ECpE
IOWA STATE UNIVERSITY
Connections
The ELECTRICAL and COMPUTER ENGINEERING Alumni Newsletter
Vol. 20, No. 2 Spring 2004

Dear Friends:

"Reach for the top." That's the name of the ISU College of Engineering's initiative to push the college into the top 20 engineering programs in the nation, and it often brings forth an image of a mountain, with faculty, staff, and students struggling to reach its pinnacle.

But the mountain image is really the wrong one, because mountains stay put. When you're a mountain climber, your destination is firm; and when you've reached the top, you know it. You can even stay there for a while, observing the world beneath you.

Almost more than any other discipline, the challenges of computer and electrical engineering change, shift, and grow daily. For example, in this newsletter you will read about efforts to make virtual communication faster, safer, and more efficient. In order to respond to this dynamic environment, we must have cutting-edge equipment, top-notch researchers and teachers, and an ongoing dialogue with our industry partners. We're proud of the progress we've made.

New laboratories are on the horizon. Our High Speed System Engineering Laboratory, funded by the National Science Foundation, will enhance our work with wireless and optical fiber networks. A wavelength division multiplexing optical fiber network will allow experimentation with high-speed communication and traffic management. Our Software Engineering Laboratory, funded by Lockheed and Rockwell, will include 24 stations equipped with tools and techniques that will help our young graduates respond to today's marketplace and anticipate tomorrow's needs. The new Information Infrastructure Institute (iCube) Laboratory will allow us to research high-speed wireless communication and sensor networks.

Three new faculty searches are underway. We are in the process of a search for a candidate for the Palmer Endowed Chair, a distinguished scholar at the full professorship level to develop a research program. We are interviewing for two faculty members who will support our software engineering initiative and strengthen our information technology research.

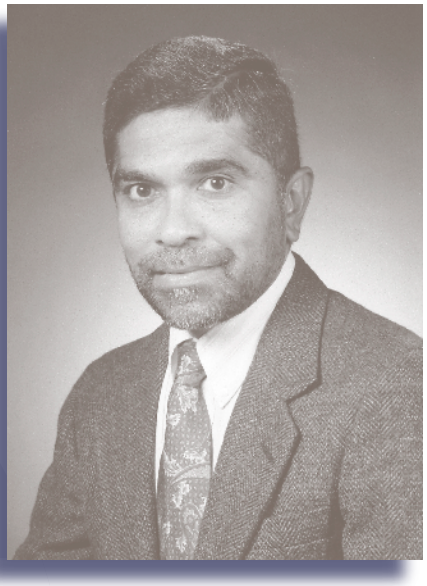
And, finally, **we have received funding** for faculty for iCube, one of Iowa State's newest initiatives announced by ISU President Geoffroy last year to support research in application-specific computing.

The top may be elusive—but we will keep on climbing.

Thank you for your ongoing support and interest in electrical and computer engineering at Iowa State.

Arun Somani, Chair
Department of Electrical and Computer Engineering

Vijay Vittal elected to National Academy of Engineering



Vijay Vittal, Harpole Professor of Electrical and Computer Engineering, has been elected to the National Academy of Engineering (NAE), one of the highest distinctions accorded an engineer. The academy has honored Vittal for his leadership and cutting-edge research in the area of improvements in real-time control and dynamic security assessment for electric power systems. Vittal will be installed into the academy in an October 3 ceremony in Washington, D.C.

Vittal is one of 76 new national members and 11 new foreign associates elected to the NAE and the second member of the Iowa State engineering faculty to be so honored in the past year. **R. Bruce Thompson**, distinguished professor of aerospace engineering and materials science engineering, was elected to the academy last fall.

"With the election of Professor Vittal to the NAE right on the heels of Bruce Thompson, Iowa State continues to claim its place as one of the top engineering programs in the nation," said **James L. Melsa**, dean of the College of Engineering. "We're especially proud that, as an Iowa State Ph.D. graduate, Vijay represents the caliber of person, scholar, and engineer the college both attracts and produces."

