virginia Tech
Advisor: Yilu Liu
Research: Power system dynamic response to line and generator outages. Focus on the use of bulk power system eigenproperties to determine event type; location and assess overall power system condition. Also studying generator rotor train torsional response to pulsating loads, transformer condition assessment, FACTS/ESSS applications in power system oscillation damping.

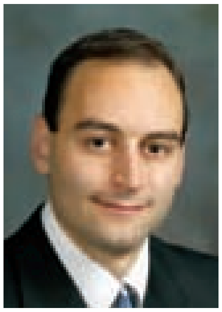
William C. Headley
BSEE '06, Virginia Tech
Advisor: Claudio R.C.M. da Silva
Research: Signal detection and modulation classification and its applications to cognitive radio systems. He developed a distributed feature-based modulation classifier that showed how distributed system can out-perform non-distributed classifiers. He is now developing a likelihood-based modulation classifier in multipath fading channels.





Daniel Friend
BSEE, MSEE '98, Brigham Young University
Advisor: Allen MacKenzie
Research: Cognitive networks, which are the combining of intelligence with highly reconfigurable communication networks. Specifically an application for dynamic spectrum access and another for routing in mobile wireless networks.
Career plans: Joining Northrop Grumman TASC this fall as a communications systems engineer.

Ryan Irwin
BSCPE '07, Mississippi State
Advisor: Luiz DaSilva
Research: Development of a MAC protocol for a dynamic spectrum access (DSA) environment, related to the Wireless Network after Next (WNaN) project. He is building on preliminary work on multi-channel MACs, while incorporating the new DSA design challenges.



BRADLEY ALUMNI

JoAnn M. Adams (BSEE '94)
Co-owner, Big Fish Design
Centerville, Va.

Robert J. Adams (MS '95, Ph.D. '98)
Assistant Professor, ECE
University of Kentucky
Lexington, Ky.
Won 2006 NSF CAREER Award

J. Shawn Addington (BSEE '90. MSEE '92, Ph.D. '96)
Department Head, ECE
Virginia Military Institute
Lexington, Va.
Addington has been awarded the Jamison-Payne Institute Professorship in Electrical Engineering

Sarah S. Airey (BSCPE '01)

Christopher R. Anderson (BSEE '99, MSEE '02, Ph.D '06)
Assistant Professor, ECE
United States Naval Academy
Annapolis, Md.

Matthew Anderson (BSCPE '04)

Nathaniel August (BSCPE '98. MSEE '01, Ph.D. '05)
Design Engineer
Advanced Design Group, Intel
Portland, Ore.
August is working on process sensitive mixed-signal circuits.

Carrie Ellen Aust (BSCPE '98)

William Barnhart
(BSEE '00, MSEE '02)
Raytheon; Denver, Colo.
Recently graduated from Raytheon's Engineering Leadership Development Program and was awarded Technical Honors by his peers.

Brian L. Berg (Ph.D. '01)
Director of Engineering and Product Development
DTS; Agoura Hills, Calif.
DTS is known for its audio codec that is now mandatory in next-gen home theater systems.

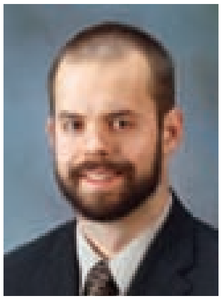
Ray A. Bittner, Jr (Ph.D. '97)
Microsoft Research
Sammamish, Wash.
Bittner has projects in computer architecture, run-time reconfigurations and portable devices.

Kirsten Brown (BSEE '94)
Chief of Staff to the CEO
MicroStrategy Inc.,
Alexandria, Va.

Steve Bucca (BSEE '87, MSEE '90)

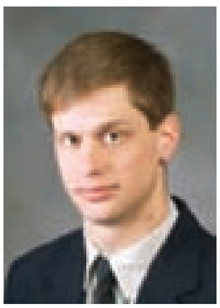
Mark Bucciero
(BSCPE '01, MSCPE '04)
Argon ST, Inc.; Fairfax, Va.

R. Michael Buehrer (Ph.D. '96)
Associate Professor
Virginia Tech

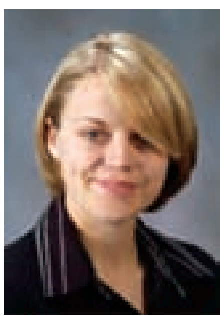


Evan M. Lally
BSEE '03, MSEE '06, Virginia Tech
Advisor: Anbo Wang
Research: Development of a high-resolution particle imaging system. Also developing a sapphire pressure sensor for ultra high-temperature harsh environments – operating up to 1500°C. Investigating a new method of sensor construction through a novel combination of etching and bonding techniques applied to single-crystal sapphire components.

Mark A. Lehne
BSEE '94, Seattle Pacific University; MSME '98, MSEE '00, Oregon State University.
Advisor: Sanjay Raman
Research: Analog and mixed signal IC design, specifically new discrete-time signal processing circuits that will enable more power efficient, interference immune UWB wireless transceivers. His discrete-time FFT processor is being used in wireless digital handheld devices for higher data rates.

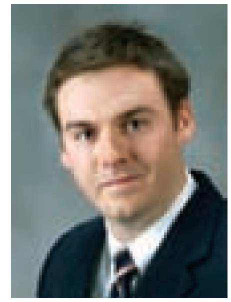


Andrew Love
BSCPE '05, University of Virginia
Advisor: Thomas Martin
Research: Modeling and pattern recognition with e-textile sensor systems. Accelerometer and gyroscopic sensors are deployed on e-textile pants to determine the activity of the user and location of sensors. High accuracy real-time realization of this can allow for accurate tracking of users.

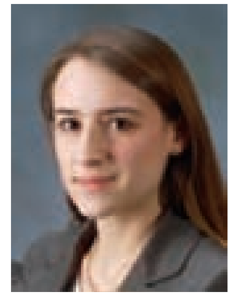


Parrish Ralston
BSEE '06, Virginia Tech
Advisor: Kathleen Meehan
Research: The physical phenomena that characterize isolated gate bipolar transistors (IGBT). She is characterizing 5th generation low punch-through carrier-store trench-bipolar-transistors for the Freedom Car project and will work at NIST this summer in parameter extraction of Si IGBTs and other high-power SiC devices.

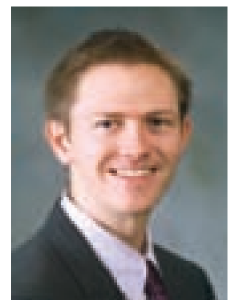
David Reusch
BSEE '04, MSEE '06, Virginia Tech
Advisor: Fred C. Lee
Research: High frequency DC-DC conversion to miniaturize power supplies in such applications as telecom, automotive electronics, laptops, servers, and wireless communications. Developing a three-level buck converter for low current point of load applications. He is working on a fully integrated product based of this topology.



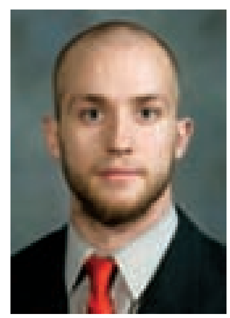
Rebecca Shelton
BSE EE/BA English '06, University of Tennessee at Chattanooga
Advisor: William Baumann
Research: Modeling and parameter estimation of small gene networks, especially networks created by synthetic biology. She is currently investigating how much data is needed to ensure that the parameters identified are biologically meaningful.



Ethan B. Swint
BSECE '02, Baylor; MSME '05, University of Texas, Austin
Advisor: Krishnan Ramu
Research: Circuit topologies and control systems for switched reluctance machines, which are limiting factors in the technology's adoption. He is working on novel circuit topologies to reduce the number and cost of electrical components, which, in turn, requires the development of new control strategies.



Phillip A. Zellner
BSEE '07, Virginia Tech
Advisor: Masoud Agah
Research: Development of a MEMs device targeted at the separation of cancer cells from blood. He is using micromachining techniques to develop a low power, high yield separation device based on demonstrated mechanical and electrical property differences between cancer cells and healthy cells.



Charles F. Bunting (Ph.D. '94)
Associate Professor
Oklahoma State University

Carey Buxton (Ph.D. '02)
Electronics Engineer, FBI
Buxton has been named a Director of National Intelligence Fellow.

Scott C. Cappiello (BSCPE '94)
Senior Director of Program Management;
MicroStrategy, Inc.,
Carlsbad, Calif.
He is responsible for product planning for some business intelligence products.

J. Matthew Carson (BSEE '98)
Engineer, Engine Dept.
Joe Gibbs Racing
Huntersville, N.C.
Carson is also serving as a judge at the Formula SAE competition in Danville, Va., in late April.

Ricky T. Castles (BSCPE '03)
Ph.D. Student; Virginia Tech

Eric Caswell (Ph.D. '02)

Kevin Cooley (BSEE '02)
Industrial Automation Specialists (IAS) Corp., Hampton, Va.
Cooley enjoys opportunities in embedded systems and design and testing electrical circuits.

Cas Dalton (BSCPE '03)

Phillip Danner (BSCPE '91)

Bradley A. Davis (Ph.D. '01)

Daniel Davis (BSEE '03)

Scott Davis (BSCPE '00)

Brian M. Donlan (MSEE '05)

Joel A. Donohue (MSEE '94)

Thomas Drayer (Ph.D. '97)

Bradley D. Duncan (Ph.D. '91)
Professor, ECE
University of Dayton, Ohio

Gregory D. Durgin (Ph.D. '00)
Assistant Professor,
Georgia Tech;
Won 2006 NSF CAREER award
Won the Class of 1940 Howard Ector Classroom Teacher Award – the highest teaching honor at Georgia Tech.

W. Ashley Eanes (BSEE '95)
Duke Energy, Burlington, N.C.

Richard B. Ertel (Ph.D. '00)

Brian F. Flanagan
(BSEE '97, MSEE '98)

Kevin P. Flanagan
(BSCPE '00, MSCPE '01)
Rancho Cordova, Calif.

Todd Fleming (BSEE '94, MSEE '96)

Ryan J. Fong (BSCPE '01, MSCPE '04)

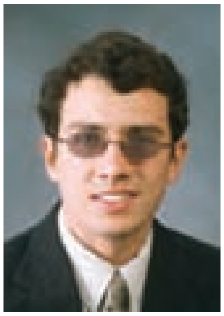
Jayda B. Freibert (BSEE '98)

Bradley H. Gale (BSEE '97)

Daniel J. Gillespie (BSCPE '95)

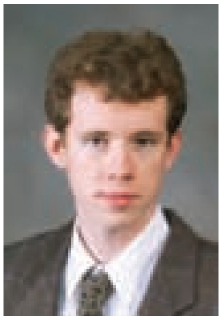
2007 2008 BRADLEY SCHOLARS

"I can confidently say this is where I was meant to be, and immersion in a culture of students with diverse mindsets, professors with thorough knowledge, and an environment of passion and compassion for others has changed me for the better."
Daniel Michael Hager



Benjamin A. Beasley
EE/Music '09
Kernersville, N.C.
J.B. West Scholarship; National Merit Scholar; Robert C. Byrd Scholar; Sam Walton Community Scholar; BPO Elks Walter "Buddy" Green Scholar; Guilford County Schools/Harris Teeter Scholar; New River Valley Symphony; Horn Ensemble.
Experience: 3 co-op rotations with Analog Devices, working with a high-speed converters group, learning much about ADCs, RF design, lab skills, board-level design, hardware description languages, lab and testing automation and more.

