COMPUTER SCIENCE DEPARTMENT

SCHOOL OF ENGINEERING

UNIVERSITY OF SOUTHERN CALIFORNIA

Academic Review

February 6, 2004

Gérard Medioni, Chairman

I. EXECUTIVE SUMMARY OF COMPREHENSIVE PLAN OF IMPROVEMENT

Computer Science is a rapidly advancing field. Because progress in most areas of science and technology, and often the humanities, depends upon computing, Computer Science can be seen as a hub discipline: contributions and advances at the hub radiate outward along many points to facilitate growth in other disciplines, and many innovations in Computer Science will come about through the combined efforts of multiple disciplines.

The field itself is changing dramatically, from its initial focus on programming to new areas such as embedded and pervasive computing, the interaction of computers with one another and with the physical world, understanding the computational ability of the human brain, and computation at the molecular level. Given these new developments, an essential question arises: "How can the USC Computer Science Department best build upon its strengths and respond to and affect emerging challenges?"

The USC Computer Science Department is at a major crossroads. Pursuing the correct path is critical for the Department to rise in stature and reputation to become a national leader among the top 10 departments in the country. If we fail to muster the intellectual and physical resources needed to meet the challenge, we risk sinking to the second rank of Computer Science Departments in the country. Inactivity is not an option in this fast-changing field. Complacency in the face of increasing competition from many other strong universities risks jeopardizing the future potential of the department.

This report summarizes our considerable current strength as a basis for analyzing areas where improvement is needed to enable us to move rapidly along the "right road" to accomplish this goal. We are implementing a comprehensive plan for improvement, which includes:

- Improving the national perception of our department to better reflect our current strengths
- Continuing to demonstrate excellence in research
- Hiring outstanding faculty
- Continuing revision of the curriculum and academic requirements at all levels (UG, MS, PhD) in line with the evolution of the field
- Devoting resources and defining a strategy to accommodate the large MS student population
- Developing a comprehensive plan to handle the retention problem at the UG level
- Increasing diversity in the department
- Increasing the domestic graduate student population
- Recognizing faculty who are performing outstanding research
- Success in achieving a top 10 ranking depends critically on our obtaining a new building dedicated to the Computer Science Department

Achieving these goals would assuredly put the USC Computer Science Department in the elite group of the CS departments in the country.

II. OVERVIEW AND VISION

A. A Brief History of the Department

In 1972 the Department was created as a Graduate Program in Computer Science, administered by the Department of Electrical Engineering-Systems (EE-S), with joint sponsorship by the Department of Mathematics and the School of Library Science. Original faculty included Professors Breuer, Ginsburg, Reed, and Bekey from EE-S and Prof. Blum from Mathematics. The first degree offered was a BA in Computer Science through the College of Letters, Arts and Sciences in 1973. In the Fall of 1976, the Computer Science Program formally became a department and acquired its own building (Salvatori Computer Science Center) due to a generous gift from Henry Salvatori, a member of the USC Board of Trustees.

The Department's first chair was Jack Munushian (1972-76). Since his field was Material Science, his appointment was entirely administrative. He was followed by Per Brinch-Hansen (1976-78), Lee Cooprider (1978-80), Rick Carlson (1981-84), George Bekey (1984-89), Rick Carlson (1989), Ellis Horowitz (1990-99), Michael Arbib (1999-2001), and Gérard Medioni (2001-present).

From its inception, the Computer Science department emphasized research. In the 1970s the department's major research areas reflected the themes of the times. Topics included algorithms and data structures, operating systems, programming languages, and compilers. The Information Sciences Institute (ISI) was also engaged in a wide variety of Computer Science research, most notably in the areas of networking and artificial intelligence. There were, however, few collaborative links between ISI and the CS department. These early years were at times turbulent and characterized by few promotions of junior faculty to tenured positions, and few research grants and contracts. This changed as the department began to develop a solid academic base that has continued to improve.

In the 1980s, the department made several key senior faculty appointments, e.g. Profs. Leonard Adleman, Ram Nevatia and Michael Arbib. This gave the department new strengths in the areas of cryptography, computer vision and neural computing. The department also started to receive major research grants. By 1989 the department had 22 tenure track faculty and 5 ISI research faculty (Schorr, Balzer, Wile, Johnson, and Swartout). Meanwhile, student enrollment at all levels was slowly increasing. Average entering SAT scores remained between 1150-1200, combined verbal and math.

The 1990s were a period of growth and great change. The department continued to make key faculty appointments. Of special note is Prof. Barry Boehm, who founded our Center for Software Engineering. At the undergraduate level, a new major was introduced, Computer Engineering/Computer Science. This major is now the largest in the School of Engineering. Entering student SAT scores rose steadily, exceeding 1,300. Enrollments at all levels continued to grow from 75 UG, 300 MS and 114 Ph.D.'s in 1989 to 600 UG (CS and CECS), 424 MS and 153 Ph.D in 1999.

A policy was then introduced to encourage researchers at ISI to participate in the life of the department by becoming Research faculty. We now have more than 30 ISI research faculty who provide additional breadth and strength to our programs. Another major effort was begun in Multimedia research. The award of an NSF Engineering Research Center (ERC) in 1996 to USC created the Integrated Media Systems Center (IMSC). Through this center, we have invigorated our multimedia research and curriculum. Another major research center, the Institute for Creative Technology (ICT) was created in 1999.

