I. NARRATIVE

Overview

Since our last program review in 1999, our department has become one of the top Computer Science and Computer Engineering departments in the United States. In the last *US News and World Report* ranking of graduate programs in Computer Science (in their 2006 survey), our program was ranked 13th in the nation. In 2008, our rankings dropped slightly.

![Graph showing rankings of Computer Science Departments](image)

*Figure 1: US News and World Report Rankings of Computer Science Departments*

Figure 1 shows how our rankings have improved since 1994. Our goal is to break into the top ten and to have the strength to comfortably remain there.

Of the specialties called out by *US News and World Report*, we were 15th in Artificial Intelligence, and 9th in Systems. We did not break into the top rankings in any of these specialties in 2002 except for Systems, in which we were ranked 16th. If Bioinformatics were ranked, we would most likely be in the top three departments; Cryptography would be in the top five and Databases would be in
the top ten. We are also becoming well known in Embedded Systems and Computer Architecture, and are growing in importance in Graphics and Vision.

The fuel that drove our rapid ascendancy was our ability to grow. Since our last review we have hired 25 professors. Areas in which we had no faculty in 1999 and in which we are now active and are having an impact include Bioinformatics, Graphics, and Vision. Our earlier faculty members have also become quite productive – for example, of the 15 PhDs who graduated between 2004 through 2007 and who are now in a tenure track position, three are from these new 25 professors.

We have used an aggressive strategy to grow. A huge amount of effort went into educating ourselves on the key issues and strengths of the individuals in areas in which we were making our first hire. We also followed a "rule of three": strive to have three active researchers in each area both for synergy and to be able to withstand the loss of one person. This has done us well so far; we have lost eleven faculty members and one adjunct professor who was a major contributor to our PhD program, but we have not yet dropped to a research area with a single faculty member. Our deans have also supported us with strong startup packages, and we quickly acquired a reputation as being a department on its way up.

**Strengths**

Our principal strength is our faculty.

We have recently grown in *Artificial Intelligence* with the addition of Yoav Freund and Lawrence Saul. Both are senior faculty renowned in their field. Combined with Garrison Cottrell, Sanjoy Dasgupta, and Charles Elkan, and with other hires in UCSD, this is becoming one of our strongest groups in the department. It is the home of both an IGERT and an NSF Science of Learning Center.

*Bioinformatics* lost research faculty member, Eleazar Eskin, two years ago when he went to UCLA as a tenured professor. Vineet Bafna and Pavel Pevzner have been making tremendous progress in the Bioinformatics program and have brought in a large amount of research funding. A center of Algorithms in Bioinformatics was established by this group under the auspices of Calit2. We face the serious problem of being able to cover the courses in the Bioinformatics program; we badly need a third person in this area.
Systems and Networks is the largest group in our department (faculty includes Walt Burkhard, Keith Marzullo, Joe Pasquale, Stefan Savage, Hovav Shacham, Alex Snoeren, Amin Vahdat, George Varghese and Geoff Voelker) and is very well funded. It is the home of one of the two NSF-funded CyberTrust centers, the Collaborative Center for Internet Epidemiology and Defenses (CCIED), established in 2004. We have entrepreneurs in this group: the company Netsift, started by Savage and Varghese, was sold to Cisco. Such entrepreneurship has a short-term overhead: the faculty member usually takes a one-year leave but continues to work with his or her students. The long-term benefits, including technology transfer, impact on funding, increased influence of the department, and possible financial gain to the university and department, are very large. We recently lost Andrew Chien when he decided to join Intel as the Director of Research.

We recently added Ryan Kastner to our VLSI/Embedded Systems group. Other members are C.K. Cheng, Andrew Kahng, Alex Orailoglu, Tajana Rosing, and Rajesh Gupta. This is a strong group that is beginning to increase its amount of collaboration. In particular, Gupta and Rosing are building the research infrastructure and courses for an embedded system concentration.

The faculty members in our Architecture group are Steven Swanson, Michael Taylor, and Dean Tullsen. This is a strong group, but the recent loss of Brad Calder to Microsoft has been substantial. There is significant collaboration between this group and the VLSI/Embedded systems group.

Programming Languages/Software Systems recently added two new junior faculty members: Ranjit Jhala and Sorin Lerner, and lost one senior faculty, Joseph Goguen. Along with Bill Griswold, Bill Howden, and Ingolf Krueger, the area that this group covers is broad and deep. In particular, Ingolf Krueger has built an excellent relationship with the automobile industry in helping them apply service oriented architectures to automobile systems, and Jhala and Lerner are broadening the scope into the practical use of formal methods.