Brittany Clore
CPE '10
Fairfax, Va.
Gamma Beta Phi; Hypatia Engineering Community.
Career aspirations: working with robotics and encouraging women to get into engineering.
Why ECE: "My idea of fun as a child was to take apart the VCR."
Fun experience: Making pancakes while watching a salsa practice before starting work on a big project for class. "People here know how to have fun, but still realize when it's time to work. They were really good pancakes."



Ross Benjamin Clay
CPE '09, Minor in Economics
Raleigh, N.C.
Career aspirations: consultant or communications/systems product architect
Research: Spring 2008, pervasive computing. Summer 2007, Los Alamos National Laboratory. "I developed a proof-of-concept program applying probabilistic buffer control to streaming video…working with researchers at LANL and VLC's developers…Through this project I developed my programming skills and learned quite a bit about the research and open-source communities."
Experience: IBM's WebSphere Application Server System Verification Team; IT Consultant.

Thomas Alan Cooper
EE '10
Oak Ridge, Tenn.
Galileo Engineering Community; Student Engineers' Council Publicity Committee; Intramural soccer; IEEE; WUVT Radio Corps.
Memorable design projects: Sustainable Energy Design Project "helped me to better understand the current search for alternative sources of energy." Contemporary Issue Research Project exploring the possibility of using Helium-3 in fusion reactors as a source of energy.

BRADLEY ALUMNI Continued

Brian Gold (BSEE '01, MSCPE '03)
Ph.D. Student; Carnegie Mellon
Gold's thesis work is on reliable, scalable multiprocessor computer architectures.

Jonathan Graf
(BSCPE '02, MSCPE '04)
Senior Research Engineer
Luna Innovations, Blacksburg, Va.
Graf is developing anti-tamper security solutions for military software and electronics. He is also pursuing a Ph.D. at Virginia Tech.

Timothy Gredler (BSCPE '03)

Christopher R. Griger (BSCPE '02)
Senior Digital Hardware Engineer
National Instruments
Austin, Texas
Projects have included frame grabbers, high speed digital I/O boards, SMUs, and DMMs. He has a strong interest in renewable energy and sustainable lifestyles.

Alex Hanisch (BSCPE/Math '03)
Simulation and Modeling Group
Joint Warfare Analysis Center
King George, Va.

Abigail Harrison (BSCPE '04)

Jennifer J. Hastings (BSEE '96)

Dwayne A. Hawbaker(MSEE'91)
Senior Staff Engineer; Johns Hopkins Applied Physics Lab

Matt C. Helton (BSEE '01)
Resident EE
Coal Gasification Plant
Eastman Chemical Co.
Kingsport, Tenn.

Benjamin E. Henty (MSEE '01)

Jason Hess (MSEE '99)

H. Erik Hia (BSCPE '99, MSCPE '01)
Software Engineer
Hatteras Networks
Research Triangle Park, N.C.
Delivering broadband Ethernet solutions over existing copper facilities to enable service providers to deliver transparent Metro Ethernet services.

James Hicks (Ph.D. '03)

Hugh E. Hockett (BSCPE '03)

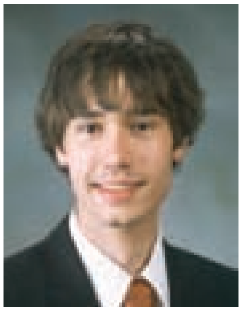
Janie Hodges (BSCPE '01)

Spencer Hoke (BSCPE '03)
Software Engineer
Garmin International
Kansas City, Kan.
Hoke earned his MS in 2005 from Illinois with a thesis on wireless network protocol.

Russell T. Holbrook (BSCPE '03)

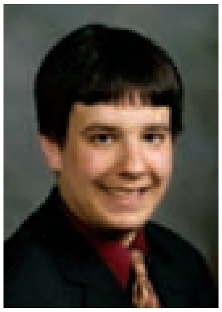
Andrew Hollingsworth BSCPE '02

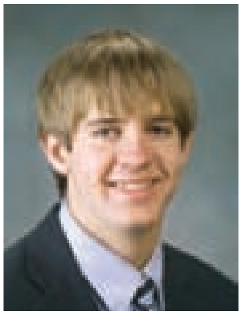
Ryan Hurrell (BSEE '03)
Electrical Engineer; Remotec, a subsidiary of Northrop Grumman Mission Systems Division
Knoxille, Tenn.



David C. Craven
CPE ’08
Winston-Salem, N.C.
Hillcrest Honors Community; Corresponding Secretary, HKN; Pratt Engineering Scholar.
Career aspirations: To design and create software for embedded systems
Memorable design project: a Microprocessor System Design project that required using a VGA controller on a small development board to make an animated screensaver. “It was the first major project to include a hard real-time requirement. I probably learned more about developing for embedded systems in that project than any other.”

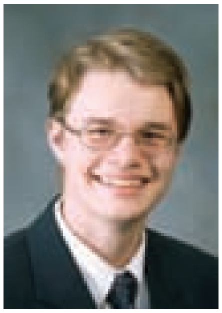
David C. Mazur
EE ’11
Pittsburgh, Pa.
IEEE Robotics Team, U.S. Soccer Refereee.
Career aspirations: To own my own engineering firm
Design project: IEEE Robotics has allowed me to experience real world engineering techniques as well as information taught in advanced level electronics labs.
Why Tech: “The engineering program is very strong and competes with the best in the nation. Plus, the brotherhood of the Virginia Tech student body convinced me to attend Virginia Tech.”

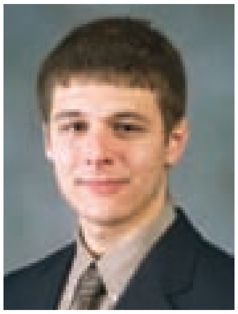




Daniel Michael Hager
CPE ’08; Minors in Math and Psychology
High Point, N.C.
Hillcrest Honors Community; National Merit Scholar; Robert Byrd Scholar; captain, intramural softball.
Career aspirations: NASA Mission Specialist; applying embedded software design to fighter jets and defense
Research: Spring 2008, dynamic FPGA programming.
Experience: Lockheed Martin Information Technology Division developing software used to install and maintain hardware at the Pentagon; Lockheed Martin Aeronautics, Marietta, Ga., involved with software for production and enhancement of F-22s and C-130s.

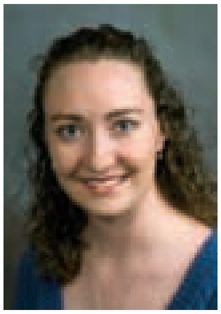
Jacob Simmons
CPE ’08
Smithfield, Va.
Hillcrest Honors Community; dorm softball coach.
Career aspirations: Robotics and embedded systems and/or digital control
Most rewarding design project: Designing the sound system for a table-mounted train in Embedded Systems. “I enjoyed experiencing the entire embedded systems design process from start to finish.”
Experience: Database technician, Northrop Grumman Newport News, Summer 2007. Maintained existing record systems and designed new program for quick, reliable printing of mailing labels for drawing updates.





Zachary La Celle
CPE ’09
Lansing, N.Y.
IEEE; National Society of Collegiate Scholars.
Study abroad: Spring 2008, Georgia Tech Lorraine in France.
Career aspirations: Researcher in robotics.
Experience: Build engineer, Autodesk, Inc., Summer 2007. Used scripts and IBM Rational Build Forge to control product builds; made code submissions.
Most fun: “I really love my hardware classes on a daily basis, but most exciting so far was my first home football game. Coming from New York, I’d never experienced anything like it.”

Chelsy Wynn Smidler
EE ’11
Lafayette, Ind.
Career aspirations: Work in a company like Rockwell Automation and be able to travel around the world
Why ECE: “I have always enjoyed learning about everyday electronic devices.”



Recent projects relate to participation in a new robot platform for the British Ministry of Defense and a specialized platform for Yuma Proving Ground.

John Todd Hutson (BSEE ’93)

Madiha Jafri (BSCPE ’03)

Daniel A. Johnson (MSEE ’01)

Adam Kania (BSEE ’01)

David A. Kapp (Ph.D. ’96)

Dimosthenis C. Katsis (Ph.D.’03)

David Kleppinger (BSCPE ’04)

Paul A. Kline (Ph.D. ’97)

Gregory Kozick (BSCPE ’03)

William B. Kuhn (Ph.D. ’95)
Professor, EECE
Kansas State University

Jeffery D. Laster (Ph.D. ’97)
Product Specialist, Analog, Mixed Signal, and RF IC
MentorGraphics,Richardson, Texas
He recently became a member of the Platinum Club at Mentor Graphics.

Charles Lepple (BSEE ’99, MSEE ’04)

Jason Lewis (BSEE ’99)

Joseph C. Liberti (Ph.D. ’95)

Zion Lo (BSEE ’94)
Sr. SoftwareEngineer/Architect
IQNavigator, Colorado

Daniel L. Lough
(BSCPE ’94, MSEE ’97, Ph.D. ’01)
Warrenton, Va.
Lough recently published a book chapter on IEEE 802.11 Security

Cheryl Duty Martin (BSEE ’95)
Head, Cyber Information Assurance and Decision Support
Applied Research Laboratories
University of Texas at Austin
After earning a Ph.D. in 2001, Martin worked for NASA on software for crew working with advanced life support automation. Since 2004, she has worked in information assurance and security applications, including detecting computer activity relevant to insider threat and automated security classification of text portions.

Stephanie Martin (BSEE ’04)
Columbia, Md.
Martin is working in electronic warfare and is taking night classes at Johns Hopkins toward an MSEE.

Michael Mattern (BSEE ’02)

Christopher A. Maxey (BSCPE ’02)

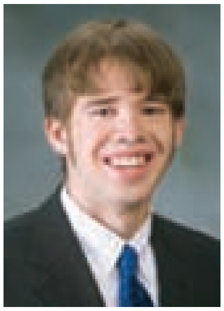
Eric J. Mayfield (BSEE ’97)

Patrick McDougle (BSEE ’03)

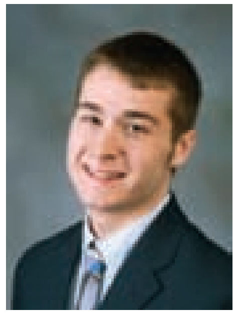
Brian J. McGiverin (BSCPE ’96)

John T. McHenry (BSEE ’98, MSEE ’90, Ph.D. ’93)
Senior Electronic Engineer,
U.S. Department of Defense
McHenry’s interests are in high-speed network processing and FPGA design.

