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**McCormick**

Robert R. McCormick  
School of Engineering  
and Applied Science



NORTHWESTERN  
UNIVERSITY

DEPARTMENT OF ELECTRICAL AND  
COMPUTER ENGINEERING

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# CHAIRMAN'S MESSAGE

During the 2001-02 academic year (while Prith Banerjee was on leave), I served as Interim Chairman of the Department of Electrical and Computer Engineering (ECE) of Northwestern University. It is my pleasure to report on the ECE Department's activities and accomplishments during 2001-02 in the following paragraphs.

## GENERAL

With 30 full-time faculty members, 293 undergraduate students, and 123 graduate students, the ECE Department is the largest academic unit in Northwestern's McCormick School of Engineering. The Department offers separate B.S. degree programs in electrical engineering (EE) and in computer engineering (CompE). At the graduate level, the Department offers M.S. and Ph.D. degrees in electrical and computer engineering.

In 2002, *U.S. News and World Report* ranked the Department's EE program at 17 and the CompE program at 18. Overall, Northwestern University was ranked 10 and McCormick was ranked 20.

## FACULTY

During 2001-02, the ECE Department numbered 30 full-time faculty members: 16 full professors, nine associate professors, and five assistant professors. Of these, five are chaired professors and three are University professors of teaching excellence. Seven are Fellows of the Institute of Electrical and Electronics Engineers (IEEE); two are Fellows of the Optical Society of America; one is a Fellow of the Society of Photo-Optical Instrumentation Engineers; one is a Fellow of the Association of Computing Machinery; one is a Fellow of the American Physical Society; and one is a Fellow of the American Association for the Advancement of Science. Eight ECE faculty have received PYI, NYI, or CAREER awards from the National Science Foundation. One has been named to the *Highly Cited Researchers* list of the Institute for Scientific Information. Finally, two emeritus faculty are members of the National Academy of Engineering.

Four faculty joined our Department during 2001-02: Renato Figueiredo (Ph.D., Purdue, 2001) as an assistant professor in the computer architecture area; Selim Shahriar (Ph.D., MIT, 1992) as an associate professor in the photonic systems area; Ying Wu (Ph.D., University of Illinois, Urbana-Champaign, 2001) as an assistant professor in the signal and image processing area; and Hai Zhou (Ph.D., University of Texas, Austin, 1999) as an assistant professor in the VLSI design/CAD area.

One faculty member left our Department. Due to family reasons, Renato Figueiredo joined the University of Florida in July 2002.

I am pleased to announce that Valerie Taylor was promoted to the rank of full professor during 2001-02.

## RECRUITING

During 2001-02, we made four tenure-track offers to faculty candidates in computer engineering and networks, and attempted to recruit a senior faculty in the solid-state area. Only one offer was accepted — Robert Dick (Ph.D., Princeton, 2002), whose biography is below, joined us in January 2003 as an assistant professor in the VLSI/CAD area. In retrospect, our strategy of making offers to only our first- or second-choice candidates placed us in direct and difficult competition with other top universities including Cornell, University of Texas at Austin, and Stanford. The senior faculty member we tried to recruit decided to stay at the University of Minnesota where he was offered a chaired faculty position.

**Dr. Robert P. Dick** received his Ph.D. degree in electrical engineering in 2002 from Princeton University. His thesis advisor was Prof. Niraj K. Jha. Dr. Dick's current research interests include embedded systems design automation, probabilistic optimization algorithms (when there aren't complete and tractable alternatives), and ad-hoc wireless networks.



Robert is the author of the *Embedded Systems Synthesis Benchmarks Suite (E3S)*, a collection of benchmarks based on embedded processor and task information from the Embedded Microprocessor Benchmark Consortium (EEMBC). *E3S* was developed for use in system-level allocation, assignment, and scheduling research. The current version, 0.9, contains 17 processors, e.g., the AMD ElanSC520, Analog Devices 21065L, the Motorola MPC555, and the Texas Instruments TMS320C6203. These processors are characterized based on the measured execution times of 47 tasks, power numbers derived from processor datasheets, and additional information, e.g., die sizes, some of which were necessarily estimated, and prices gathered by emailing and calling numerous processor vendors. In addition, *E3S* contains communication resources modeling a number of different buses, e.g., CAN, IEEE1394, PCI, USB 2.0, and VME.