Database and Information Management is a small but well-known group: Alin Deutsch, Yannis Papakonstantinou, and Victor Vianu. Their impact is broad, ranging from theory applied to workflow management to supporting queries on XML documents. This group has had a large impact on industry.
Graphics and Vision has one junior member - Matthias Zwicker, in graphics, and three senior members, Serge Belongie, Henrik Wann Jensen, and David Kriegman. Two startup ventures are currently being led in this area by Belongie and Kriegman, and there have been other substantial interactions with industry.

Algorithms, Complexity and Cryptography is a core group. Its members include some of the most well-known faculty in our department: Mihir Bellare, Fan Chung Graham (1/3 appointment), Ron Graham (50% appointment), Russell Impagliazzo, Daniele Miccianico, and Mohan Paturi. There is a weakness in this group: Bellare and Micciancio concentrate on cryptography, and one member, T. C. Hu, recently retired. Hence, the only Complexity and Algorithms people are Impagliazzo and Paturi. Fixing this weakness is a high priority of our hiring.

The High Performance Computing group consists of Scott Baden, Fran Berman, Jeanne Ferrante, and Larry Smarr. They are all well-known leaders in their fields, but this group also bears a huge load of university service. Berman is the director of SDSC, Ferrante is an Associate Dean of the Jacobs School of Engineering, and Smarr is the director of CalIT2.

Research Centers

A key contributor to our Ph.D. program is the set of organized research units and research centers. These serve many purposes, including providing a source of funds to support Ph.D. students, increasing interaction with our students and industry, and fostering collaboration.

CalIT2

The California Institute for Telecommunications and Information Technology (CalIT2) is a campus-level institution that has had strong roots in the CSE department from its very beginnings. The institute proposal was put together by its founding director and CSE professor Larry Smarr working in conjunction with a number of our faculty members including Andrew Chien, Rajesh Gupta, and Andrew Kahng. While the scope of the institute is very broad -- ranging from science/technology policy to networked systems to software to nanoscale devices -- the role of Computer Science is central to many of its themes. More importantly, from a CSE point of view, the institute represents an enormous experimental facility for our researchers: the "CERN of Computer Science" includes unique facilities for scientific visualization, novel computing fabrics,
high-speed networking fabrics and embedded sensing and signal processing. A number of our faculty members, including Brad Calder, Henrik Jenen, William Griswold, Rajesh Gupta, and Tajana Rosing, have been engaged as individual researchers working on specific projects made possible and hosted at CalIT2. More recently, our faculty have become more centrally involved in defining new thematic efforts and centers. Two examples are the Structural Health Monitoring laboratory with Michael Todd of SE, Tom Bewley of MAE and Curt Schurgers of ECE under the CSE leadership of Rajesh Gupta and Tajana Rosing. Another example is the Center for Algorithmic and Systems Biology which brings together Pavel Pevzner, Vineet Bafna and Mohan Paturi along with scientists from UCSD, Scripps and the Burnham Institute. In addition, Ingolf Krueger has organized three workshops on Automotive Software (Advanced Automotive Software and Systems Development: Model-Driven Development of Reliable Automotive Services). These are held approximately every two years and bring together world wide researchers on automotive software. For the coming year, the workshop will be expanding to include avionics software.

Clearly, CalIT2 is a significant resource which serves as a magnet for talent in Computer Science and which provides opportunities for all of our students, both graduate and undergraduate, to engage in substantial research projects. It also creates opportunities for fostering cross-disciplinary research. Going forward, we expect to continue to create more research efforts and centers with CalIT2.

San Diego Supercomputer Center

The San Diego Supercomputer Center (SDSC) is a world leader in innovating, providing and using information technology to enable advances and discoveries in science and engineering. Focusing on data-oriented and computational applications, SDSC serves both the National Science Foundation (NSF) and the broader community as a national and international center for data cyber infrastructure through its software, hardware and human resources. SDSC is a world leader in innovating, providing and using information technology to enable advances and discoveries in science and engineering.