Vittal was born in Bangalore, India, where he received his B.E. in electrical engineering from the B.M.S. College of Engineering. He earned an M.T. in electrical engineering from the Indian Institute of Technology in Kanpur, India, and in 1982 was awarded the Ph.D. in electrical engineering from Iowa State University, where he joined the faculty of the Department of Electrical and Computer Engineering.

As director of Iowa State's Electric Power Research Center, Vittal researches a broad range of areas, including power system dynamics, the dynamic security assessment of power systems, power system operation and control, and application of robust control techniques to power systems.

NATIONAL ACADEMY OF ENGINEERING

An internationally acclaimed scholar and the author of two textbooks in power system analysis, Vittal has received numerous awards, including the Outstanding Power Engineering Educator Award from the Power Engineering Society of the Institute of Electrical and Electronics Engineers in 2000 and the Iowa State University Foundation Award for Outstanding Achievement in Research in 2003.

Vittal lives in Ames, Iowa, with his wife, **Sunanda**, and son, **Vinayak**, 18. Another son, **Eknath**, 20, is studying electrical engineering at the University of Illinois. ■

ECpE Connections

Published by The Department of Electrical and Computer Engineering

2215 Coover Hall
Iowa State University
Ames, IA 50011-3060
(Voice) 515-294-2664
(Fax) 515-294-3637
(E-mail) ece@ee.iastate.edu
(Web) www3.ee.iastate.edu

Prepared for the department by Engineering Communications and Marketing, College of Engineering 04358

Bringing Internet technology up to speed

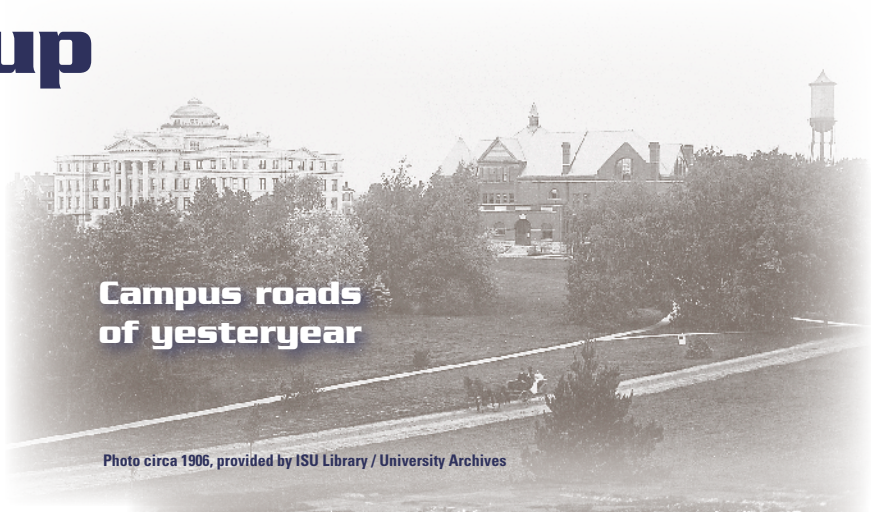
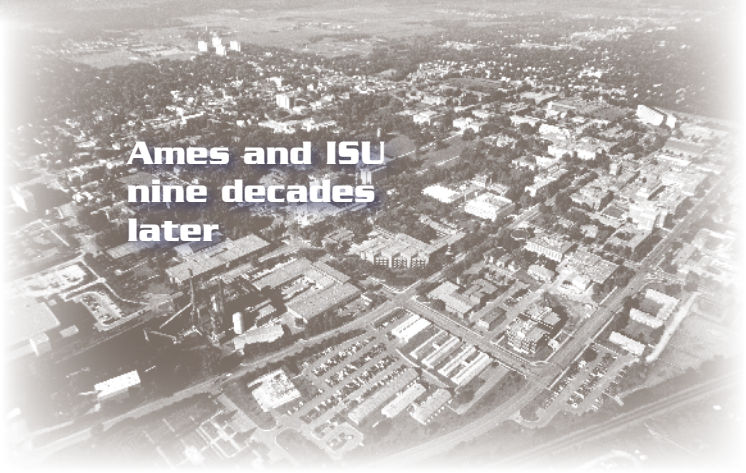


Photo circa 1906, provided by ISU Library / University Archives



Imagine for a moment the dirt roads of America in the late 1800s. Now jam them with today's traffic—roaring semis, intense commuters, and family-packed RVs.