Robert is also the co-author of *TGFF*, which creates problem instances for use in allocation and scheduling research. *TGFF* has the ability to generate independent tasks as well as task sets which are composed of partially ordered task graphs. A complete description of a scheduling problem instance is created, including attributes for processors, communication resources, tasks, and inter-task communication.

## EXTERNAL AWARDS AND HONORS

One measure of the excellence of an academic department is the nature and extent of the external awards and honors that its faculty, students, and alumni receive. During the 2001-02 academic year, our Department was well represented in this regard, as seen in the following listing (alphabetical by last name):

**Randy Berry, Yehea Ismail, and Hai Zhou** were each selected to receive a National Science Foundation (NSF) CAREER Award beginning in 2003. One of the most prestigious recognitions for junior faculty in the U.S, the NSF CAREER Award provides to each recipient \$400,000 over five years which can be used to support graduate students and other research expenses. This brings to eight the total number of our Department's faculty who have received CAREER, PYI, or NYI awards. (Our previous recipients include *Prith Banerjee, Alok Choudhary, Randy Freeman, Seng Ho, and Valerie Taylor.*)

**Susan Hagness**, a 1993 BSEE and 1998 Ph.D. alumna of our Department, was named by MIT as one of the top 100 technologists in the world under the age of 35 for her research in early stage breast cancer detection using ultrawideband microwave radar. Susan is currently an assistant professor in the ECE Department of the University of Wisconsin-Madison.

**Michael Honig** and his Ph.D. student **Weimin Xiao** received the 2002 IEEE Communications Society and Information Theory Society Joint Paper Award for their article appearing in the *IEEE Trans. Information Theory*.

**Yehea Ismail** received the 2002 IEEE Circuits and Systems Outstanding Young Author Award for his paper appearing in *IEEE Trans. VLSI Systems*.

**Aggelos Katsaggelos** received the IEEE Signal Processing Society Meritorious Service Award and the Best Paper Award for his article appearing in *IEEE Trans. Image Processing*. Aggelos was also appointed an Associate Editor of *Proceedings of the IEEE*.

**Prem Kumar** was elevated to IEEE Fellow (effective Jan. 1, 2003) "for the development of nonlinear optical devices for communication networks." This brings to seven the total number of IEEE Fellows in our Department. (Our other IEEE Fellows include *Prith Banerjee, Abe Haddad, Mike Honig, Aggelos Katsaggelos, Martin Plonus, and Allen Taflove.*)

**Alan Sahakian** was named to the honor roll of Northwestern's best teachers by the University's Associated Student Government.

**Steve Slivken** received the Best Student Paper Award at the International Semiconductor Device Research Symposium. This paper was co-authored with his advisor, **Manijeh Razeghi**.

**Allen Taflove** was named to the *Highly Cited Researchers* list of the Institute for Scientific Information. He was also named to the honor roll of Northwestern's best teachers by the University's Associated Student Government.

**Valerie Taylor** received the IEEE Education Society Harriet B. Rigas Medal, the Computing Research Association A. Nico Habermann Award, the ACM Service Award, the Northwestern University Women in Leadership Pathbreaker Award, and the University of California–Berkeley Distinguished Alumnus Award. Valerie was also appointed to the NSF CISE Directorate Advisory committee.

## RESEARCH

Research in the ECE Department spans a wide variety of disciplines essential to the growing information technology area. To this end, our faculty are organized into three research groups:

- Solid State and Photonics (specializations in solid-state engineering, photonics, and nanotechnology)
- Systems (specializations in networking; image, signal, and video processing; and control systems)
- Computer Engineering (specializations in parallel and distributed computing; computer architecture; VLSI computer aided design and theory; distributed databases; and data mining).

In addition, the Department is involved with six interdisciplinary research centers:

- Center for Dynamic Systems and Control
- Center for Optimization Technology
- Center for Parallel and Distributed Computing
- Center for Photonic Communications and Computing
- Center for Quantum Devices
- Motorola Center for Communications

Our 30 faculty members had a total research funding expenditure of approximately \$7.5 million during 2001-02, which translates to \$250,000 per faculty member. This resulted in the graduation of 18 Ph.D. recipients and the publication of two books, seven book chapters, and 83 journal papers.

