

# Computer Engineering Annual Report, 2005-2006

*Computer Engineering focuses on the design, analysis and application of computers and on their applications as components of systems. The UCSC Department of Computer Engineering sustains and strengthens its teaching and research program to provide students with inspiration and quality education in the theory and practice of computer engineering.*

Departmental Mission Statement

## Achievements

The past year has seen many achievements within the Department of Computer Engineering.

- We hired Assistant Professor Matthew Gutthaus, our top computer system design candidate.
- We appointed Adjunct Assistant Professor Bradley Smith, long-time member of the SOE, networks researcher and educator.
- We developed a B.S. in Bioengineering program with biomolecular engineering; electrical engineering; and molecular, cell & developmental biology.
- We led a team of researchers from six top universities to develop the new science of ad hoc networking.
- We launched a new networks laboratory and curriculum with increasingly strong support from Cisco.
- We secured future faculty positions in Autonomous Systems to catalyze our robotics and control program, and facilitate the School's development of areas associated with mechanical engineering.
- We gained recognition of the excellence of recent hires through Jose Renau's NSF CAREER award, William Dunbar's NIH K-25 fellowship, and Gabriel Elkaim's GPS World cover story.
- We created a new first-quarter introduction to robotics course to smooth the transition from high school mathematics to engineering mathematics within an exciting discipline.
- We designed a course on Assistive Technology and Universal Access to broaden offerings for those interested in approaches to helping the elderly and disabled.
- We doubled our frosh Statements of Intent to Register from 29 to 59.
- We received grant and gift income of \$4M, 20% larger than the previous year, and increased research expenditures 25%.
- We educated 184 majors and pre-majors and 75 graduate students
- We graduated 40 BS, 19 MS, and 8 PhD students.

## Goals

The Department of Computer Engineering has goals of excellence in research, undergraduate and graduate teaching, and service. In research, we target five specific areas of research excellence:

- computer system design
- design technologies
- digital media and sensor technology
- computer networks
- embedded and autonomous systems.

We have also defined a cross-cutting interdisciplinary emphasis in assistive technology as a targeted area of opportunity as we seek to train undergraduate and graduate engineers for the future. In teaching, we strive for innovation and excellence in the classroom and in academic programs. We have led efforts to integrate modern technology in teaching, and are constantly working to improve our undergraduate and graduate curricula. In service, we dedicate ourselves to serving the Baskin School, UCSC, and our professional disciplines. Computer Engineering faculty frequently dedicate themselves to leading many efforts, both on campus and off.

During the coming year, our specific goals will include:

- Successful recruitment of an exceptional Assistant Professor working in the broad field of Assistive Technologies.
- Graduate student outreach and recruitment.
- Development, with the SOE, of a comprehensive publicity campaign to ensure awareness of the excellence of our programs, in an effort to increase reputation-based rankings such as USN&WR.
- Approval of the bioengineering B.S. program.

## Opportunities

The Department has identified five exciting opportunities for the near future.

- Assistive technologies and Bioengineering. This area is of extreme importance to the aging population. A group of 3-6 faculty and the creation of a research center could propel us to excellence. The group would have strong collaborations with faculty in digital media and sensor technology, embedded and autonomous systems, Biomolecular Engineering, and Electrical Engineering. This could form a nucleus, with other SOE programs, for launching academic and research programs in bioengineering. Between 1999 and 2002, the number of Bioengineering B.S. degrees granted increased by 50%, M.S. by 78%, and Ph.D. by 30%. In the System, bioengineering programs have been or are being created at every campus, and UCSC hosted the 2005 Systemwide Symposium on Bioengineering.
- Program in Autonomous Systems. William Dunbar, Gabriel Elkaim, Jorge Cortes (AMS) have developed a graduate course sequence in control. Computer Engineering has proposed as part of the five-year perspective, the development of a graduate program in control. This cross-cutting area would be expected to include faculty in CE, EE, AMS, ISM, Economics, and potentially other areas. We are poised to launch exceptional robotics research and degree programs with 2 hires in autonomous systems and one hire in embedded systems during the next 5 years. All such positions may be part of the assistive technology emphasis.
- Networks Pinnacle of Excellence. Computer Engineering's most productive research group is in Computer Networks. Indeed, within the School of Engineering, this group has produced more Ph.D. graduates than any other group, and has placed students at many academic institutions. Presently we have a strong focus on wireless networks (JJ Garcia-Luna and Katia Obraczka) and on high-speed network architectures (Anujan Varma). This group is poised to expand to internetworking and applied network security. Network and internet security has become a key area of applied research within the computer networks field, thanks to the popularity of wireless networks which are more difficult to secure than wireline networks. The demand for graduates with specialization

in network security is currently far higher than the supply, and this is likely to persist for some time.