Bradley Scholars continued



Jerry Alwynne Towler
EE '08
Greer, S.C.
Student Technology Council
Co-op; Digital Receiver Technologies, Inc., writing software to test radio equipment. "I learned a great deal about radio communications … This was the first time I saw the actual results of various circuit configurations and transmission methods. As importantly, I learned what mistakes can be made and how they affect integrity of signal reception."
Why ECE: Originally interested in MEMS and NEMS, now interests are shifting to controls, especially as related to robotics.



Matt Welch
EE '09
Richmond, Ky.
IEEE; HKN Intramural Sports Chair, TBP, SEC, National Society of Collegiate Scholars, RHF West Eggleston Hall Vice President; Galileo Learning Community.
Experience: Summer 2008 will work for gas turbine division of GE Energy.
Why ECE: "Ever since I was little, I wanted to learn the reason why I could plug a device into a power outlet and expect it to work."

BRADLEY ALUMNI Continued

David McKinstry (MSEE '03)

Garrett Mears (BSCPE '00)
Head of Development
Open Vantage Ltd., London

Vinodh Menon (BSCPE '02)

Michael Mera (BSEE '03)
U.S. Army, Bangor, Pa.
Mera earned an MSECE from Purdue and is doing R&D.

Carl Minton (MSCPE '99)

John Morton (MSEE '98)

Stephen Nash (BSCPE '03)
Senior Software Engineer
Lockheed Martin, Sykesville, Md.

Troy Nergaard (MSEE '00)
Tesla Motors; San Carlos, CA

Michael H. Newkirk
(BSEE '88, MSEE '90, Ph.D. '94)
Section Supervisor in the Air and Missile Defense Dept.
Applied Physics Laboratory
Johns Hopkins University
Laurel, Md.
Newkirk is involved in analysis of environmental effects on RF systems, particularly radar and communications systems, as well as testing, upgrading radars, and RF propagation modeling.

Paul Erik Nguyen
(BSCPE '98, MSCPE '99)

J. Eric Nuckols (BSEE '97, MSEE '99)
Manager of Embedded Software
ITT Advanced Engineering & Sciences; Advanced Communications System Develoment Group
Herndon, Va.

Neal Patwari (BSEE '97, MSEE '99)
University of Utah
Won 2007 NSF CAREER Award for RF-Sensing Networks for Radio Tomographic Environmental Imaging.

Joseph Allen Payne (BSEE '00)

W. Bruce Puckett (MSEE '00)

Yaron Rachlin (BSEE/Math '00)
Researcher; Accenture Technology Labs, Chicago, Ill.
Rachlin earned his Ph.D. in 2007 from Carnegie Mellon.

Christian J. Reiser (Ph.D. '05)

Steve Richmond (MSEE '01)

Jamie Riggins (BSEE/BSCPE '04)

Pablo Max Robert (Ph.D. '03)

Thomas W. Rondeau (BSEE '03)
Postdoctoral Fellow
Trinity College Dublin, Ireland

Thomas M. Rose (MSEE '96)
Radar Analyst
Electro-Optics and Physics Group
Boeing Company
University City, Mo.

Jon Scalera (MSCPE '01)

Amy Schneider (BSCPE '03)

Steven Schulz (MSEE '91)

David C. Schroder (BSEE '05)

Jeff Scruggs (MSEE '99)

Kashan Shaikh (BSCPE '02)
R&D Engineer
GE Global Research Center
Niskayuna, N.Y.
Shaikh earned his Ph.D. from Illinois in 2007. He focused on developing MEMS and microfluidic systems for biotech applications.

Raymond A. Sharp (BSEE '02)

Roger Skidmore (BSCPE '94. MSEE '97, Ph.D. '03)
Distinguished Innovator
Wireless Broadband Group
Motorola; Austin, Texas
Skidmore co-founded Wireless Valley Communications, which Motorola acquired the firm in 2005.

Jeff Smidler (BSEE '98)

Amanda (Martin) Staley
(BSEE '99, MSEE '01)

Graham Stead (BSCPE '93)

Douglas R. Sterk (MSEE '03)
Ph.D. s0tudent, Virginia Tech

Scott Stern (BSEE '93)

Samuel S. Stone (BSCPE '03)

Anne (Palmore) Stublen
(BSEE '91) Newark, Del.

Seema Sud (Ph.D. '02)

David Tarnoff (MSEE '91)
Assistant Professor
Computer & Information Science
East Tennessee State University
Tarnoff won the 2006-2007 ETSU ACM Outstanding Teacher Award, which follows numerous awards over the years, including the Tri-Cities "40 under 40 Award" in 2004. He recently published a free downloadable textbook, *Computer Organization and Design Fundamentals*.

Daniel Tebben (Ph.D. '06)

Rose Trepkowski (MSEE '04)

Christian Twaddle (BSCPE '01)

Matthew C. Valenti (Ph.D. '99)
Associate Professor, CS & ECE
West Virginia University
Morgantown, W.V.

Wesley Wade (BSEE '93)

Kristin Weary (BSEE '03)
Lockheed Martin – Knolls Atomic Power Lab.

Michael L. Webber (MSEE '03)

Jason Wienke (BSEE '02)

Thomas Williams (BSEE '00)

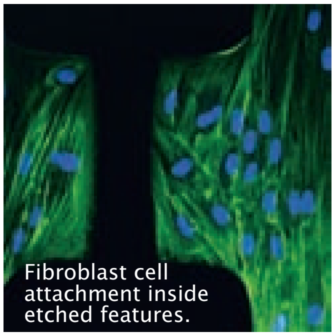
William J. Worek
(BSCPE '99, MSCPE '02)
SAIC, Washington, D.C.
Worek's research is in biometric analysis and evaluation, biometric fusion techniques, and network communication protocols for RF networks.

Kai Xu (BSEE '95)

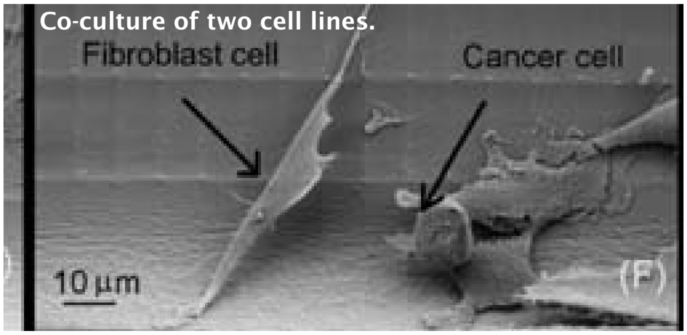
Jason Jon Yoho (Ph.D. '01)

Gregory A. Zvonar (MSEE '91)

Silicon micro device may help diagnose, treat cancer



Fibroblast cell attachment inside etched features.



Co-culture of two cell lines.

A team from ECE's Microelectromechanical System (MEMS) Laboratory has developed a 3-D silicon microstructure that has potential to detect breast cancer cells and to separate cancer cells from other cell types.

The devices consist of arrays of microchambers connected with channels and were fabricated using a single-mask one-pass etching process developed in the laboratory (see p. 12.). When cultured on the devices, breast cancer cells stuck to the shallow curved walls, but the normal fibroblast cells stretched inside the channels, avoiding the curved walls.

The fibroblast cells grew on both flat silicon surfaces and inside the microchambers regardless of microchamber depth, according to Masoud Agah, director of the laboratory. The cancer cells, however, typically did not grow on the flat surfaces when there were microchambers having depths of 78 and 88 micrometers.

The microdevices have potential use in diagnosing cancer, determining prognosis, and in testing the reaction of an individual's cancer cells to different drug treatments. Agah is working with Dr. Jeannine Strobl from the Virginia College of Osteaopathic Medicine and Mehdi Nikkhah, an graduate student in mechanical engineering. For more information, visit *www.ece.vt.edu/mems/*.

Safety-critical embedded software: correct by construction?

What do a Renault car and an AirBus 380 have in common? "Millions of lines of embedded software running in networked communication" is the reply from Sandeep Shukla, director of Virginia Tech's FERMAT lab. Safety-critical systems, such as those on cars and jets, are increasingly run by concurrent software systems reacting to a myriad sensor inputs.

The problem, he says, is verifying the correctness of an entire system functioning together. He is working with the Air Force Research Lab to generate software that is correct by construction for its specifications and can generate multiple sequential software components to work correctly across a network. They also may be multi-threaded, he says.

Shukla has been working with the French National Laboratory Institut National de Recherche en Informatique et en Automatic (IRISA) on a specification methodology called Polychrony, which allows one to specify the concurrent computations.

Based on Polychrony, the IRISA team and Shukla's FERMAT lab have previously proposed various methodologies for composing existing components to create new designs of systems-on-a-chip. For more information, visit *http://fermat.ece.vt.edu*.

ECE does about $25 million of research yearly, in applications ranging from cancer research to wind power.

RESEARCH

VLSI & DESIGN AUTOMATION

FACULTY
Peter Athanas
Dong Ha
Michael Hsiao
Chao Huang
Tom Martin
Patrick Schaumont
Sandeep Shukla
Joseph Tront

Research laboratory information

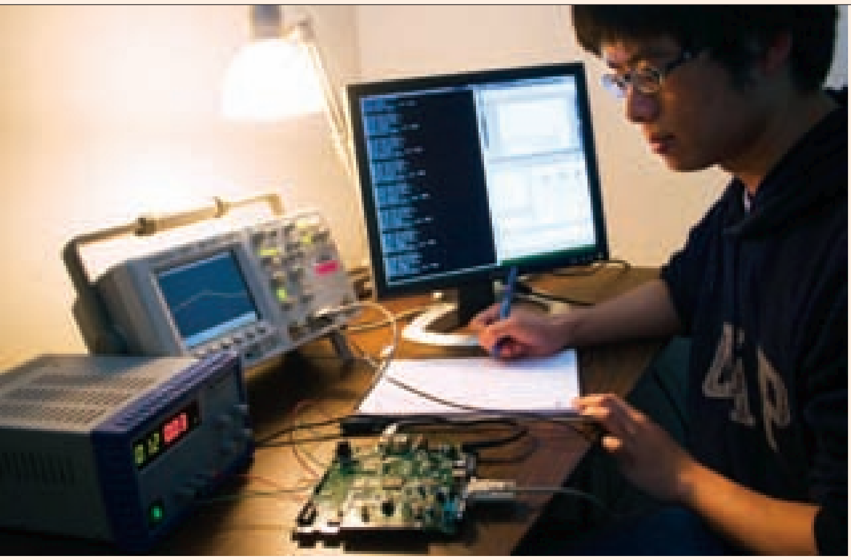
Center for Embedded Systems in Critical Applications
www.cesca.centers.vt.edu

FERMAT: *http://fermat.ece.vt.edu*

PROACTIVE: *www.proactive.vt.edu*

VT VLSI for Telecommunications (VTVT)
www.ee.vt.edu/~ha/research/research

Secure Embedded Systems
www.ece.vt.edu/schaum/research



Christina O'Connor

Using inexpensive, easily available tools — an ocilloscope and MATLAB, Zhimin Chen demonstrates how to crack the security key on a Spartan FPGA board that is used in Virginia Tech computer engineering courses. "This is cheap equipment," says Assistant Professor Patrick Schaumont. "If we can do this, anybody can."