The ties between CSE and SDSC are deep – the original director (Sid Karin) and the second and current director (Fran Berman) are both members of our department. Several faculty members have participated in SDSC hosted research projects and have made use of the computational and storage facilities there. And, several of our
Ph.D. students have had advisors or committee members from the SDSC staff, including Allan Snively of the Performance Modeling and Characterization Laboratory and Kim Claffy of the Cooperative Association for Internet Data Analysis. There are concerns about the difficulties that SDSC has had in sustaining its funding.

**CCIED**

The Collaborative Center for Internet Epidemiology and Defenses (CCIED, "SeaSide") is a joint effort between researchers at UCSD and the International Computer Science Institute’s Center for Internet Research. CCIED addresses the critical challenges posed by large-scale Internet-based pathogens, such as worms and viruses. CCIED efforts focus on analyzing the behavior and limitations of Internet pathogens, developing early-warning and forensic capabilities, and developing technologies that can automatically defend against new outbreaks in real-time.

CCIED was set up by Stefan Savage of UCSD and Vern Paxson of ISI. CSE professors Alex Snoeren, George Varghese and Geoffrey M. Voelker are co-investigators. CCIED has a large number of industrial sponsors including Microsoft Research, Google, Cisco, Intel, HP, Websense, Ericsson, and VMWare. It supports 18 students, including several in our department.

**TDLC**

The Temporal Dynamics of Learning Center (TDLC) aims to achieve an integrated understanding of the role of time and timing in learning across multiple scales, brain systems, and social systems. The scientific goal of the center is to understand the temporal dynamics of learning and to apply this understanding to improve educational practice.

TDLC is directed by CSE professor Gary Cottrell and has partners at UCSD, the Salk Institute, CMU, Brown, the University of Colorado, Rutgers, the University of Victoria, Yale, and the University of Queensland. TDLC has become an important source of funding and collaboration for AI students in CSE.

**CNS**

The Center for Networked Systems (CNS) is an organized research unit whose mission is to bring together leading faculty, students, and companies to investigate the most challenging, interesting, and important problems in computer networks, and to train our students
to continue their leadership throughout their career. CNS partners with companies such as AT&T, HP, Google, Qualcomm, NetApp, Sun and Cisco to develop key technologies and frameworks for networked systems. By combining UCSD research talents and strengths in partnership with key industrial leaders, CNS strives to accelerate research progress and create key technologies, framework, and systems understanding for robust and secure networked systems, as well as innovative new applications.

The first director of CNS was CSE professor Andrew Chien, who defined the mission and assembled the initial set of faculty and industrial partners. CSE professor Amin Vahdat became the director after Chien left the department to become the director of research at Intel as well as vice president of its Corporate Technology Group. CNS has been an important source of funding, industrial interactions and collaboration for system students in CSE.

Challenges

We face several challenges with respect to continued improvement of our Ph.D. program: tuning the degree program, increasing collaboration, increasing industrial relations, and increasing alumni tracking.

Degree Program

Our Ph.D. program was revised since the last graduate program review. The goal of this revision was to involve students in research sooner in their career, and to encourage students and advisors to associate early in a student’s career. We have had some successes, but we do need adjustments.

Most students are still taking their research exam in their third year. This slows their research progress and puts them at risk of not advancing to candidacy before the university deadline. We plan to re-examine the core courses and the research exam requirements to enable most students to pass it in two years. In addition, we plan to review the content of our core courses in terms of what is being taught in the undergraduate curricula of the departments that feed into ours, and we plan to increase the number of advanced technical, non-seminar graduate courses. This is important both to increase the knowledge available to our students and to increase collaboration opportunities.
Collaboration

One of the ways that the field of Computer Science has grown has been through collaboration with other fields. A recent example is Bioinformatics, where the application of algorithms has revolutionized sequencing genomes and has led to breakthroughs in our understanding of evolution. Another recent example is Grid Computing, which grew out of collaborations between computer scientists and physicists who wished to collect and reduce the data from huge long-running experiments.

Joint appointments and joint programs are a mixed blessing. On the plus side, joint appointments are a force multiplier: they provide specialized expertise. For example, Professor Fan Chung Graham brings a welcome expertise in graph theory to our department, but her main tie is with the Math Department, in which her work is more broadly applicable. Similarly, Professor Falko Kuester in Structural Engineering brings strong expertise in Data Visualization, which fits well with our Graphics group. However, joint programs have serious problems of management. Department chairs and undergraduate and graduate committees often treat joint programs with lower priority since to do so requires the cooperation of another committee. Indeed, the Computer Engineering program has suffered these problems, which finally led to the chairs of CSE and ECE to address the issue face-on. We have created a cross-department faculty committee to oversee and tune the program, and are talking about jointly developing a brochure and organizing an annual retreat for the members of the program. CSE sees supporting such joint ventures as a high priority.