A highlight of the Department's research during 2001–02 involved an advance in quantum cryptography made by Profs. **Prem Kumar** and **Horace Yuen**. Under a \$4.7 million DARPA grant, they demonstrated a new high-speed quantum cryptography method codenamed “AlphaEta” that uses the properties of light to encrypt information into a form of code. Their prototype has demonstrated encryption of data moving at 250 Mbits/ second. A second-generation model that can encrypt the 2.5-Gbit/s streams typical of Internet backbones will be developed within five years. The news has appeared in a variety of places including:

<http://www.eetimes.com/story/OEG20021111S0036>

<http://www.eprairie.com/news/viewnews.asp?newsletterID=4317>

[http://news.com.com/2100-1001-965957.html?tag=fd\\_top](http://news.com.com/2100-1001-965957.html?tag=fd_top)

## CURRICULUM

Our revamped undergraduate curricula are well under way and student reaction continues to be very positive. We are continuing the process of improving the two freshman introductory courses, Introduction to Electrical Engineering and Introduction to Computer Engineering. The Introduction to EE will continue to be taught by a team of five faculty members to cover all areas of EE. Such a recommendation was made by our Advisory Board, who felt that the move to a single instructor was not as palatable to the students. We reduced the number of required courses to give students more flexibility. We continue to make minor adjustments in the new courses in response to student feedback.

We are also continuing to develop new and exciting hands-on lab experiments to complement the courses. With funding from Hewlett-Packard and the University, we were able to develop labs for several courses with computer-controlled instrumentation, namely, digital oscilloscopes, waveform generators, and power supplies. Microsoft also donated 20 high-end workstations for our undergraduate lab. We continue to upgrade one major laboratory every year, including this past year.

## STUDENTS

During 2001-02, we had 293 undergraduate students (146 EE majors, 147 CompE majors), an increase from 260 in 2000-01. This increase was due to the largest crop of freshmen in more than 15 years (68 total) who declared either EE (35) or CompE (33) as their major. Freshman academic quality remained excellent with a median (average) SAT score of 1400 (1384). We graduated a total of 73 B.S. students (vs. 47 the previous year), with 42 students receiving the B.S. in CompE and 31 receiving the B.S. in EE.

During 2001-02, we had 123 graduate students, a decrease from 162 in 2000-01. This decrease was due to the ending of several research projects and a reduced number of students pursuing M.S.-only degrees. We granted 22 Ph.D. degrees (vs. 21 the previous year) and 32 M.S. degrees (vs. 26).

One of the most exciting developments this past year was the increase in the number of undergraduates engaged in research under the guidance of faculty advisors. This was made possible by gifts from Motorola and Microsoft. These gifts allowed us to offer stipends to undergraduate students and unrestricted grants to the faculty advisors. More than 16 undergraduate students participated. Motorola hosted a poster session at its Schaumburg headquarters in which the students presented the results of their research efforts.

## STUDENT PLACEMENT

We continued our efforts to place our graduating students in top professional and academic situations. For those seeking professional employment, we again generated ECE Resume Books that contained one-page resumes for our B.S. and M.S. students and two-page resumes for our Ph.D. students, and sent them to more than 40 companies.

According to an incomplete response to our survey, our B.S. graduates accepted professional employment with Beghou Consulting, Braun Consulting, Cardiomedix, Control Engineering Corp., Epic Systems, F5, Ford, IBM, ID Tech Camps, Intel, Lockheed-Martin, McMaster-Carr, MC Wilkerm, Motorola, OMF International, SixtySeven KiloHertz Inc., Streamline Studios, Visteon, and Wolverine Trading. Graduate school destinations included Arizona State, Northwestern, Princeton, Purdue, University of California-Berkeley, University of Illinois at Urbana-Champaign, University of Michigan, and University of Wisconsin-Madison.

Our graduate students accepted positions with 3Com, Accelchip, Argonne National Laboratory, Florida International University, IBM, Illinois Institute of Technology, Intel, University of Kansas, Motorola, RedmaNE Technology, Science Applications Inc., and Ziena Optimization.

## PROGRAM REVIEW

In 2001-02 we established processes to carry out the recommendations of the Program Review conducted during 2000-01. To this end, we:

- Consolidated our six graduate research groups into three groups while still promoting research by using our key subareas, administratively, in term of graduate admission and management.
- Established a joint committee with the Computer Science (CS) Department to improve our cooperation. As a result we now have a number of courses cross-listed with CS, and our faculty are involved in teaching these courses with CS faculty.
- Began searching for a senior faculty in the solid-state area. We shall continue the search in 2002-03.