ECEs spot FPGA security weakness; Finding may lead to new chip ID

Researchers in Secure Embedded Systems have demonstrated a previously unremarked security hole in embedded systems — leaving proprietary data available to thieves and hackers using side channel attacks.

Side channel attacks use non-intrusive monitoring of secure hardware to unlock the secrets of an embedded system. By measuring the power consumption for example, hackers are able to infer the internal activities of the system including internally hidden security keys.

Conventional wisdom says that a glitch-free masked circuit is good protection against these common power-based attacks, but Patrick Schaumont's group has shown that state-dependent circuit effects are also a source of leakage. "Because of the difficulties of mass producing intricate microchips, every single chip is a little bit different," Schaumont explains. "Each individual chip leaks differently."

The good news is that the same findings can be used to develop unique identifiers for individual chips.

"We want to quantify the differences and see if this could help with applications such as automobile identification, or for software firms to track their licenses," he says.

For more information: *www.ece.vt.edu/schaum/research.html*

FACULTY
Lynn Abbott
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Virgilio Centeno
Mohamed Eltoweissy
Michael Hsiao
Chao Huang
Mark Jones
Tom Martin
Leyla Nazhandali
Jung-Min Park
Cameron Patterson
JoAnn Paul
Paul Plassmann
Binoy Ravindran
Patrick Schaumont
Sandeep Shukla
Joseph Tront
Chris Wyatt
Yaling Yang

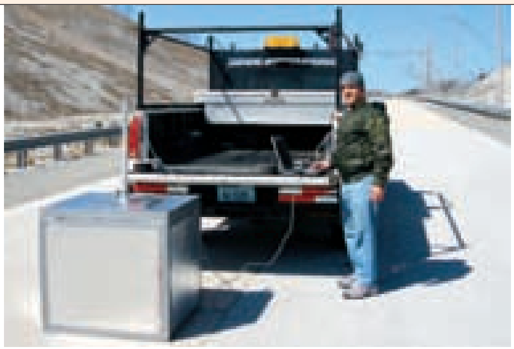
COMPUTER SYSTEMS

Laboratory and group information

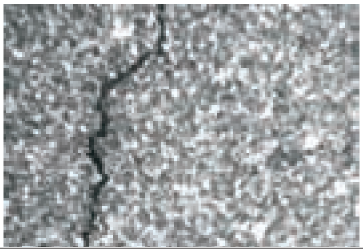
e-Textile Laboratory
www.ccm.ece.vt.edu/etextiles/

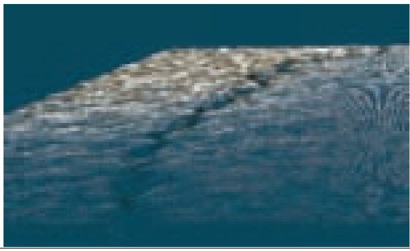
Configurable Computing Laboratory
www.ccm.ece.vt.edu

Real Time Systems Laboratory
www.real-time.ece.vt.edu



Left:Mohamed Saleh tests a system that measures the texture of pavement. Below left: Cracked pavement. Below: computer representation of the cracked texture.





Improving night vision with new super-res processing

The low-resolution images produced by infrared systems can make it difficult for night-vision users to estimate distances or identify far objects. "Resolution enhancement" attempts to address these problems by converting several low-quality images into a single, higher-quality version. Unfortunately, conventional methods of reconstructing these low-quality images are computationally intense, making them too expensive or too slow for real-time, affordable use.

Researchers in ECE's Computer Vision Laboratory have developed a new resolution enhancement technique based on super-resolution reconstruction (SRR). The new method is fast and memory efficient, providing performance comparable to previous techniques but with dramatically reduced computation requirements, according to Ph.D. student Jae Cha and his advisor, Lynn Abbott.

Their closed-form, one-pass method is much faster than existing iterative approaches. In several experiments, they demonstrated a 10-fold speed-up in computation time. The speed, combined with low memory requirements, make this method suitable for use in a low-cost distance-estimation system for infrared applications.

FACULTY
Lynn Abbott
Robert Broadwater
Mark Jones
Pushkin Kachroo
Cameron Patterson
Paul Plassmann
Binoy Ravindran
Sandeep Shukla
Yue Wang
Chris Wyatt
Jason Xuan

SOFTWARE & MACHINE INTELLIGENCE

For more information:

Computer Vision Laboratory:
http://vision.ece.vt.edu

Using computer vision for a smoother ride

The texture of the roads we drive is a factor in the noise, comfort, and safety travelers experience. Measuring the pavement texture, however, entails interrupting traffic and the need for traffic control measures — while providing only a limited sample of the road.

Ph.D. student Mohamed Saleh is developing a stereo vision system that can provide continual road texture measurements at highway speeds over an entire area and will not interrupt traffic.

Saleh's system uses two cameras placed side by side capturing the same image, yielding a slightly different views of a 3-D scene. The images are processed, aligning the epipolar lines and performing edge detection. A matching algorithm identifies the candidate correspondence and produces a 3-D image, allowing depth measures of the area to be examined.

"The benefit of an area measurement, instead of a thin longitudinal line, will give us better characterization of the road surface," says Saleh, who is working with advisor Lynn Abbott. "This is needed to better determine most tire-pavement interactions, such as friction, noise, splash and spray, rolling resistance, and tire wear."

VT software technique speeds up development of new analysis apps

A GA-based integrated system model (ISM) of Staten Island goes from the transmission level down to every customer. The two types of views, geographic and schematic,are concurrently driven by a GA analysis engine.

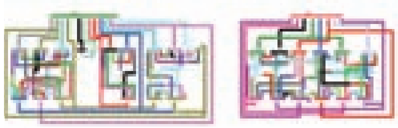
Electric utilities, national laboratories, universities, and the department of defense are using a Virginia Tech software technique to quickly develop new analysis applications at low cost.

The technique, called generic analysis (GA), was developed by Robert Broadwater in the 1980s and is becoming more widely used each year. GA can handle models involving millions of components and has been successful analyzing complex systems, including downtown electric supply systems of St. Louis and New York City. Due to the speed of the technique, the entire St. Louis downtown electric supply system solves in about one second.

GA is based on the generic programming paradigm, which places data in containers. In GA, the container corresponds to the system model. All algorithms access data in the container using iterators. In GA, the same algorithm can be used across different types of models, or different algorithms can be applied to the same model.

New data and analysis can be attached to the model without affecting any existing functionality. Furthermore, a new analysis function can make use of any existing analysis functions attached to the model. "With GA, algorithms written by different people can collaborate through the model, in the way teams of people collaborate," he explained.

With GA, he said, personnel throughout a large enterprise can share a common system model across many functions — from planning and design to real-time operation and control. "With GA, the vision is that the model becomes a reusable, maintained unit throughout the life of the plant."



GA can analyze systems where the system model changes, such as occurs in cascading power failures. Four of the 10 largest U.S. electric utilities are using GA. ECE Ph.D. students Kevin Russell, Lynn Feinauer, and David Kleppinger are solving reconfiguration for restoration problems for cooling water, fire main, and electric power systems on naval ships. ECE's Kwa-Sur Tam is using GA for an economic analysis of the Detroit Edison electric system. Researchers in civil and environmental engineering are modeling critical infrastructure systems for the U.S. Army, including sewage, gas, and real-time potable water. Georgia Tech and the West Virginia University are using GA modeling, as are several national laboratories and overseas power companies.

FACULTY

WIRELESS
Tamal Bose
Charles Bostian
Michael Buehrer
Claudio da Silva
Allen MacKenzie
Tim Pratt
William Tranter
Amir Zaghloul

DSP
Louis Beex
Amy Bell
Lamine Mili
Jeffrey Reed

VLSI Circuits
Peter Athanas
Dong Ha
Michael Hsiao

Networks
Luiz DaSilva
Thomas Hou
Scott Midkiff
Jung-Min Park
Yaling Yang

Fiber Comm
Ira Jacobs

Optics
T.-C. Poon

Propagation
Gary Brown
William Davis
Steven Ellingson
Majid Manteghi
Sanjay Raman
Sedki Riad
Ahmad Safaai-Jazi

COMMUNICATIONS

Laboratory and group web sites:

Wireless@Virginia Tech:
www.wireless.vt.edu

Digital Signal Processing & Communications Lab:
www.ece.vt.edu/fac_support/dspcl

Setting limits for cognitive radio networks

Many researchers expect that as cognitive radio (CR) technology matures, it will play a pivotal role in wireless mesh and ad hoc networks, according to Tom Hou, an associate professor of ECE.

"Due to its unique characteristics in spectrum usage, a CR network differs significantly from the existing multi-channel, multi-radio network," he says. He was recently awarded a two-year grant from the National Science Foundation NeTS program to develop network theoretical bounds and performance limits for future CR networks. "Such efforts are not only of theoretical interest, but also offer fundamental understanding of the potential and limits of such networks, as well as provide performance benchmarks for the design and evaluation of distributed algorithms and protocols."

Networks for the GPS-challenged

A single receiver in a dense forest does not get enough information to determine its location using the GPS system, which requires a lock on four different satellites. Obstructions in the forest (trees to most people) typically prevent receivers from communicating with more than one or two satellites at any single time.

A Wireless@VT effort, headed by Michael Buehrer, an associate ECE professor, is developing outdoor sensor network technology that enables receivers to share GPS information and determine their own location. Nodes will share their limited GPS information to calculate a known coordinate for at least one node in the network. By range-finding between themselves, the nodes will know each other's relative location and be able to precisely compute the latitude and longitude for each node.

In an effort to characterize the EM propagation and GPS performance in forest environments, a team of graduate and undergraduate students measured 93 different locations in four different forest environments. More than 1400 measurements were recorded in light brush and light, medium, and dense forest situations.

The undergraduates were funded under the National Science Foundation (NSF) Research Experience for Undergraduates (REU) program. Undergraduate students involved were Alyse Bowers, Kyle Forrester, Chris Hutchens, Jason McKillican, and Brian Sarbin. Their work was presented in a paper at the 2008 IEEE Wireless Communications and Networking Conference.

The team was led by postdoctoral research faculty member Chris Anderson and a graduate student team of Haris Volos, Bradley Fellow Chris Headley, and Tao Jia. Anderson is now an assistant professor of ECE at the United States Naval Academy.

