Computation for Design and Optimization

Academic year 2008 was the third operational year of MIT's master of science program in Computation for Design and Optimization (CDO). During this period, the program continued to expand in terms of the number of students, affiliated faculty, and program-related activities. The program conducted its second independent activities period (IAP) session, sponsored its third Distinguished Speaker Series, and administered its fourth admissions cycle. The roster of CDO-affiliated faculty members, representing nine departments, increased to 34. Thirteen students graduated in September 2007, three in February 2008, and five June 2008. Fifteen students are on the September 2008 degree list, and 17 new students will begin their CDO studies in September 2008. The program headquarters relocated to its own office space in Building 35.

The CDO Program

Substantial improvements in numerical methods and dramatic advances in computer hardware have generated vast opportunities for computational science and engineering. Consequently, intensive computation for design and optimization has become an essential activity in the design and operation of many complex engineered systems, such as micro-machined devices, guidance/control systems, imaging systems, distribution networks, telecommunications and transportation systems. The critical role that computation plays across engineering disciplines in both academia and industry has created a clear need to educate tomorrow's engineers in computational science for design and optimization. The interdepartmental CDO master's degree program addresses this need by educating students in the formulation, analysis, and critical application of computational approaches to designing, predicting, controlling, and optimizing engineered systems. Graduates of the CDO program have the requisite education to create and harness the computational tools to drive the engineered systems of the future.

Current Goals

The CDO program's goals for the upcoming year include:

- Establishing a mechanism through which CDO students can qualify for doctoral study in select MIT departments
- Establishing a CDO research center which will conduct research and offer fellowship support to PhD students
- Securing (non-Singapore-MIT Alliance) sources of funding for students and affiliated faculty
- Fostering community among CDO-affiliated faculty and students
- Expanding the outreach of CDO at MIT and elsewhere
- Developing permanent solutions for program administration, staffing, reporting, and space

Accomplishments

Awards

CDO-affiliated faculty members received the following awards and recognition during the 2007-2008 academic year.

Retsef Levi received the Outstanding Teacher Award from the Sloan School of Management.

Thomas Magnanti received an Honorary Doctoral Degree from The Technion in June 2007, as well as the Harold Lardner Prize, Canadian Operations Research Society, in May 2008. The Harold Larnder Prize is awarded annually to an individual who has achieved international distinction in Operational Research.

Georgia Perakis and her former PhD student Guillaume Roels received Honorable Mention for the 2007 Best Paper Award of the Transportation Science & Logistics Society of INFORMS. This award is given annually to an outstanding paper in the field of transportation science and logistics.

Gilbert Strang was recognized at the International Congress of Industrial and Applied Mathematics in Zurich in July 2007, where he received the Henrici Prize for Applied and Numerical Analysis, and the Su Buchin Prize for leadership in mathematics for developing countries.

Karen Willcox received the AIAA Multidisciplinary Design Optimization Technical Committee Service Award, in May 2008.

Admissions

Of 111 applications submitted to CDO for AY2009 admission, 37 students were admitted, 17 accepted the admissions offer, and five deferred admission to 2009. In addition, CDO will have 11 continuing students, including four dual-degree candidates simultaneously pursuing PhDs in MIT departments. There will be 28 students actively participating in the CDO program in September 2008.

Research Support and SMA-2

In 2005, CDO was awarded a five-year collaborative research and education program grant through the Singapore–MIT Alliance (SMA-2), working alongside colleagues from the National University of Singapore. As CDO enters its fourth year of the grant period, the program and CDO-affiliated faculty continue to receive approximately $1.8 million per year in research funding from SMA-2.

The educational adjunct to this SMA-sponsored research support is composed of a two-year dual-degree program in computational engineering (CE), in which students are awarded two master's degrees: one in CDO from MIT, and the second in CE from the National University of Singapore. Up to 16 SMA fellowships per year are available for CDO students through the SMA-CE program. Of the 22 students who enrolled in

CDO in AY2008, 14 received SMA fellowships and will complete their CDO degrees in September 2008. These students were the first in the dual-degree program to be in residence at MIT for a full academic year. (In previous years, students had spent only one semester plus a summer at MIT.)

Initiatives

CDO Student and Faculty Environment

CDO program activities are intended to establish a productive, collegial environment for students and faculty. For CDO students, this year we conducted a fall program orientation, held several lunches for students to meet with the CDO co-directors, hosted a winter reception in our new office space for students and faculty, as well as a June celebration for our graduates, conducted an IAP offering, elected our first student representative to the Graduate Student Council, and received a Graduate Student Life grant which was used to fund a student-coordinated series of guest speakers at informal student gatherings.

For faculty, we held regular faculty meetings to discuss emerging program issues and common interests, and we convened the CDO Steering Committee (composed of six CDO-affiliated faculty members) once per semester to discuss strategic matters relevant to the future of CDO.

CDO sponsored the third year of its Distinguished Speaker Series, in which seven world-renowned researchers presented their latest research on topics relevant to computation for design, control, simulation, and optimization. These seminars are free and open to the public, and streaming videos of the lectures are provided on the CDO website. We expect to continue the series annually.

We believe that the CDO program, which currently engages 32 affiliated faculty from across the Institute, has the potential to involve many more MIT faculty members.

CDO PhD Offering

There is strong interest among current CDO-affiliated faculty to create a doctoral program in Computational Science and Engineering (CS&E) that is aligned with existing departmental doctoral programs in the School of Engineering. Such a program would work either side-by-side with the CDO SM program, or would predominate or replace the CDO SM program. During the past year we have worked on several possible doctoral program architectures and have put together a draft proposal for a doctoral program. We have met with relevant department heads and Deans in the School of Engineering to seek their input, interest, and feedback on our doctoral program efforts. The preliminary response has been very positive, and these efforts will continue through the coming academic year. Potential funding for such a doctoral program is discussed below.

Finances and Funding

The CDO program and its affiliated faculty continue to receive $1.8 million per year in research funding through SMA-2. We expect this funding to continue through 2010.

However, with only two years of SMA funding remaining, the CDO program must seek other funds.

The program codirectors submitted and subsequently were awarded a research grant proposal from the Air Force Office of Scientific Research (ASOFR) on band-gap optimization for wave propagation in periodic media. The grant is for $250,000 per year, with an initial funding period of three years; the research will involve three CDO-affiliated faculty and will support one doctoral student and one post-doctoral fellow.

As indicated earlier, there is strong interest among current CDO-affiliated faculty to create a doctoral program in Computational Science and Engineering (CS&E) that is aligned with existing departmental doctoral programs in the School of Engineering. A committee comprised of CDO-affiliated faculty is developing a funding strategy for a doctoral program and is identifying and pursuing a variety of funding sources for CS&E research and education, including government research grants, internal funding sources, and private donors.

Personnel

The CDO program codirectors are Professor Robert Freund (Sloan School of Management) and Professor Jaime Peraire (Department of Aeronautics and Astronautics). Laura Koller is the CDO academic administrator and is responsible for program administration, graduate student support, admissions, and communications.

CDO currently has 32 affiliated faculty. We hope to expand this number during the coming year.

Robert M. Freund
Codirector
Theresa Seley Professor of Management Sciences

Jaime Peraire
Codirector
Professor of Aeronautics and Astronautics

More information about the Computation for Design and Optimization program can be found at http://web.mit.edu/cdo-program/.