## MOTOROLA DISTINGUISHED LECTURE SERIES

Because of the Motorola gift of \$500,000 over five years, we were able to host four Distinguished Lecturers this year. The first was Thomas Huang from the University of Illinois at Urbana Champaign. The other three lectures were part of a distinguished lecture series in computer architecture sponsored jointly with the CS Department. The lecturers were James Smith from the University of Wisconsin, John Stankovic from the University of Virginia, and Mendel Rosenblum from Stanford.

## ACKNOWLEDGEMENT



It has been a pleasure serving the ECE Department again. I thank Dean John Birge for his strong support during the year.

Best wishes,

*Abe Haddad*  
Henry and Isabelle Dever Professor

# DEPARTMENT FACTS

## INTRODUCTION

Northwestern University, chartered in 1851, has grown to be one of the strongest research universities in the U.S. Northwestern has two campuses, one in Evanston and one in downtown Chicago, 12 miles south of the Evanston campus. The 239-acre Evanston campus is located in a beautiful setting stretching more than one mile along Lake Michigan in Chicago's "North Shore" suburban region. This campus is the site of the Kellogg School of Management, the McCormick School of Engineering, the Medill School of Journalism, the Weinberg College of Arts and Sciences, and the Schools of Education and Social Policy, Music, and Communications. The 20-acre Chicago campus, located just to the east of Chicago's "Magnificent Mile" of Michigan Avenue, is the site of Northwestern's McGaw Medical Center and School of Law. Overall, the University has 2,500 faculty and 17,800 students (including 3,500 graduate students) on the two campuses.



The research reputation of Northwestern's McCormick School of Engineering is first-rate. An unambiguous quantitative indication of this is given by the National Research Council (NRC), which ranks engineering schools by the average number of citations of each scientific paper written by the faculty. According to this measure, McCormick ranks *fourth* (after Stanford, University of California-Berkeley, and MIT) among schools with at least 8 of the 9 engineering disciplines in the NRC survey. Confirming this measure, McCormick also ranks fourth in the number of faculty named to the list of the world's most cited engineers by the Institute for Scientific Information.

The Department of Electrical and Computer Engineering (ECE) is part of the McCormick School of Engineering. According to the NRC survey, the ECE Department ranks 13th nationally in the average number of citations per paper published by the faculty. Comparably ranked departments in this survey include Cornell and the University of Michigan.

## DEGREE PROGRAMS

The ECE Department offers two undergraduate programs leading to B.S. degrees, one in electrical engineering (EE) and one in computer engineering (CompE). ECE also offers a graduate program in electrical and computer engineering leading to the M.S. and Ph.D. degrees. In addition, it offers a professional Master's degree program in the area of Information Technology (MITP).

## FACULTY AND STAFF

During 2001–02, the ECE Department numbered 30 full-time faculty members: 16 full professors, nine associate professors, and five assistant professors. Of these, five are chaired professors and three are University professors of teaching excellence. Seven are Fellows of the Institute of Electrical and Electronics Engineers (IEEE); two are Fellows of the Optical Society of America; one is a Fellow of the Society of Photo-Optical Instrumentation Engineers; one is a Fellow of the Association of Computing Machinery; one is a Fellow of the American Physical Society; and one is a Fellow of the American Association for the Advancement of Science. Eight ECE faculty have received PYI, NYI, or CAREER awards from the National Science Foundation. One has been named to the *Highly Cited Researchers* list of the Institute for Scientific Information. Finally, two emeritus faculty are members of the National Academy of Engineering.

The ECE Department has a staff of 19 including secretaries, computing-services staff, and staff for the MITP program.

## STUDENTS

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## SPACE

The ECE Department occupies about 50,000 square feet in the Technological Institute which houses the McCormick School of Engineering. Of this total, about 8,100 square feet are assigned to instructional labs; 25,000 square feet are for research labs; 3,400 square feet are for computing labs; and the rest are assigned to faculty and departmental offices. The space comes to about 1,560 square feet per faculty, or 140 square feet per student.

## LABORATORY AND COMPUTING FACILITIES

The ECE Department has well-equipped instruction and research laboratories for electronic circuits, digital circuits, solid-state electronics, thin-film device development, biomedical electronics, communications, microwave techniques, real-time control systems, holography and coherent light optics, biological control systems, digital systems design, computer vision, and robotics.