A student team took more than 1400 measurements to help characterize the EM propagation and GPS performance in forests.

Wireless students take tops in international competition

ECE graduate students took top honors during the 2007 Software Defined Radio Forum conference in November.

Teams representing Wireless@Virginia Tech participated in the international Smart Radio Challenge. Tech was the only school with two teams among the finalists. Each group had to design, develop, and test a software defined radio (SDR) in a way that would solve a specific problem.

A team of eight graduate students, advised by professor Charles Bostian, won the competition's grand prize by developing a software defined radio capable of finding available spectrum within a pre-defined band, rendezvousing with an intended receiver, and successfully transmitting data accordingly.

Tech's other team of graduate students, advised by Carl Dietrich, won the "Best Design" in the Smart Radio Challenge for its approach to the problem of spectrum access for first responders.

Software defined radio devices use software rather than traditional dedicated hardware to define and modify the way they perform signal processing for transmission and reception. This technology is used in two-way communications devices by tactical military forces and emergency responders, as well as in the development of wireless networks that provide Internet services to rural areas.

Automated design for networks

Networks of the future will evolve instead of being designed by engineers, according to Yaling Yang, an assistant professor of ECE. She is leading a Virginia Tech effort to replace today's ad hoc, manual process of network design with automatic system design and adaptation.

"Traditionally, network engineers have designed network systems, based on complex collections of objectives, policies, principles, and past experiences, she says. "The design process is top-down and based on a set of over-simplified assumptions about the operation environments and performance objectives." Because of limited human experience and capability, this manual design process makes it impossible to exploit and evaluate the entire design space for network systems, resulting in extreme challenges for identifying the best designs and promptly responding to network environment changes, she explains.

Instead, she says, a network could be automatically assembled from a set of reusable "genes" and tested in its actual environment. In this scenario, a gene is a small piece of computer code that implements a particular design for a small part of a network component, such as an intrusion detection system, a routing protocol, or a transmit power adaptation strategy. The selection of genes in the automatic process would be based on performance analysis and guided by an evolution process based on interoperability and compatibility theory, optimization theory, and game theory.

Reasoning and learning in wireless networks

ECE communications and networking researchers are investigating reasoning and learning mechanisms in an adaptive wireless network.

Virginia Tech is part of a team led by BBN Technologies and funded by DARPA's Wireless Network after Next (WNaN) program

WNaN is developing technology to provide low-cost communications for the military to communicate with each soldier and device in a tactical situation. The program aims to develop handheld wireless nodes that can be used to establish dense ad hoc networks and links to the information grid. By working around the limitations of the low-cost nodes that form the network and by using the rich interconnection fabric created by dense deployment, the WNaN network should provide reliable battlefield communications at low system cost.

ECE faculty members involved in the effort include Luiz DaSilva, Allen MacKenzie, R. Michael Buehrer, Charles Bostian and Jeffrey Reed.

Wireless@VT joins NSF's WICAT

Tamal Bose was named Virginia Tech's site director for the multi-university Wireless Internet Center for Advanced Technology (WICAT) to collaborate with industry research partners to create flexible, efficient, and secure wireless networks. WICAT, an NSF center, includes teams from Polytechnic University, the University of Virginia, Columbia, and Auburn University. WICAT's mission is to create networks that satisfy the needs of businesses and of consumers.

Virginia Tech's research contributions to the center are focused on cognitive radio-based wireless networks, with efforts in software defined radios (SDR), cognitive radios, cognitive network testbed implementation, theoretical foundations of wireless communications and wireless systems modeling and simulation. Virginia Tech's part of the award amounts to $350,000.

NETWORKING

Laboratory and group websites:

Advanced Research in Information Assurance and Security:
www.arias.ece.vt.edu

Laboratory for Advanced Networking:
www.irean.vt.edu/lan

FACULTY

Luiz DaSilva
Mohamed Eltoweissy
Thomas Hou
Allen MacKenzie
Scott Midkiff
Leyla Nazhandali
Jung-Min Park
Binoy Ravindran
Yaling Yang

New sensor technique more than doubles temperature capabilities

Researchers in the Center for Photonics Technology are developing a new process to manufacture robust pressure sensors that can operate in temperatures up to 1500°C and in extremely harsh environments. Current pressure sensing technology is limited to about 600°C.

"This technology could be used to monitor real-time pressure fluctuations in high temperature furnaces, jet engines, combustion engines, chemical reactions, or corrosive environments," said Bradley Fellow Evan Lally, who is on the development team.

The all-sapphire pressure sensor is constructed through a novel combination of etching and bonding techniques applied to single-crystal sapphire components. The result is a Fabry-Perot cavity with a thin diaphragm, which flexes in response to ambient pressure changes. The sensor can be made smaller than 1 cm. wide.

Sapphire is an extremely hard, corrosion resistant crystal with a melting point over 2000°C, which makes it an ideal material for high-temperature, harsh environments, he explained. It is immune to electromagnetic interference, and because sapphire is a good insulator, the sensor could be used in applications where electronic pressure sensors could cause an ignition hazard.

ELECTROMAGNETICS

FACULTY

Scott Bailey
Charles Bostian
Gary Brown
C. Robert Clauer
William Davis
Steven Ellingson
Louis Guido
Ira Jacobs
Brent Ledvina
Majid Manteghi
Kathleen Meehan
Hardus Odendaal
T.-C. Poon
Sanjay Raman
Sedki Riad
Ahmad Safaai-Jazi
Wayne Scales
Anbo Wang
Yong Xu
Amir Zaghloul

For more information:

Center for Photonics Technology
www.photonics.ece.vt.edu

Center for Space Science and Engineering Research
www.space.vt.edu

Time Domain & RF Measurement Laboratory
www.tdl.ece.vt.edu

Virginia Tech Antenna Group
http://antenna.ece.vt.edu

Buzz Be Gone

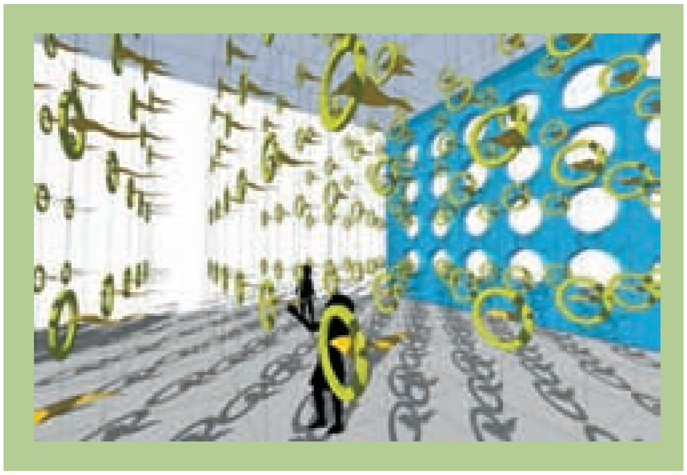
UWB antenna reduces cell interference with hearing aids

The nation's 5.6 million hearing aid users sometimes get too much buzz from interference by nearby cellular phones. Some parts in the hearing aid act as unintended antennas and couple the energy from phones to the hearing devices. The coupled energy is demodulated in the phone's amplifier circuits, producing the irritating buzz hearing aid wearers know so well.

ECE graduate student Taeyoung Yang says the solution could be a new antenna. He proposes solving this problem with a UWB antenna that minimizes near-field radiation from the phone as well as interference to hearing aids, pacemakers, and other medical devices. Yang, with advisors William Davis and Warren Stutzman, designed an antenna and installed it on a cellular phone mockup. The low-Q (ratio of total non-radiating energy to average radiated power per radian) antenna has low non-radiating stored energy in the near field, reducing interference with hearing aids and potential power absorption by the human head, while not reducing far field performance.

His project, entitled 'Cellular Phone and Hearing Aid Interaction: An Antenna Solution,' won a national honorable mention in the 2007 FEKO student competition for simulation techniques used to solve electromagnetic problems. He also received Virginia Tech's Torgersen Graduate Student Research Excellence Award for scientific originality and contribution.

Left: Cell phone mockup with conventional antenna and proposed UWB antenna (right).



Phoebe's Field project lets kids handle scientific concepts

An international team of educators and professionals based at Virginia Tech is working on giving middle-schoolers innovative ways to learn scientific concepts, such as electromagnetic and acoustic fields. Their goal is to encourage interest in science among children, especially girls. ECE faculty member Steve Ellingson is part of the team, which is led by Mitzi Vernon of the School of Architecture and Design and includes eight other collaborators.

The effort, which includes a children's book and a traveling exhibition, is called Phoebe's Field and is targeted especially for girls, who often lose interest in science at adolescence.

The exhibition will use metaphors in nature to explain complex concepts, such as electromagnetism. As they tour the exhibition, students see, hear, touch, and carry out physical activities in fields usually beyond their perception. A quest storyline captures the student's attention and focuses their interest in concepts.

Ellingson is contributing to the development of the electromagnetic field exhibit, which deals with the concept of electromagnetic signals such as those found in cell phones. He is also working on an RFID-based system that will allow new forms of interaction between the exhibits and the visitors. Visit: *www.phoebesfield.org*.

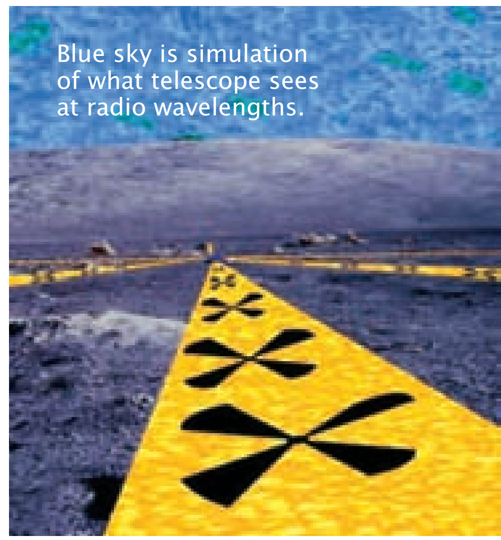
DALI on the dark side

Astronomers have long dreamed about putting telescopes on the far side of the moon, away from Earth's turbulent ionosphere and torrent of radio signals. In the moon's radio-free shadow, radio telescopes might possibly pick up faint signals from the early universe that could not be otherwise detected.

ECE's Steve Ellingson is part of a Naval Research Laboratory team fleshing out ideas for rolled-up radio antennas that would pop open after being dropped on the lunar surface for transmitting data and for taking advantage of the planned presence of astronauts on the moon around 2019.

The team wants to build radio telescopes (antennas) that can capture signals at the very long wavelengths generated by events that occurred within hundreds of thousands — as opposed to billions — of years after the big bang. The universe consisted then of still-dark matter, hydrogen and helium. Efforts to test theories about the Universe's origins would benefit from the kind of data a moon-based radio telescope could provide.