The resulting mess is not unlike trying to pack today's Internet information needs into yesterday's technology. If the number of available lanes is one measure of a highway's efficiency, so are more and faster electromagnetic wavelength channels essential "lanes" for high-speed Internet traffic. The amount of information that can be carried by a signal—whether from a radio, optical fiber, or microwave—increases with the frequency of the electromagnetic wave carrying that information. Frequencies are grouped together in bands, and the width of these bands determines how much and how fast information can speed across the Internet's "super highways."

Three ECpE researchers are pooling their expertise to improve the delivery of Internet information, each bringing a different focus. **Bob Weber** understands high frequencies, **Mani Mina** understands high speeds and testing, and **Arun Somani** understands traffic networking protocols.

The team is researching how to use the system's available bandwidth to increase the bit-rate. However, moving from a 1- to a 40-gigabit system has as many potential consequences as sending a semi down a dirt road. Weber's focus is to understand and design for energy drains called parasitics. "Electrical circuit parasitics are similar to many biological parasites; they drain energy away from its intended use," says Weber. An example of a circuit parasitic is the magnetic energy contained in a capacitor, which is intended to store electrical energy. "In a capacitor, the magnetic field goes along for the ride because it physically has to, diminishing the effectiveness of the capacitor," says Weber. "If you increase the frequency by 10, the effect of a parasitic becomes 10 times as bad. The effect of circuit parasitics can be minimized by the way we create the system's geometric layout."

> "Society wants more and more information . . ."

There is little question that technology has not kept up with society's demands. "Society wants more and more information," says Mina. "There's a movement in the communications industry to send long-distance calls over the Internet, which will require more bits per second of bandwidth. We want to transmit video information over the Internet. And as the banking system migrates to the Internet, we want secure information transfer."

"But over the last four years," Mina continues, "the economic downturn has had an impact in the electronics industry. We saw a slowdown in people moving towards a 40-gigabit system. In the past two years, they haven't been thinking nearly as much about high frequency transmission as before the economic downturn."

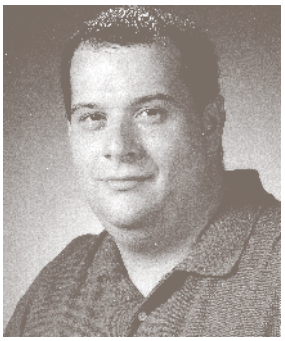
But team members say they are seeing evidence that industrial interest in high-speed systems engineering is picking up. "It takes a lot of time to test and climb to the multi-gigabit area," says Somani. "How we build test protocol, how we lay out the circuits in order to test them, and how we build the equipment needed to test them will be increasingly important.

"I forecast in the next five years we'll again see more progression towards a 40-gigabit system." ■

Unmasking computer criminals

Computer forensics receives major contract

There was a time—about 20 years ago —when computer criminals walked off with relatively small potatoes. The lawbreakers were usually employees who had learned to manipulate an internal computer system to shave off a few bucks or snoop for information.



Tom Daniels

But in the past five years, computer crime has grown increasingly serious. Vandalism has taken the form of viruses and worms that attack systems. Perpetrators have held on-line merchants hostage, threatening to release customer databases. Identity theft has skyrocketed.

In February 2000, the country's most prominent Internet sites were brought to their knees by a 16-year-old nicknamed "Mafiaboy." For three days, the networks of Amazon, e-Bay, Yahoo!, Charles Schwab, CNN, e-Trade, and others were so jammed with a flood of requests that they were immobilized. Called "denial-of-service" attacks, the crime has become the weapon not only of juvenile delinquents but also of white-collar business competitors.