In addition, the ECE Department has excellent computing facilities, with most of its computers upgraded in the last three years and all of its computers linked to Northwestern's 622 Mbps OC-12 SONET network. Specifically, the Center for Parallel and Distributed Computing has 50 Hewlett-Packard workstations, three file servers, a 16-processor IBM SP-2 distributed-memory message-passing multicomputer, an 8-processor IBM J-40 shared-memory multiprocessor, an 8-processor SGI Origin 2000 distributed shared-memory multiprocessor, and several PC's. These are connected via a high-speed ATM network. The Wilkinson Computing Lab has several powerful servers, 14 high-performance HP workstations, and 14 high-performance SUN workstations. A wide variety of graphics, CAD, circuit design/simulation, database and other software packages are available on these machines. Finally, 20 late-model PC's are available in the freshman Engineering First lab.

## UNDERGRADUATE CURRICULUM

The ECE Department has recently significantly updated and strengthened its undergraduate curricula in EE and CompE. One aspect of this progress is the complete revision of these curricula. Each curriculum now incorporates an introductory freshman course (with an associated exciting hands-on lab) which communicates to the students a broad early overview of, and motivation for, EE or CompE. Further, each curriculum now incorporates a specific set of five fundamentals courses which provide students with a solid foundation in either EE or CompE. All subsequent courses in each curriculum are electives.

The ECE Department has also updated and strengthened its undergraduate labs in EE and CompE. 25 Hewlett-Packard and Sun workstations and 20 PC's were acquired for the computing labs. In addition, with funding from Hewlett-Packard, the Department acquired 15 computer-controlled lab stations. Each lab station consists of a high-quality wideband digital oscilloscope, a digital logic analyzer, a function generator, and a dc power supply. All of these instruments are integrated with a PC for equipment control and data acquisition.

Finally, all of the CompE courses now use commercial-grade CAD tools from Mentor Graphics. Courses in this group include logic design, computer architecture, VLSI design, and independent-study projects. In addition, many of the EE courses in networking, communications, and signal processing are now using software packages in MATLAB for their design and analysis problems.

## ENGINEERING FIRST PROGRAM

In 1997, the McCormick School innovated a core freshman / sophomore engineering curriculum called *Engineering First*. Previously, engineering students were not exposed to their field during their freshman and sophomore years, taking instead basic courses in physics, chemistry, and mathematics in a manner largely disconnected from any engineering perspective. However, under the Engineering First curriculum, the study of mathematics, physics, and computer programming is carefully integrated with examples and problems drawn from various fields of engineering during a sequence of four quarter-length courses designated *Engineering Analysis*.

In addition, under the Engineering First curriculum, there is a two-quarter freshman sequence of courses designated *Engineering Design and Communications* (EDC). Here, each section of 16 students is team-taught by two professors, one from the Writing Program of the Weinberg College of Arts and Sciences, and the other from the McCormick School. EDC is project-based and team-based, with real design problems solicited from clients both inside and outside the University posed to four-person student teams. While conducting their projects, the students learn the principal methods of engineering design, key aspects of team dynamics and project management, and the written and presentation skills appropriate for a professional engineering environment.

## RESEARCH

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- Center for Dynamic Systems and Control
- Center for Optimization Technology
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- Center for Photonic Communications and Computing
- Center for Quantum Devices
- Motorola Center for Communications

Overall, the 30 faculty members of the ECE Department had a total research funding expenditure of approximately \$7.5 million during 2001-02, which translates to \$250,000 per faculty.

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<http://www.eetimes.com/story/OEG20021111S0036>  
<http://www.eprairie.com/news/viewnews.asp?newsletterID=4317>  
[http://news.com.com/2100-1001-965957.html?tag=fd\\_top](http://news.com.com/2100-1001-965957.html?tag=fd_top)

## PUBLICATIONS

During 2001-02, ECE Department faculty members continued to publish widely in a variety of prestigious journals and proceedings. Their publications included two books, three edited conference proceedings, seven book chapters, 83 journal papers, 104 conference papers, and five U.S. patents. Four of the journal publications received a Best-Paper Award. In addition, ECE faculty presented 91 invited talks and seminars at locations all over the world. Finally, during this academic year, 18 students received their Ph.D. degrees.

According to a study by the National Research Council, the ECE Department ranks 13th nationally in the average number of citations per paper. During 2002, one ECE faculty was named to the *Highly Cited Researchers* list of the Institute for Scientific Information.

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