The team, which includes researchers from Berkeley, the University of Colorado, Harvard, and Yale, is working under a $500,000 NASA-funded planning grant as part of the Dark Ages Lunar Interferometer (DALI) project. The team has recently merged with a similar effort led by MIT. The Dark Ages refers to the time after the initial universe explosion and before stars and galaxies formed.



An artist's conception of one of the antenna arrays comprising the radio telescope. The antennas are printed on a thin material which is rolled out from a central electronics hub that contains receivers and communication gear.

.1 micron precision

When the measurable difference between two equal fiber path lengths in a fiber coupler could not exceed 5 micrometers, researchers in the Center for Photonics Technology designed a new polishing technique.

Bradley Fellow Evan Lally and undergraduate Tyler Shillig have been working on a special white-light interferometry technique to monitor the exact optical path length difference between two coupler arms. The two lengths of fiber are placed in a precision adjustable polishing jig, and their lengths are monitored as the fiber tips are ground down.

The team reports they expect their polishing system to achieve 0.1 micron path length equalization.

Having a fiber coupler with exactly equal length output arms is critical to the operation of a system they are developing to image small rock and sand particles in asphalt. The project is sponsored by the National Cooperative Highway Research Program.

ELECTRONICS

FACULTY

Masoud Agah
Dushan Boroyevich
William Davis
Louis Guido
Robert Hendricks
Chao Huang
Jason Lai
Fred C. Lee
G.Q. Lu
Kathleen Meehan
Khai Ngo
Hardus Odendaal
Marius Orlowski
Sanjay Raman
Anbo Wang
Fred Wang
Ming Xu
Sedki Riad
Amir Zaghloul
Kwa-Sur Tam
Krishnan Ramu
Douglas Lindner
Joseph Tront
Yong Xu

For more information:

Center for Power Electronics Systems: *www.cpes.vt.edu*

Future Energy Electronics Center: *www.feec.ece.vt.edu*

Microelectronics, Optoelectronics and Nanotechnology (MicrON): *www.micron.ece.vt.edu*

ECE invention named to R&D Top 100

G.Q. Lu's invention of nanoTach was named one of the 100 top inventions of 2007 by *R&D Magazine*. NanoTach is a nanoparticle paste made of silver for interconnecting high-power electronic devices. It turns silver when heated.

The growing national interest in sustainable homes and alternative energy sources has spurred several research efforts tackling the technology problems from different perspectives.

Dave Franusich

Living laboratory for sustainable building research

The Center for Power Electronics Systems (CPES) is developing two testbed/laboratories for its research in power electronics energy management of sustainable buildings.

The center is developing a "living lab" to provide a testbed for the energy systems of a sustainable home of the future and a DC-based electric power system.

Four rooms in the CPES laboratories are being converted into a conference room, library/lounge, kitchen, and utility room. Students, faculty, and staff will use the rooms for normal daily functions.

The experimental laboratory will be powered by a power-system testbed supplied by multiple renewable energy sources, including a 3.5 kW turbine generator, a 5kW PV solar panel system, lithium-ion battery bank for energy storage, and a plug-in hybrid car with bidirectional energy flow.

The electrical system has both a high-voltage DC bus for HVAC, simulated kitchen loads and major appliances and a low-voltage bus for telecommunications, computers, and LED lighting.

Jason Lai (right) demonstrates previous milestone efficiencies to Bradley Fellow Parrish Ralston, who is characterizing fifth generation transistors for the FreedomCAR project.

FreedomCAR: Seeking 98.5% efficiency

Jason Lai, director of the Future Energy Research Center, is heading a $2.7 million effort to develop a power electronics inverter for the Department of Energy FreedomCAR project. The FreedomCar is a multi-year effort to develop technologies that enable the adoption of first gas/hybrid, then fuel cell/hybrid vehicles.

Lai's is the only university-based team of the five involved in the drive train development. The target for the project is to be able to run the entire drive train at 105°C at the cost of $8.50 per kW.

"With today's technology, it is practically impossible to run electronics at that temperature with a reasonable cost," he says. His goal is to develop the system that can run with consumer-grade silicon in order to keep the cost down. The other teams are using silicon carbide (SiC), which can handle the temperature, but is very expensive and has reliability issues, according to Lai. "A four-inch silicon wafer is $25 and a two-inch SiC wafer is $950. A three-inch SiC wafer is $5000," he says.

Lai's team is pursuing two key issues: soft switching technology and advanced power module packaging, which he is partnering with Powerex to develop. The Virginia Tech team is developing the soft-switching technology, trying to get the efficiency higher than 98.5 percent. "We can get it to 99 percent with the use of more silicon, which we don't want to do obviously for the economical reason."

Lai's team has previously achieved record-breaking efficiency on other projects, including a 97 percent efficient isolated DC-to-DC converter for fuel cells, developed in 2005. "If we cannot achieve the 98.5 efficiency, nobody can," he says. "That's why we won the project."

Storing solar energy for the swing shift

A team of Virginia Tech researchers is developing the technology to store solar energy in fuel cells for when the sun goes down. "Electricity generated via solar energy peaks in mid-day, but power consumption at home is typically concentrated from evening to early morning," says Kathleen Meehan, an assistant professor and principal investigator on the project.

Solarized fuel cells would enable energy produced in daytime to be stored for evening and cloudy-day use, while eliminating the need for batteries, she explains. Energy would be stored as hydrogen and oxygen through water electrolysis. When the solar system cannot produce enough energy for the load, the fuel cell would be used.

Technology improvements are needed, however, before such systems are affordable and reliable — and the expertise to develop them is at Virginia Tech, she says. The team, which includes electrical, materials, chemical, and mechanical engineers is working on developing advanced solar cells with nanoscale conversion films; power tracking systems to divide solar power generated between the load and the electrolysis system, nanoscale catalysts to improve solar energy conversion to hydrogen optimized power conversion, and power conditioning for household and plug-in hybrid electric vehicle loads.

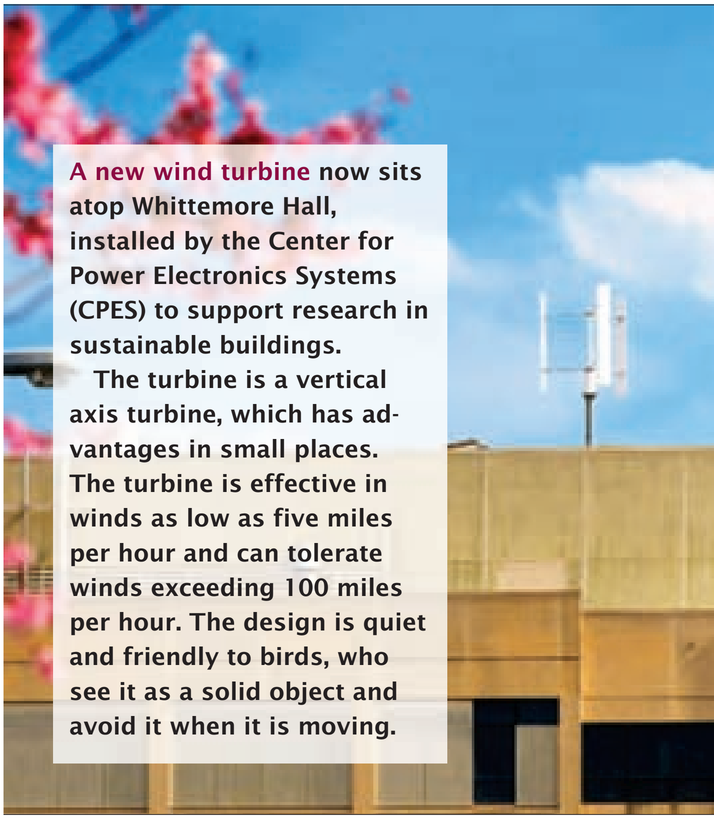
In addition to Meehan, principal investigators on the project are ECE's Jason Lai, G.Q. Lu, and Lou Guido, along with Richey Davis of chemical engineering and Douglas Nelson of mechanical engineering.

POWER

For more information:
Power IT Laboratory:
www.powerit.vt.edu

FACULTY
Robert Broadwater
Virgilio Centeno
Jaime de la Ree
Yilu Liu
Lamine Mili
Saifur Rahman
Kwa-Sur Tam
James Thorp

Researchers under the direction of Virgilio Centeno are using the testbed in the Power Engineering Laboratory to test the dynamic performance of Phasor Measurement Units (PMU).



A new wind turbine now sits atop Whittemore Hall, installed by the Center for Power Electronics Systems (CPES) to support research in sustainable buildings.

The turbine is a vertical axis turbine, which has advantages in small places. The turbine is effective in winds as low as five miles per hour and can tolerate winds exceeding 100 miles per hour. The design is quiet and friendly to birds, who see it as a solid object and avoid it when it is moving.

Christina O'Connor

ECE team joins China-sponsored Energy Security Group

National Academy of Engineering members Arun Phadke and James Thorp are part of a Chinese funded research team directed to improve the protection and security of the worldwide, interconnected electric power grid. China's Ministry of Education and State Administration of Foreign Experts Affairs is sponsoring the five-year, $1.2 million project, called the "Expertise-Introduction Project for Disciplinary Innovation of Universities."

Phadke and Thorp are both leading experts in power system digital protection. Traditionally electric power networks have used the computer and communication networks in a variety of critical applications. However, researchers are looking at new configurations of power, communication and computer networks that could be more easily controlled and protected for optimum security, economy, and performance.

Playing well with others — autonomously

Virginia Tech air, surface and ground autonomous vehicles showed their teamwork ability in a reconnaissance demonstration at the U.S. Navy's 2007 AUVFest.

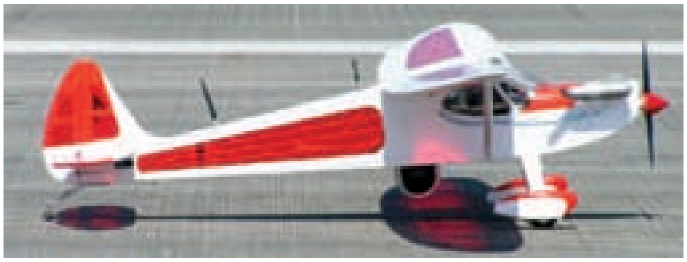
The autonomous surface vehicle (ASV) deployed first, and patrolled on a river through preprogrammed way-points. Because the AUV has limited field-of-view, the "Rascal" unmanned air vehicle (UAV) then flew over the operating area, to look for potential objects of interest. It detected the targeted object, localized it, and sent the coordinates to the ASV, which then changed its route to pass around the object for close-up inspection. At the same time, Tech's unmanned ground vehicle, "Rocky," patrolled the shore and maneuvered to keep the object in its camera's field of view.