"Computer crime has skyrocketed," says **Tom Daniels**, Iowa State University assistant professor of electrical and computer engineering. "But the ability to secure systems hasn't skyrocketed. The motives of the perpetrators are difficult to guess. Sometimes they are politically or socially driven. Sometimes people do it just because they can. But there is nothing benign about it. The threat is real. It's costing us millions."

Daniels and two colleagues have received a $1.2-million, 30-month contract from Advanced Research and Development Activity (ARDA), a joint office of the U.S. Department of Defense and federal intelligence agencies, including the Central Intelligence Agency and the National Security Agency. The Iowa State team was directed to develop software that will serve to "fingerprint" and track down computer criminals. The contract, which Daniels believes may be the largest awarded to a research effort in this area at Iowa State, supports Daniels' work, as well as that of ECpE team members **Julie Dickerson** and **Yong Guan**.

The team's work will be valuable to a wide range of on-line businesses. "Let's say you try to log on to E-Trade to trade stock. But a denial of service is being launched and you can't log on. The market changes and you lose thousands of dollars. Who do you sue? Who does the Securities Exchange Commission sue? Who does E-Trade go after?"

Software that "fingerprints"

The "whodunit" software that Daniels and his team are developing will identify just the right amount of clues and red flags to track down perpetrators. Existing programs have fallen short, he says, because either too many or too few clues are identified. "If the program is too simple, sophisticated attackers can get around it," Daniels notes. "And if a program is too broad, there are too many false alarms and wrong guesses."

> "Computer crime has sky-rocketed."

The techniques that computer criminals use to hide their identities have become increasingly complex and many-layered, says Daniels.

Perpetrators may use "zombies"—computers whose owners are unaware they are being hijacked—to attack systems. Or they may create misleading "return addresses" that are akin to writing the wrong address on an envelope, an approach called "spoofing."

"We will develop techniques that postmark traffic at every point," Daniels says. "Computer traffic needs the equivalent of a Federal Express tracking number, not a post card with a wrong address." Called "marking," this virtual tracking will be driven by statistical analyses of network structure. By better understanding how networks link together, Daniels will develop improved traffic marking methods. He will also observe attacks and record them for future study. Daniels is confident that patterns and commonalities can be identified that will effectively unmask computer criminals.

Virtual "dots and dashes"

In a separate study, Daniels will test a personal hypothesis. He believes that a surveillance method used in World Wars I and II to warn officials when the operator of a telegraph had changed might be employed to decipher 21st-century virtual "dots and dashes."

"When people were communicating by telegraph, experts could tell who was sending the message by the rhythm and pattern of the keying. We believe that network cards in computers have similar, distinctive

Can you hear me now?

Kim improves quality of wireless communications

Sang Kim

Wireless communication has given new meaning to the notion of "keeping in touch." People make calls while they walk, drive, and shop. Consumers demand dependable service and feel cheated when calls are cut off, voices are garbled, or "no service" messages flash on their screens. As cell phone use and other wireless applications expand, advances in technology are essential.

Associate Professor **Sang W. Kim**, an innovator in wireless communication, is working to improve reliability and performance while reducing power consumption. Kim came to Iowa State after 14 years at the Korea Advanced Institute of Science and Technology and Cal Tech. He also spent last year in the Wireless Systems Research Department of AT&T Labs in New Jersey. An expert in code division multiple access (CDMA), adaptive modulation, channel coding, multi-user detection, and multiple antenna techniques, Kim has published over seventy papers and holds three patents for techniques to expand and improve wireless communications.

Data reliability: A finite resource?

The process of wireless signal transmission is highly complex: a single phone call requires millions of calculations per second as voice streams are digitized, compressed, and protected against interference. CDMA addresses this challenge by assigning each call a unique code, with data spread across a wide frequency band to accommodate and ensure security for multiple users. Still, signal distortion and resulting data errors occur due to physical distance between transmitter and receiver, transmission of signals through buildings and other obstacles, and interference from other units using the same channel. The rate at which data errors occur determines the voice and sound quality of the communication—and thus its reliability.