We see collaboration growing between us and the following departments and divisions:

- The Department of Communications is spearheading an interdisciplinary initiative in information technology. This initiative, which is joint with their department and with Visual Arts, Cognitive Sciences, and Computer Science and Engineering, is modeled somewhat after the renowned MIT Media Lab. Our research directions in disaster management, the use of tablet PCs, and machine learning all have an overlap with this proposed initiative.

- Many of the research groups working high up on the abstraction stack - for example, in data mining and in machine learning - come face to face with issues in human computer interaction (HCI). This is an interest we share with Cognitive Sciences, and a joint appointment in HCI could be fruitful. We have a long history of
cooperation with Cognitive Sciences, especially through our Artificial Intelligence research group.

- The ties between Bioinformatics and the School of Medicine are obvious. We have twice tried to hire a faculty member who would have a joint appointment with the SOM via the Cancer Center and hope to try again this year.

- The interests of the Rady School of Management overlap with CSE in several ways. There is an interest in creating certificate programs along the line of the Architecture-based Enterprise Systems Engineering program run by Hal Sorenson. A possible certificate program could be created based on software certification. In addition, both the Rady School and CSE share an interest in E-Commerce.

In some cases, there are funds already allocated to support such efforts. For example, the funds we used to try to bring on a faculty member joint with the School of Medicine are still available, and the Jacobs family has donated a set of chairs to be used by the Rady School and departments in other divisions.

*Interaction with Local Industry*

Southern California is an incubator for many companies developing products in our areas of strength. For example, there are many local companies which work in network security, and we have one of the two NSF CyberTrust centers in network security. Surprisingly, this situation is not well known to these companies or to us. We know that such companies exist, and they know that we exist, but that is the extent. Opportunities between our institution and local companies need to be explored.

This state of affairs presents an opportunity for us to create our own Industrial Affiliates program. We would share some goals with the Jacobs School program Corporate Affiliates Program (CAP), but there are differences.

Our goal with this program would be to create research ties which would eventually lead to funded research, cooperation in joint proposals, and placement of undergrad and graduate students. We expect that many of these smaller companies would have narrower interests and a Research Forum day would probably not be the best way to engage them. Instead, we would have focused presentations with engineers and our faculty to foster an exchange of ideas. As the smaller companies mature and grow, those who
are not already members would be natural additions to the Jacobs School of Engineering CAP program.

It is worth noting that a similar goal was given in the narrative in the 1999 review. Our growth has only made this goal more pressing and more attainable.

*Alumni Tracking*

Tracking CSE alumni has a large number of benefits. Alumni are a natural source of funding for our graduate students in terms of providing fellowships, scholarships, and other contributions to our facilities. They are ambassadors to our program, and are proud to hear how their department has grown; they can spread the good news to their colleagues who didn't attend UCSD. As they mature, their own children may attend UCSD. In addition, some of the alumni will reach positions of hiring authority, and so become conduits for student placement. These goals and benefits apply across all of our degree programs, undergraduate and graduate.

In the past we have had some notable successes. The most notable is the UCSD Pascal reunion, which was organized and run by the Jacobs School of Engineering. This event renewed friendships and contacts with our department, and gave a sense of history to the current faculty and students.

There is ample room, however, for improvement in tracking and keeping contact with our alumni. A major problem is that the task is spread across at least three organizations: central development, the school, and the department. Care must be taken so that increasing activities of one organization is not seen as threatening to the other organizations. With this in mind, we plan to implement an exit interview for our students. We intend to model ours after the one used by the University of Washington. As part of this interview, we would give the graduating student an email address that could be used for forwarding mail; enrollment in AfterSchool.com and in some social network systems. For the Ph.D. students, a book or memento of UCSD and CSE could be provided. Note that some of these are already available, such as access to AfterSchool.com, but these benefits are sufficiently buried so that they are not widely known to be available.

We have requested the university to fund an Assistant III in the CSE Student Affairs unit to manage this process. He or she would work closely with the Jacobs School of Engineering, since some of the services we would offer would need support from the School,
and the resulting mailing lists would be useful to the school. Indeed, we see this as a way for our department to help work with the school to be more effective with our alumni tracking and engagement.