The demonstration was a collaboration between Virginia Tech autonomous vehicle researchers and the U.S. Navy Postgraduate School (NPS). "Despite this being our first opportunity for Tech and NPS to operate all systems simultaneously, the demonstration worked perfectly on the first attempt," said ECE's Dan Stillwell, whose team developed the ASV and control algorithms. ECE's Chris Wyatt lead development of machine vision algorithms for the ASV.

In another demonstration, Virginia Tech's high speed autonomous underwater vehicle (AUV) demonstrated its high-speed capability. In just 40 seconds, it launched and covered more than 200 meters at about 10 knots.

A platoon of other AUVs, including the VT 475 AUV, demonstrated coordinated motion control and adaptive environmental sampling capabilities. For environmental sampling, an AUV detected and then mapped the outflow of a waste water treatment plant that flows into St. Andrew Bay near Panama City, Fla. The AUV detected and ran through the plume. When the AUV recognized that it had returned to the ambient environment, it turned back on a different trajectory. The AUV repeated the process many times and constructed a map of the plume and estimated center of the plume. (*www.ascl.ece.vt.edu*)

Reconnaissance demonstrations of the ASV, Rascal UAV, a platoon of other AUVs, and the unmanned "Rocky" by Virginia Tech and the U.S. Navy Postgraduate School.



Unraveling the environmental and genetic factors of common diseases

Yue (Joseph) Wang and Jason Xuan are applying machine learning to understanding the complex interactions between environmental and genetic factors in common diseases.

Many diseases result from a complex interaction of multiple environmental and genetic factors and since the sequencing of the human genome, researchers have been gathering genetic data associated with common diseases. However, it is largely unknown how specific variations in a person's genes interact with each other to increase the propensity for any given disease.

Researchers have started using genome-wide association studies (GWAS), — hailed by Science magazine as the breakthrough of the year — to identify the risk associated with each factor. GWAS studies involve using arrays that can compare 500,000 factors against thousands of people.

"GWAS studies generate huge datasets on these genetic factors," said Wang, who directs ECE's Computational Bioinformatics and Bio-imaging Laboratory. "To understand what combination of factors triggers these diseases and how they each contribute is an enormous computational task."

The diseases are caused by many small effects, which are hard to see in the data, he explained. The effects are not just complex, but also nonlinear. "Not everybody has all the effects. Taken together, however, all the small effects can equal disease."

The team plans to develop parallel and economics portfolio computing techniques to meet the computational challenges of the problem.

Wang and Xuan have received a grant from the National Institutes of Health (NIH) as a part of the Gene and Environmental Initiatives (GEI) to pursue the effort, jointly with Wake Forest University School of Medicine and Pennsylvania State University College of Engineering

For more information, visit *www.cbil.ece.vt.edu*.

In May 2007, ECE Professor Krishnan Ramu sold his five-year-old Panaphase Technologies to Magnetic Torque International of Reston, making a successful technology transfer of intellectual property in the field of variable reluctance and permanent magnet electric motors and drives.

SIGNALS, SYSTEMS AND CONTROLS

FACULTY

William Baumann
A.A. (Louis) Beex
Pushkin Kachroo
Douglas Lindner
Krishnan Ramu
Daniel Stilwell
Yue (Joseph) Wang
Chris Wyatt
Jason Xuan

For more information:

Autonomous Systems & Controls Laboratory:
www.ascl.ece.vt.edu

Digital Signal Processing Research Laboratory:
www.dsprl.ece.vt.edu

Jumping head-first into the unknown

When working on a research project in ECE's Digital Signal Processing Research Laboratory this spring, Gary Wheelock (EE '08) found that diving head-first into a project can get messy. With funding from BAE Systems, Wheelock has been working with a DSP board to develop a BPSK (binary phase-shift keying) transmitter and receiver and measure the bit-error-rate of the system.

Christina O'Connor

Wheelock said his biggest challenge was overcoming his lack of specific background. "I dove right in head-first with no good starting place," he said. "Things got messy, so I backed off and decided to implement a simple design based on my experience, then build from that."

Developing the transmitter required dealing with issues in sampling, carrier recovery, filtering, synchronization, and bit detection. "There are multiple ways to implement a receiver — all ranging in complexity." Before completing the project, he hoped to develop a synchronous receiver and possibly implement pulse shaping to help limit bandwidth.

As a result of his experience, he feels more confident to tackle an unknown project. But the most fun, he says, was finally understanding the details of the board and the system. "Once you understand it, it's more fun. You can play around with the system, tweak it, add parts: basically make it your own. This is almost mine."

Getting comfortable with mutagens and E. coli

For her research in modeling and parameter estimation of small gene networks, Bradley Fellow Rebecca Shelton needed a firm understanding of the strengths and weaknesses of the data involved. This led to spending a couple months in Jean Pecoud's "wet" laboratory at the Virginia Bioinformatics Institute (VBI).

Her task was to prepare DNA constructs for testing. Putting the constructs together involved using restriction enzymes to digest, or cut, the pieces first, she explained. The digestion was then inserted into a gel made with agar, merged in a buffer, and electrified — a process called electrophoresis. Different sized DNA fragments, which are negatively charged, move at different speeds toward the anode. "We then compared the fragments with a constant to select the size we needed. We cut it from the gel and isolated it," she said. "We were hoping to get data for a system model."

She found some interesting differences between an EE laboratory and a biology wet laboratory. "In engineering, we don't set things up and wait overnight to see if they grow. We just turn equipment on." She also gained an appreciation for good laboratory technique. "Not only is it surprisingly hard," she said, "but I also had to get comfortable working around mutagens and what you think of as potential disease-causing organisms like E. coli."

Her biggest lesson, however, was a new appreciation for data. "I thought I knew where data comes from and what variables go into it. In the lab, however, you see where the errors can come from. You can see all the things that can happen between giving someone a design for an experiment and the data that come out."

Christina O'Connor

2006 2007 PH.D. DEGREES AWARDED

Akbar, Ihsan Ali
Statistical Analysis of Wireless Systems Using Markov Models
Committee Chair: Tranter, W. H.

Al-Nasur, Sadeq Jawad
New Models for Crowd Dynamics and Control
Committee Chair: Kachroo, P.

Anderson, Christopher Robert
A Software Defined Ultra Wideband Transceiver Testbed for Communications, Ranging, or Imaging
Committee Chair: Reed, J. H.

Atcitty, Stanley
Electrochemical Capacitor Characterization for Electric Utility Applications
Committee Chair: Liu, Y.

Bhaduri, Debayan
Design and Analysis of Defect- and Fault-Tolerant Nano-Computing Systems
Committee Chair: Shukla, S.K.

Chembil-Palat, Ramesh
Performance Analysis of Cooperative Communication for Wireless Networks
Committee Chair: Reed, J. H.

Chen, Xiaoding
Exploring Temporal and Spatial Correlations on Circuit Variables for Enhancing Simulation-Based Test Generation
Committee Chair: Hsiao, M. S.

Chen, Xiaopei
Ultra-Narrow Laser Linewidth Measurement
Committee Chair: Wang, A.

Cho, Hyeonjoong
Utility Accrual Real-Time Scheduling and Synchronization on Single and Multiprocessors: Models, Algorithms, and Tradeoffs
Committee Chair: Ravindran, B.

Clark, Jeffrey Robert
Double Negative Metamaterials in Dielectric Waveguide Configurations
Committee Chair: Safaai-Jazi, A.

Collins, Gustina Bernette
Design, Fabrication and Testing of Conformal, Localized Wafer-Level Packaging for RF MEMS Devices
Committee Chair: Raman, S. & Lu, G. Q.

Donolo, Marcos Angel
A Continuum Approach to Power System Simulation
Committee Chair: Centeno, V.

Edmison, Joshua Nathaniel
Hardware Architectures for Software Security
Committee Chair: Jones, M. T.

Gadre, Aditya
Observability Analysis in Navigation Systems with an Underwater Vehicle Application
Committee Chair: Stilwell, D. J.

Ibrahim, Jihad El Sayeed Abdal
Algorithms and Architectures for UWB Receiver Design
Committee Chair: Buehrer, R. M.

Ikuma, Takeshi
Non-Wiener Effects in Narrowband Interference Mitigation Using Adaptive Transversal Equalizers
Committee Chair: Beex, A. A.

Kim, Jong-Han
On the Impact of MIMO Implementations on Cellular Networks: An Analytical Approach from a Systems Perspective
Committee Chair: Reed, J. H.

Kompella, Sastry Venkata
Video Communications over Dynamic Ad Hoc Networks
Committee Chair: Hou, Y. T.

Kook, Kyung Soo
Simulation Studies on Novel Findings in Power Systems
Committee Chair: Liu, Y.

Koujah, Fahad
A Power-Aware Routing Scheme for Ad Hoc Networks
Committee Chair: Midkiff, S. F.

Lee, Unghee
A Proactive Routing Protocol for Multi-Channel Wireless Ad-Hoc Networks
Committee Chair: Midkiff, S. F.

Lim, Hong Sun
Design and Control of a Ropeless Elevator with Linear Switched Reluctance Motor Drive Actuation Systems
Committee Chair: Ramu, K.

Louganski, Konstantin Pavlovic
Generalized Average-Current-Mode Control of Single-Phase AC-DC Boost Converters with Power Factor Correction
Committee Chair: Lai, J.

Lu, Bing
Investigation of High-Density Integrated Solution for AC/DC Conversion of a Distributed Power System
Committee Chair: Lee, F. C.

Mellodge, Patricia Ann
Model Abstraction in Dynamical Systems: Application to Mobile Robot Control
Committee Chair: Kachroo, P.

Menon, Rekha
Interference Avoidance based Underlay Techniques for Dynamic Spectrum Sharing
Committee Chair: Buehrer, R. M. & Reed, J. H.

Mo, Tianmin
Throughput Optimization and Transmitter Power Saving (TOTPS) Algorithm and Extended TOTPS (ETOTPS) Algorithm for IEEE 802.11 Links
Committee Chair: Bostian, C.W.

Mohammad, Maruf Hossain
Cellular Diagnostic Systems Using Hidden Markov Models
Committee Chair: Tranter, W. H.

Nayfeh, Nader Ali
Local and Global Stability and Dynamics of a Class of Nonlinear Time-Delayed One-Degree-of-Freedom Systems
Committee Chair: Baumann, W. T.

Neel, James O'Daniell
Analysis and Design of Cognitive Radio Networks and Distributed Radio Resource Management Algorithms
Committee Chair: Reed, J. H.

Patcha, Animesh
Network Anomaly Detection with Incomplete Audit Data
Committee Chair: Park, J. M.

Patel, Hiren Dhanji
Ingredients for Successful System Level Automation & Design Methodology
Committee Chair: Shukla, S. K.

Refaei, Mohamed Tamer A.
Adaptation in Reputation Management Systems for Ad hoc Networks
Committee Chair: DaSilva, L. A.

Schoenig, Gregory Neumann
Contributions to Robust Adaptive Signal Processing with Application to Space-Time Adaptive Radar
Committee Chair: Mili, L. M.