Another aspect of data reliability is error correction. As millions of data are transmitted over the radio interface, electromagnetic interference causes errors. "We want a zero error rate," says Kim, who notes that 100 percent accuracy is particularly critical for bank transactions. Strengthening the signal overcomes some difficulties but drains phone batteries and often interferes with other users. In response, Kim developed a method to both increase data reliability and save power, a so-called "diversity technique" that provides multiple channels between transmitter and receiver to find the best available signal. He has also developed a decoding algorithm for error correction that increases reliability and decreases decoding delay.

Piggybacking signals over multiple antennas

At AT&T, Kim worked on multiple input multiple output (MIMO) technology, a rapidly growing area in wireless communication and a top candidate for fourth-generation wireless standards to be deployed around 2010. "Higher data rates are needed for faster Internet access," he says. "The conventional method is to use more spectrum, but that's a limited resource. MIMO should allow us to add more antennas, increasing data rates but leaving the spectrum and power consumption fixed."

Kim acknowledges that using multiple antennas presents challenges. The practice of imbedding antennas inside cell phones to improve their appearance makes spacing even more critical, as fitting even two antennas inside handsets is difficult. Still, Kim is excited about the possibilities. "I did some interesting work at AT&T," he says, "and there are ways to implement a virtual MIMO employing others' handsets as relays to transfer information. It has great potential to provide better service, better quality, and higher data rates but will require new ways of thinking about the fundamentals of communications." ■

voices," Daniels says. If, for example, a perpetrator illegally plugged a laptop into a port, the network card that connects the computer to the network might give off a different pattern. "This could be a way for network users to recognize their neighbors by their electromagnetic properties. So if their neighbors change, they can tell."

Daniels, who joined Iowa State last year, conducted research in the areas of network forensics and intrusion detection at Purdue, where he received his M.S. and Ph.D. degrees in computer science. He received his B.S. in computer science from Southwest Missouri State University. He teaches courses on information systems security and on the ethics and legal issues of information assurance.

This fairly new research and teaching area is inherently multidisciplinary, he says. "It's a good area to be in. The discipline deals with people's behavior, their motives, and how they interact with computing devices. People—especially in academia—tend to view everything as a machine problem. But we can't completely engineer around this problem. For example, there is nothing an engineer can do if a user shares a password with someone claiming to be support staff. The work is a combination of business, psychology, education, and engineering. Most of all, the field is fun—it's always moving." ■

Special delivery

Improving Internet quality of service

At any given moment, millions of e-mailers simultaneously mouse-click their "send" command, with equal confidence that the system will serve them well. At any given second, the spammer, the professor, the presidential candidate, and the Wall Street trader may unknowingly share the same virtual communication pathways.

And at any given moment, millions of consumers trust the Internet to stream live video onto their personal computers. The teen watching a rock concert, the surgeon advising a medical emergency, the sports fan watching the Super Bowl all want clear, uninterrupted images and sounds.

But an increasingly congested delivery system may disappoint its users, regardless of who they are. An image may flicker, and a note may drop. A key participant may disappear in the middle of a virtual conference. A sluggish message may affect a financial decision.

First-class special delivery is within reach.

Differentiated services and multicasting improve service

Manimaran Govindarasu is part of a select team of ISU electrical and computer engineering professors working to improve Internet quality of service (QoS), primarily by improving two technologies: differentiated services and multicasting. Differentiated services (DiffServ) classifies Internet traffic into behavior aggregates based on service requirements and allocates and manages resources (e.g., bandwidth, buffer) to each aggregate, guaranteeing the desired quality of service. Multicasting provides a way for one host to send packets to a select group of receivers, a system not as straightforward as it sounds, says Govindarasu.