- Invigoration of core areas of computer system design and design technologies. The successful hires of Jose Renau and Matthew Guthaus have begun the rebuilding of our core strength, though we will need one or two more faculty in this area within the next 5 years to ensure and enable undergraduate and graduate education, training, and research of the highest quality.
- Sustained excellence in Digital Media and Sensor Technology. Our dynamic and collaborative group working in digital media and sensor technology interfaces collaborates extensively in CE, the SOE, and on campus. We have a particular interest in “rich media” technology for education, both in the classroom and on the web. Another hire in this area in the next 5 years will leverage and multiply our research activity in this growing area.

## **Collaborations**

The Department will continue its high level of interdepartmental, interdivisional, and inter-campus collaborations. During the past year, these collaborations have included:

- Professors Garcia-Luna, Obraczka and Sadjadpour led a successful effort by teams of researchers from Maryland, MIT, UCB, UCLA, UIUC, and Stanford to establish a research institute to develop the new science of Dynamic Ad Hoc Networking (DAWN), a \$5M ARO MURI.
- Professor Ferguson served as Provost of Crown College, SOE Associate Dean, and Chair of the Council of Provosts.
- In the Academic Senate, Professor Ferguson served on Committees, Professor Larrabee served on Educational Policy, Professor Hughey chaired Educational Policy, and Professor de Alfaro on Computing and Telecommunication.
- Professor Larrabee served as the SOE Outreach Coordinator.
- Professor Tao serves as Associated Editor of Pattern Recognition, the leading journal in the area, and of the Machine Vision and Applications Journal.
- Professor de Alfaro chaired the SOE Computing Infrastructure Committee.
- Professor Hughey served on the Academic Advisory Committee, Senate Executive Committee, and the University Committee on Educational Policy.
- Within the SOE, Professor Varma directed the Korea Telcom program, and Professor Mantey chaired the Information Systems and Technology Management advisory committee.
- Our Senior Design Projects Class, led by Professors Petersen and Bazeghi, has catalyzed many SOE and cross-campus collaborations, especially with Ecology and Evolutionary Biology, as well as industrial connections several companies.
- Professor Mantey has been involved in STEPS, IGPP, UARC, CITRIS, IUCRP Steering Committee, CRS (Center for Remote Sensing, a part of IGPP), CIMT (Long Marine Lab) and SSRC (CS)
- Professors Dunbar, Hughey, and Manduchi worked with a broad team from science and engineering to develop a B.S. in bioengineering.

## **Advancing diversity**

The Department of Computer Engineering will continue to address issues of diversity in manners similar to the prior academic year. Last year,

- Professors Manduchi and Hughey lead an NSF Research Experiences for Undergraduates Site SURF-IT, a summer research program with a focus on increasing the number of women and underrepresented minorities in engineering
- Professor Ferguson has leadership roles in the Multicultural Engineering Participation (MEP) program and the NSF Developing Effective Engineering Pathways (DEEP) program with De Anza and Foothill Colleges.
- Professor Hughey is faculty advisor to our Society of Women Engineers chapter, and continues CE's strong support of the School's new graduate group, eWomen.
- Professor Manduchi is advisor to our Society of Hispanic Professional Engineers chapter.

In the coming year, at the undergraduate level we see CE1 (Hands On Computer Engineering) as being a continuing instrument for retention and diversity. At all levels (student and faculty) the growing focus on assistive technology within CE and bioengineering within the SOE is likely to significantly promote diversity within the School.

