

Interdisciplinary Research Centers

Overview

In addition to its research groups, the ECE Department also is involved with six interdisciplinary research Centers:

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

These Centers allow exploration of emerging research areas which overlap a number of the traditional electrical and computer engineering disciplines.

In contrast to the Department's research Groups, the Centers have no academic or administrative role in a graduate student's progress toward his or her M.S. or Ph.D. degrees. However, the Centers substantially benefit their affiliated students by providing unusually wide-ranging and long-term opportunities for financial support and technical collaboration.

The centers routinely facilitate close collaboration with students, faculty, and research professionals affiliated with other McCormick departments; University departments outside McCormick; the University's other multidisciplinary centers; other universities; federal national laboratories; and private industry. Such collaboration enables affiliated students to broaden their research experiences and expose themselves to a wide range of career opportunities.

Center for Dynamic Systems and Control

The Center for Dynamic Systems and Control involves educational and research activities of faculty and students in several departments of the McCormick School, including Chemical Engineering (ChemE), Electrical and Computer Engineering (ECE), Industrial Engineering and Management Sciences (IEMS), and Mechanical Engineering (MechE). Students in this program have an unusual opportunity to perform cutting-edge, interdisciplinary research in the fields of systems, control, and manufacturing processes. Specific research areas include process control, robotics, operator-assisted devices for assembly, haptic interfaces, manufacturing systems, scheduling, and logistics. Although each student must register in one of the participating departments, the curriculum and research opportunities draw upon the offerings of all departments represented in the Council.

Affiliated Northwestern faculty include: J. Edward Colgate, MechE; Randy Freeman, ECE (Director); Abraham Haddad, ECE; Michael Mavrovouniotis, ChemE; Michael Peshkin, MechE; and Mark Van Oyen, IEMS.

Motorola Center for Communications

The Motorola Center for Communications, established in Aug. 1998, has a wide variety of interests addressing important issues of the telecommunications industry. These include:

- Efficient compression, encoding, and transmission of multimedia data;
- Efficient allocation of wireless channel resources to multimedia network traffic, including voice, packet data, and video;
- Enhancement of the capabilities of current wireless technologies such as code-division multiple access (CDMA) used for mobile cellular voice services;
- Rapid design and manufacture of high-quality, small-size, low-power, application-specific processors for image and multimedia signals;
- Encryption of data for security and privacy.

As part of the Motorola Center, industrial and McCormick researchers and students develop strong collaborations and are educated in the latest telecommunications techniques. Affiliated Northwestern faculty include: Randy Berry, ECE; Abraham Haddad, ECE; Michael Honig, ECE; Aggelos Katsaggelos, ECE (Director); C.-C. Lee, ECE; Thrasos Pappas, ECE; Allen Taflove, ECE; and Chi-Haur Wu, ECE.

Center for Optimization Technology

The Center for Optimization Technology is a joint enterprise of Argonne National Laboratory and Northwestern University. It was founded in 1994 with support from Northwestern and the U.S. Department of Energy. The Center's mission is to: (1) increase awareness of the benefits of the latest optimization techniques among potential users in industry, government, and academia; and (2) make these techniques widely available by providing advanced distributed-computing and software environments. These goals are being achieved by combining the best optimization algorithms, modern computational tools and interfaces, and the power and reach of the Internet.

Center activities currently focus on the Network-Enabled Optimization System (NEOS), consisting of a comprehensive optimization software library, interfaces and servers that allow users to run this software either locally or remotely over the network, and a guide to optimization technology on the World Wide Web. The Center's products are designed to help at each problem-solving stage: modeling real-world applications, solving mathematical problems, and interpreting the results. Users are able to download software from the NEOS Library and run it on their own hardware. The NEOS Server also offers users a novel alternative: remote solution of optimization problems on the Center's computational facilities via communication using the World Wide Web, email, and ftp. In this mode, users supply a problem description and data. Then, the NEOS Server chooses the appropriate software, solves the problem, and returns the results. This facility has already been used by hundreds of students and professionals worldwide.

The Center has a variety of research collaborations with industry and government ranging from logistics planning, power-generation schedules, optimal placement of elements in computer chips, scheduling of operators in a telephone pool, and optimal pricing of seats for airlines. Affiliated researchers from Northwestern University include: John Birge, Dean, McCormick School of Engineering; Collette Coullard, IEMS; Mark Daskin, IEMS; Robert Fourer, IEMS; Sanjay Mehrotra, IEMS; and Jorge Nocedal, ECE (Deputy Director). During 2000–2001, affiliated researchers from Argonne National Laboratory included Jorge More and Steven Wright (Director).

Center for Parallel and Distributed Computing

The Center for Parallel and Distributed Computing conducts leading-edge, fundamental science and engineering research aimed at providing a sound basis for the technology of parallel and distributed computing. Founded in 1996, the Center's research focuses on all aspects of this technology area — namely, parallel architectures, parallel compilers and software, parallel algorithms and applications, parallel and distributed database systems, and parallel I/O systems.