Shen, Fabin
UV-Induced Intrinsic Fabry-Perot Interferometric Fiber Sensors and Their Multiplexing for Quasi-Distributed Temperature and Strain Sensing
Committee Chair: Wang, A.

Shen, Wei
Design of High-Density Transformers for High-Frequency High-Power Converters
Committee Chair: Boroyevich, D. & Wang, F.

Thompson, Michael Stewart
Service Discovery in Pervasive Computing Environments
Committee Chair: Midkiff, S. F.

Venkatesh, Swaroop
The Design and Modeling of Ultra-Wideband Position-Location Networks
Committee Chair: Buehrer, R. M.

Vimjam, Vishnu Chaithanya
Strategies for SAT-Based Formal Verification
Committee Chair: Hsiao, M. S.

Wadoo, Sabiha Amin
Evacuation Distributed Feedback Control and Abstraction
Committee Chair: Kachroo, P.

Wang, Hongfang
Investigation of Power Semiconductor Devices for High Frequency High Density Power Converters
Committee Chair: Wang, F.

Wang, Xingwei
Label-free DNA Sequence Detection Using Oligonucleotide Functionalized Fiber Probe with a Miniature Protrusion
Committee Chair: Wang, A.

Wang, Zhuang
Intrinsic Fabry-Perot Interferometric Fiber Sensor Based on Ultra-Short Bragg Gratings for Quasi-Distributed Strain and Temperature Measurements
Committee Chair: Wang, A.

Wood, Kerry Neil
Directional Communications to Improve Multicast Lifetime in Ad Hoc Networks
Committee Chair: DaSilva, L. A.

Xiao, Chucheng
An Investigation of Fundamental Frequency Limitations for HF/VHF Power Conversion
Committee Chair: Odendaal, H.

Zhang, Li
Study of FACTS/ESS Applications in Bulk Power System
Committee Chair: Liu, Y.

Zhao, Youping
Enabling Cognitive Radios through Radio Environment Maps
Committee Chair: Reed, J. H.

Zhu, Dan
Electric Distribution Reliability Analysis Considering Time-Varying Load, Weather Conditions and Reconfiguration with Distributed Generation
Committee Chair: Broadwater, R. P.

In addition to his responsibility for system architecture, learning functions, and core AI abilities, Rondeau was known as "The Philospher" on Charles Bostian's cognitive radio team.

Rondeau wins best dissertation for cognitive radio work

Thomas Rondeau (BSEE '03, MSEE '06, Ph.D. '07) has been awarded the Virginia Tech 2007 Outstanding Dissertation Award for Sciences and Engineering for his dissertation, *Application of Artificial Intelligence to Wireless Communications*.

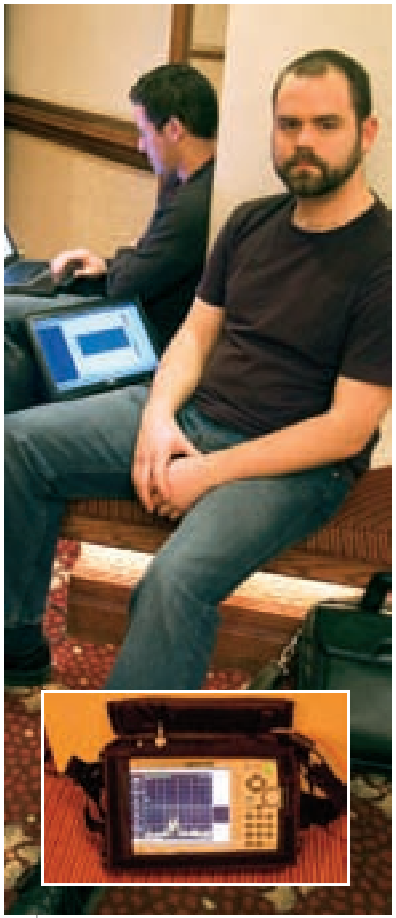
The Graduate School gives only two such awards each year; one in sciences and engineering, the other in humanities and social sciences. The awards are based on originality of the idea, contributions to the field, presentation of the ideas, and the quality of writing. Each department may nominate one dissertation per year for the award.

Rondeau's dissertation describes the theory, design, and implementation of a cognitive radio engine, the enabling technology of cognitive radio. "A cognitive radio," he writes, "is a wireless communications device capable of sensing the environment and making decisions on how to use the available radio resources to enable communications with a certain quality of service. The cognitive engine, the intelligent system behind the cognitive radio, combines sensing, learning, and optimization algorithms to control and adapt the radio system from the physical layer and up the communication stack."

His cognitive engine platform should allow easy development of new components and algorithms for the application, he says.

Rondeau became involved in ECE's wireless communications research while a sophomore and has been involved in cognitive radio development almost since its inception. His work has led to several patents in the technology. He currently holds a post-doctoral position with CTVR at Trinity College Dublin, Ireland.

On a visit to the U.S. in November, Tom Rondeau stopped to capture network data outside the MANIAC Challenge competition. When compiled, the data will be available on the CTVR website.



HONORS & ACHIEVEMENTS

International & National Service

Bob Clauer is member of the Polar Research Board of the National Academy of Sciences and also in that capacity is a member of the U.S. National Committee for the International Polar Year, which is commemorating the 50th anniversary of the International Geophysical Year.

Scott Midkiff is serving as program director of the Electrical, Communications and Cyber Systems (ECCS) program in the Directorate for Engineering of the National Science Foundation. He is also serving as a member of the Joint Tactical Radio System (JTRS) Network Enterprise Domain (NED) Defense Support Review team for the Director, Defense Research and Engineering in the Office of the Secretary of Defense.

Sanjay Raman is serving as Program Manager, Defense Advanced Research Programs Agency Microsystems Technology Office (DARPA/MTO).

T.-C. Poon has been appointed an adjunct professor by the National Central University in Taiwan.

Saifur Rahman was elected Vice President for New Initiatives of the IEEE Power and Energy Society for 2008-2009.

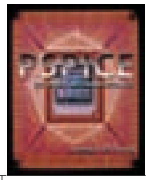
Amir Zaghloul was elected to the Board of the Applied Computational Electromagnetics Society for a three-year term.

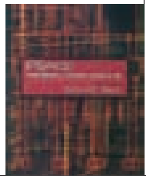
Amy Bell served as chair of the IEEE Educational Activities Board, Public Awareness Committee. She was also the founder and director of the Board's Real World Engineering Projects Program, 2007.

Yue (Joseph) Wang is serving as an external reviewer for the Food and Drug Research Programs.

Books Published

T.-C. Poon published *Optical Scanning Holography with MATLAB*, Springer, 2007. **Joseph Tront** published *PSpice for Basic Microelectronics*, McGraw-Hill Higher Education, 2008, and *PSpice for Basic Circuit Analysis, Second Edition*, McGraw-Hill Higher Education, 2007.





Honors & Awards

James Thorp and Arun Phadke were honored with the 2008 Benjamin Franklin Medal in Electrical Engineering for their combined contributions in strengthening the immunity of the power grid to blackouts. Phadke also was awarded the HKN 2007 Vladimir Karapetoff Award, along with Stanley Horowitz, for their technical contributions to the field of power system protection and control.

G.Q. Lu's development of nanoTach was listed one of the 100 most technologically significant products of 2007 by *R&D Magazine*.

Masoud Agah received an NSF CAREER award for "GC Matrix, a Microsystem Approach for Complex Gas Analysis."

Jung-Min Park received an NSF CAREER award for "Non-Conventional Solutions for Ensuring Security in Cognitive Radio Networks."

Michael Hsiao's paper was designated one of the most influential of 10 years (1998-2007) at the Design Automation and Test in Europe (DATE) Conference, 2008.

Krishnan Ramu was the keynote speaker at the POWERENG 2007 conference and spoke on "Switched reluctance motor drives: past, present, and future." A paper he co-authored received a first prize award from the IEEE Industry Applications Society's Industrial Drives Committee.

Dong Ha was named a Fellow of the IEEE for leadership in VLSI design and test.

Amy Bell was named a University Scholar-in-Residence for the American Association of University Women Education Foundation.

Joseph Tront was awarded an 2007 Laureate Award in the Computerworld Honors Program for his work in tablet PC-based learning environments.

Sandeep Shukla was honored by the State University of New York with a Distinguished Alumni Award in Science & Technology.

Student teams from Wireless@VT won top honors at the Software Defined Radio Forum's 2007 Smart Radio Design Challenge. The team advised by Charles Bostian won the overall grand prize and the team advised by Carl Dietrich and Jeff Reed won the Best Design Award.

Charles Bostian was selected as Virginia Tech's 2008 Outstanding Dissertation Advisor in the Engineering and Science category as the advisor of Thomas Rondeau.

Thomas Rondeau received the 2008 Virginia Tech Outstanding Dissertation Award.

Patrick Schaumont won an Outstanding new Assistant Professor Award in the College of Engineering.

Sanjay Raman was named a College of Engineering Faculty Fellow.

Conference Chairs

Mohamed Eltoweissy is serving as co-chair for the 2nd IEEE Workshop on Mission Critical Networks, April 2008. His is also workshops co-chair for INFOCOM 2008.

Sandeep Shukla was program co-chair for the 7th International Conference on Applications of Concurrency for System Design, June 2007.

Thomas Hou co-chaired the NSF Workshop on Bridge the Gap Between Wireless Networking Technologies and Advances at the Physical Layer, August 2007. He also co-chaired the Technical Program Committee at the Second International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CROWNCOM), July, 2007.

T.-C. Poon served as founding chair of the 2007 Optical Society of America (OSA) topical meeting "Digital Holography and 3-D Imaging," June 2007. He also served as chair of the 2008 meeting, March 2008.

Dong Ha served as sympsium chair for the Communication and Networking Technology Symposium, August 2007.

Patents Awarded

"Adaptive Bus Voltage Positioning for Two-Stage Voltage Regulators," J. Wei, M. Xu, F.C. Lee.

"Buck Converter with High Efficiency Gate Driver Providing Extremely Short Dead Time," Y. Ren, F.C. Lee.

"Cognitive Radio Engine Based on Genetic Algorithms in a Network," C.W. Bostian, W.R. Cyre, T.M. Gallagher, C.J. Rieser, T.W. Rondeau.

"Current Sensing in Multiple Coupled Industors by Time Constant Matching to Leakage Inductance," Y. Dong, M. Xu, F.C. Lee.

"Decision Selection and Associated Learning for Computing All Solutions in Automatic Test Pattern Generation (ATPG) and Satisfiability," M.S. Hsiao, K. Chandrasekar.

"Device and Method for Tuning an SPR Device," K. Meehan, R.E.Dessy.

"EMI Filter and Frequency Filters Having Capacitor with Inductance Cancellation Loop," S. Wang, F.C. Lee, W.G. Odendaal.

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