"Groups are dynamic," he explains. "Members come and go. We must find ways to manage and serve groups that are large and ever-changing."

Govindarasu and his graduate students are developing scalable architectures, algorithms, and protocols for DiffServ, multicasting, and fault management research currently funded by the National Science Foundation. The group is tackling three areas. First, they are constructing multicast tree algorithms for heterogeneous groups in which members have different QoS needs. Second, they are developing tree maintenance algorithms that focus on economic management with minimal service disruption. And finally, they are developing protocols that will detect and locate service problems and facilitate recovery, using edge-based techniques in DiffServ domain.

Supply and demand for improved Internet services has been as irregular and jumpy as a bad video. "It's not a smooth evolution," says Govindarasu. Consumers may be unwilling to pay more for guaranteed QoS and flexible group communication until they experience their benefits. But if consumers don't pay more, it becomes harder for Internet service providers to make these technologies available.

"It's Catch-22," Govindarasu says.

But he is convinced that an increasingly sophisticated and demanding public will pay for improved services. First-class special delivery is within reach. ■

Manimaran Govindarasu

Manimaran Govindarasu received his Ph.D degree in computer science and engineering from the Indian Institute of Technology, Madras, India, in 1998. He joined ISU's ECpE department in 1999 as an assistant professor. He has published more than 35 international journal papers and 50 peer-reviewed international conference/workshop papers.

Central to both his professional and personal life, says Govindarasu, is "inspiring young students in science, engineering, and social work."

McCalley named IEEE Fellow

James McCalley, professor of electrical and computer engineering, has been elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the world's largest technical professional society. In a given year, less than 1 in 1,000 IEEE members are elected to this rank. Recognized by IEEE for his contributions to power system security assessment, McCalley is one of 260 professionals to receive the honor this year. A native of Atlanta, McCalley, 44, earned his Ph.D. from Georgia Tech.

McCalley, who joined Iowa State in 1992, is part of a research team that is helping the electric power industry to assess risks more effectively. The team considers a full range of risks, including line and transformer overloads and voltage instabilities. In their work, the researchers use computational methods based on the premise that risk is the product of probability and consequence. McCalley's research has helped to move risk assessment online, which facilitates decision making in transmission control rooms and improves the balance between economy and the security of electrical grids.

In addition to his work on power industry risk and security assessment, McCalley is also studying asset management methods, integrated energy systems, multi-agent system applications, and hybrid control design techniques.

McCalley joins the following departmental faculty holding this honor: **Robert Anderson, Grover Brown, Aziz Fouad, Randall Geiger, Edwin Jones, William Lord, Jim Melsa, Arthur Pohm, Gerald Sheble, Joel Snow, Arun Somani, Subrahmanyam Venkata, Vijay Vittal**, and **Bob Weber**.

Honors and awards highlights

FACULTY/STUDENT RESEARCH and TEACHING

Anirban Chakrabarti was named by ISU's Office of the Vice Provost as the winner of the graduate student Research Excellence Award.

David Jiles, professor, was named Distinguished Professor by Iowa State President Gregory Geoffroy.

Le Jin, graduate student, received a Best Paper in the Session Award from the Semiconductor Research Corporation.

Mani Mina, assistant professor, was selected Outstanding Electrical and Computer Engineering Faculty Member of the year. Also, he and graduate student **Norm Anderson** received an American Society for Nondestructive Testing Fellowship Award for their proposed research.

Arun Somani and **Jianwei Zhou** received a Best Paper Award at the Institute of Electrical and Electronics Engineers' International Performance, Computing, and Communications Conference.

Zhengdao Wang, assistant professor, received the *IEEE Signal Processing Magazine*'s Best Paper Award for 2003 from the Signal Processing Society.

ALUMNI

Indumini W. Ranmuthu (PhD'93), manager of Preamp Design Group for Texas Instruments, received the 2004 Professional Progress in Engineering Award from the ISU College of Engineering.

Investing in people

Recipients of an endowed chair and an endowed professorship have been named. The two positions are the gifts of alumni who chose to invest in people.