Currently, the Center has the following computing resources: 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 50 high-end Hewlett-Packard Unix workstations (models C-110, C-180, and B-132). All of the workstations and parallel-processing computers are connected together to form a large distributed-computing infrastructure by 4 Cisco LS1010 ATM switches. Affiliated researchers from Northwestern University include: Prith Banerjee, ECE (Director); Alvin Bayliss, Applied Math; Ted Belytschko, CivE and MechE; Alok Choudhary, ECE; Renato Figueiredo, ECE; Yehea Ismail, ECE; Jorge Nocedal, ECE; Peter Scheuermann, ECE; Allen Taflove, ECE; and Valerie Taylor, ECE. Affiliated researchers from Argonne National Laboratory include Ian Foster and William Gropp.

Center for Photonic Communications and Computing

The Center for Photonic Communications and Computing (CPC) is the newest center in the ECE Department. Founded in the fall of 1999, the primary goal of CPC is to conduct cutting-edge fundamental science and engineering research that will lead to the development of advanced photonic communication and computing systems. Specifically, the focus of research is on optical and optoelectronic systems that push all current technological limits. General goals include: (a) attainment of optical data transmission and processing rates exceeding one terabit per second; (b) attainment of levels of integration allowing thousands of optical devices to be fabricated on one chip; and (c) pioneering of radically new ways to accomplish optical communication, signal processing, and computing by exploiting the fundamental laws of nature. CPC also provides a venue for collaboration, coordination, dissemination, and promotion of research and teaching activities in the above areas both inside and outside the University.

Research at CPC is conducted in many state-of-the-art laboratories located within the McCormick School. These include the Quantum Communications and Cryptography Lab, the Fiber-optic Communications Lab, the Quantum and Nonlinear Optics Lab, the Opto-electronics Lab, and the Quantum Electronics Lab. These labs house many advanced solid-state as well as optical-fiber laser systems, including several sources of picosecond and femtosecond duration pulses. In addition, a wide variety of optical, electro-optic, fiber-optic, and electronic instruments are available for ultrahigh speed (10–100 GHz) measurements and diagnostics. CPC researchers also have access to the advanced facilities of the Materials Research Center of Northwestern University.

Affiliated researchers from Northwestern University include: Anupam Garg, Physics; Seng-Tiong Ho, ECE; William Kath, Applied Math; John Ketterson, Physics and ECE; Prem Kumar, ECE (Director); Alan Sahakian, ECE and BiomedE; Ken Spears, Chemistry; Selim Shahriar, ECE; Allen Taflove, ECE; Bruce Wessels, Materials Science and ECE; and Horace Yuen, ECE and Physics. Other affiliated researchers include: Mauro D'Ariano, University of Pavia, Italy; Antonio Mecozzi, Fondazione Ugo Bordoni, Rome, Italy; and Ricardo Horowicz, University of Sao Paulo, Brazil.

Center for Quantum Devices

Since its founding in Sept. 1991, the Center for Quantum Devices (CQD) has been a model of high-level research and academic excellence in semiconductor research and application, bridging the gap between academia and industry. Research at CQD is multidisciplinary and industry-oriented, involving advanced work in areas as diverse as material synthesis, physical characterization, device fabrication, and modeling. Students benefit from exposure to this research and its applied technologies, fostering future leaders in research and technology transfer. CQD is the only institution in the world that has developed optoelectronic materials and devices operating throughout the visible and invisible light spectrum, often realizing first-of-a-kind breakthroughs. Successful collaborations have been formed with major universities, international industries, small businesses, and national laboratories. Funding for CQD activities is provided by private industry and government agencies.

CQD is equipped with many facilities for modeling, epitaxial growth, material characterization, device fabrication, and device characterization. CQD's semiconductor growth capabilities are housed in a new 5,000-square-foot clean room and currently include five metallorganic chemical vapor deposition systems (including commercial systems from EMCORE and AIXTRON) and two molecular beam epitaxy systems (from EPI). State-of-the-art equipment for material characterization includes a high-resolution five-crystal X-ray diffractometer, a field-emission scanning electron microscope, an atomic force microscope, Fourier-transform photoluminescence and absorption spectrometers, several photovoltage spectrometers, a deep-level transient spectrometer, a Hall-effect system, and an electrochemical capacitance voltage profiler. Device fabrication facilities include a photolithography laboratory, wet chemistry facilities, a plasma-etching system, several thermal and electron-beam evaporators, surface profilers, and bonding devices. Affiliated researchers from Northwestern University include: Robert Chang, Materials Science; Carl Kannewurf, ECE; John Ketterson, Physics and ECE; and Manijeh Razeghi, ECE (Director). Gail Brown of the U.S. Air Force is an affiliate researcher outside of Northwestern.