## 2005-6 Graduate Degrees Granted by Computer Engineering

<b>Student</b>	<b>Degree</b>	<b>Advisor</b>	<b>Title</b>
Carvalho, Marcelo	Ph.D	Garcia-Luna	Analytical Modeling of Medium Access Control Protocols in Wireless Networks
Deighan, Christine	MS	Brandwajn	Networks Project Course
Ding, Shaomin	MS	Mantey	High Performance Ocean Observing System and Power Saving Technologies
Gopalakrishnan, R	MS	Varma	Performance Evaluation of Iris with Rate Control
Gupta, Archana	MS	Larrabee	Physical Diagnosis Tool to Locate and Analyze Logical Faults on a Chip
Huang, Geofrey	MS	Brandwajn	Networks Project Course
Inani, Priyanka	MS	Dai	Macros for Domain-Specific ASIC Design Methodology Increasing Processor Power Efficiency by Dynamically Switching Pipeline Modes
Kale, Shautanu	MS	Renau	Between Application Phases
Krishna, Srilatha	MS	Larrabee	Implementation of Per-Test Fault Diagnosis Using Mentor FastScan
Kutty, Jayaram	MS	Brandwajn	Networks Project Course
Luo, Fangyi	Ph.D	Dai	Post-Layout DFM Optimization Based on Hybrid Encoded Topological Layout
Margi, Cintia	Ph.D	Obraczka	Energy Consumption trade-Offs in Power Constrained Networks
Moraes, Renato	Ph.D (EE)	Garcia-Luna	Efficient Protocols for Power-Constrained Heterogeneous Wireless Ad-Hoc Networks
Petkov, Vladislav	MS	Obraczka	Design and Implementation of Carnivores Collar Package
Rangarajan, Hari	Ph.D	Garcia-Luna	Robust Loop-Free On-Demand Routing in Ad Hoc Networks
Rao, Balaji	MS	Brandwajn	Networks Project Course
Ravindran, Rahul	MS	Garcia-Luna	Bidding Based Scheduling for Channel Access in Mobile Ad Hoc Networks
Richards, Jeremy	MS	Mantey	An Interactive Tiled Display System for Collaborative Learning Image Processing Algorithms for Tracking and Characterizing the Motion of Helicobacter Pylori
Ryder, Geoffrey	MS	Hughey	
Shi, Xiaojin (Jennifer)	Ph.D	Manducchi	Visual Learning from Small Training Datasets
Su, Liying	MS	Renau	Verilog HDL Bug Hunting Tool
Sung, Chengyu	MS	Miller (CS)	Integrating Pictorial Identity into Secure Mail
Vaishampayan, Rav	Ph.D (CS)	Garcia-Luna	Efficient and Robust Multicast Routing in Mobile Ad Hoc Networks.

## 2005-6 Extramural Research Funding and Gifts

July 2005 through June 2006. Several prior active multiyear awards not included.

Amount	Researcher(s)	Agency	Grant or Gift Title
91,429	De Alfaro, Luca	NSF	CAREER: Structured Design of Embedded Software
150,000	Larrabee, Tracy	NSF	Fault Diagnosis for Yield Improvement and Silicon Debug
25,000	Varma, Anujan	UARC	Optical Data Router (ODR) Architecture Design and Evaluation
100,000	Tao, Hai	NSF	CAREER: Elements in Solving the Multiple Object Tracking Problem
134,311	Garcia, J.J	UCSD	MURI: Space-Time Processing for Enhanced Mobile Ad-Hoc Wireless Networking
139,267	Hughey, BME	NIH/NIGMS	Predocctoral Bioinformatics Training at UCSC
164,183	Manduchi, Roberto	NASA/Ames	Managing the Information Flow in a Network of Visual Sensors
575,000	Garcia-Luna, Obraczka, Sadjadpour	US Army/AROD	DAWN: Dynamic Ad-hoc Wireless Networking
20,000	Renue, Jose	U Illinois	HPCS Complexity Management
23,798	De Alfaro, Luca	UARC	Timed Interfaces for Real-Time Software
26,018	Elkaim, Gabriel	UARC	Metasensor Technology - High Performance GNC Using Low-Cost Sensors
526,191	Manduchi, Roberto	NSF	Sensors: Exploring the World with a Ray of Light: An Environmental Sensor for the Blind
6,457	Obraczka, Katia	UC/MICRO	Energy-Efficient Medium Access Control for Wireless Sensor Networks
9,461	Obraczka, Katia	UC/MICRO	Secure and Robust Routing for Multi-Hop Ad Hoc Networks
9,375	Ferguson, Joel	UCOP	MEP Scholarships
51,000	Obraczka, Katia	NSF	Supplement to Collaborative Research: A Hybrid Systems Framework for Scalable Analysis and Design of Communciation Networks
360,021	Elkaim, Dunbar	NSF	MRI: Development of an Autonomous Robotic Vehicle Instrument (ARVIN)
300,000	Hughey, Manduchi	NSF	REU Site: REU in Information Technology at the UCSC Baskin School of Engineering
80,000	Renue, Jose	NSF	CAREER: Understanding, Estimating, and Reducing Processor Design Complexity
47,328	Renue, Jose	UARC	Fault Tolerant FPGA System on a Chip
34,518	Dunbar, William	UARC	Adaptive Optimal Air Traffic Routing: Improving Robustness to Weather Uncertainty by Leveraging Forcasts in Real-Time
143,015	Garcia, J.J	US Army/AROD	Instrumenting DAWN
32,000	Obraczka, Smith	CISCO Systems,	Gift: Networks laboratory
14,500	Obraczka	Wionics Research	Gift: Networks research
3,000	deAlfaro	Microsoft Corp	Gift
850,000	Elkaim	SVORA	Gift: Silicon Valley Overland Robotics Association , Overbot Autonomous Vehicle
21,000	Tao	NEC	Gift, the research of Professor Hai Tao
3,875	Computer Engineering	Various Donors	Gifts