Arun Somani has been named the first Jerry R. Junkins Endowed Chair. Junkins received his B.S. in electrical engineering from Iowa State in 1959 and rose to become CEO and president of Texas Instruments. He passed away suddenly while traveling on business in 1996. To honor their boss and their alma mater, Texas Instruments employees and ISU alumni organized the Jerry R. Junkins Memorial Fund Campaign. In addition to a seminar room in Howe Hall, the donations of nearly 200 alumni funded the $1.5-million Jerry R. Junkins Endowed Chair position.

Somani, chair of ECpE, researches computer interconnection networks, fault tolerant computing, WDM-based optical networking, wireless communication, computer architecture, and parallel computer systems. He earned his M.S.E.E. and Ph.D. in electrical engineering from McGill University in Montreal. Somani came to ISU in 1997 from the University of Washington in Seattle. A past David C. Nicholas Professor and a Fellow of the Institute of Electrical and Electronics Engineers, Somani has graduated more than 100 M.S. and Ph.D. students and published more than 200 technical papers.

Somani will use funds from the Junkins Chair to develop a new laboratory and to support student and faculty research in the area of high-speed communication networking.

Randall Geiger has been named the first Willard and Leitha Richardson Professor in electrical and computer engineering. The Richardsons presented Iowa State with the $500,000 gift in 2001 as part of Iowa State's Investing in People initiative. Willard Richardson received his electrical engineering degree from Iowa State in 1934 and in 1937 began a 41-year career with Henry Durham Richardson, an Omaha-based architecture and engineering consulting firm. He retired in 1977 as senior vice president and partner.

Randall Geiger, who joined Iowa State in 1991 after 13 years at Texas A&M, received his B.S. in electrical engineering and M.S. in mathematics from the University of Nebraska, Lincoln, and his Ph.D. in electrical engineering from Colorado State University. He teaches and researches very-large-scale integration, the process of putting hundreds of thousands of electronic components on a single chip. In this area, he researches data converter design, mixed-signal testing, amplifier design, and high-speed communication circuits.

Venkata leaves ECpE to head Clarkson engineering

Mani Venkata, professor and Palmer Chair in Electrical Engineering, has left ECpE and Iowa State University to become dean of the Wallace H. Coulter School of Engineering at Clarkson University, New York, effective January 1.

Under Venkata's leadership, the department experienced an explosive growth in enrollment and established the Active Learning Complex, a 3,000-square-foot, high-tech modular workspace dedicated to undergraduate learning. Also during his tenure, the faculty developed the new Information Infrastructure Institute (iCube) and kicked off a $25-million fund drive to expand and renovate Coover Hall.

"Mani Venkata has accomplished a great deal in a short time at Iowa State," said current ECpE Chair Arun Somani. "We wish him all the best and congratulate Clarkson for recruiting a top-drawer scholar and leader to head their program. He'll be missed."

ECpE would like to hear from you!

Write to us at 2215 Coover Hall, ISU, Ames, IA 50011-3060; call us at 515-294-2664; e-mail to ece@ee.iastate.edu; or fax to 515-294-3637.

We want to hear about your personal news and career moves for alumni notes in future newsletters. You're welcome to enclose photos; however, we can't return them. We need your help, too, with donations to scholarship funds, lab facilities, student groups, and other department activities. If you're making a contribution to Iowa State, please consider designating it for the Department of Electrical and Computer Engineering. This form will make it easy to send us news (feel free to add a page to this form), a pledge, or a gift.

Name _____ Grad. year, degree, student name if different _____

Address _____ City _____ State _____ ZIP _____

E-mail address _____ I want to help the ECpE department with a gift of $_____ for _____

Notes _____

_____

_____

IOWA STATE UNIVERSITY

Electrical and Computer Engineering
2215 Coover Hall
Iowa State University
Ames, IA 50011-3060

NONPROFIT ORG.
U.S. POSTAGE PAID
AMES, IA
PERMIT NO. 200