Today, we have 27 Tenure Track Faculty, 35 Research Faculty, UG enrollment is capped below 600, 775 MS, and 224 Ph.D. are in the program, and research expenditures exceed $37M. The department is again appraising this evolving field, and redefining the structures and curriculum to tackle the challenges ahead.

B. Vision

Our vision of the department's future is shaped significantly by national trends in the field, yet is driven by our own considerable current strengths. We must be sensitive and responsive to current trends; yet we also expect to influence them through success in research, and by producing outstanding graduates who will carry the USC message both to other universities and to industry.

The field of Computer Science is changing dramatically, from the early focus on programming, to today's interest in areas such as embedded and pervasive computing, the interaction of computers with one another and with the physical world, understanding the computational ability of the human brain, and performing computation at the molecular level. Such trends are reflected in the Information Technology Research (ITR) at the National Science Foundation, and the recent "Nano-Bio-Info" emphasis at DARPA. In response to these trends, we have completely restructured our graduate program as described in Section III.B.3 below. Our influence on these trends is also important to note, including the invention of DNA computing, providing (with ISI) forefront research on the internet, and establishing one of the nation's strongest linkages between empirical and computational neuroscience.

Our vision of the future includes improving the national and international recognition of our Department. By virtue of our research productivity, innovative curricula, outstanding students and increased world-wide recognition of our faculty, the USC Computer Science Department should be among the top 10 Departments of Computer Science in the country. We are dedicated to validating this ranking within the next 5 years. The implementation of this overall vision includes the following actions:

- Continuing cultivation and expansion of the enormously productive relationship between Department activities at the downtown campus and major research centers, in particular the Information Sciences Institute (ISI), the Institute for Creative Technology (ICT), and the Integrated Media Systems Center (IMSC). These three centers, with annual budgets of $75 million, $22 million and $11 million respectively, are resources unequalled at any other university. The nature of this relationship is detailed in Section II.C.2 of this Report.
- Maintaining our emphasis on research and teaching across the boundaries of traditional disciplines, since often innovation and creativity occur in a multidisciplinary environment.
- Increasing our ability to attract outstanding domestic students in our student population.
- Managing our large MS program, providing quality advisement, emphasizing specialty programs in such areas as security, multimedia and software engineering, and reaching many companies and their workforce by taking advantage of the School of Engineering Distance Education Network. We have also added a thesis option to the program.
- Improving undergraduate programs in a number of ways, including better research opportunities, and providing new minors in CS for undergraduate students throughout the University (such as a minor in computer game design and programming).
- Continuing our growth in faculty size, space, and resources. While we are one of the largest CS departments in the country, if we count our research faculty, we need to increase the number of on-campus faculty members in carefully selected areas to provide the best possible educational experience and student contact required for quality education.
- Obtaining a new Computer Science building is necessary to our vision of the future. We see this as essential to our efforts of attaining greater national stature. Without additional

facilities, we will not be able to reach our vision of excellence in research, teaching and outreach to students.

C. Current Academic/Intellectual Profile

The USC Computer Science Department's research-orientation is supported by a number of unique features:

1. Unique faculty/graduate program structure

Most Computer Science departments have "traditional" organizational structures, with typical divisions into research groups such as: Theory, Systems and Software, Databases, Intelligent Systems, and Numerical Analysis. Our department has a completely different structure, based on our vision of the future of the field. The faculty have identified the critical areas on the horizon for Computer Science, which include the following:

- Computation: the extension of the frontiers of computation through work in high performance computing, exotic forms of computation based on neural, molecular and quantum mechanisms (including nanotechnology), and innovative studies of the theoretical basis of all forms of computation.
- Interaction: technology issues related to the interaction of computers in distributed systems, in such areas as networks, protocols, system security, grid computing, software engineering and pervasive computing.
- Autonomy: the ability of computer systems to operate independently of human control. This includes not only AI and robotics, but also the field of agents that has grown into a specialty of its own in recent years.
- Immersion: the degree to which users can be immersed in systems or information, whether on-line, in interactive displays, or in new forms of storing information and data so that they become increasingly accessible to human users.

This four-fold structure, which we believe represents key directions for Computer Science over the next 5-10 years, is unique and distinct from any other university. These focal points are having a profound effect on the choice of areas in which we plan to hire new faculty, on our curriculum, on developing ideas and systems that have a major impact on the profession, and on developing larger-scale or joint efforts geared towards a major attack on one of these problems. This structure is not only a plan for the future, but also an expression of the unique strengths that the Computer Science department already possesses. We have divided the faculty into four groups corresponding to the areas described above, as shown in Appendix II (Section A 5).

2. Connections with ISI, ICT and IMSC, the EE-Systems Department and the special role of Research Faculty

The Computer Science Department is fortunate to have close working relationships with three major, nationally renowned Research Institutes: (1) the School of Engineering's Information Sciences Institute (ISI), one of the nation's premier centers for applied research in information technology, (2) the Institute for Creative Technology (ICT), a US Army-supported center working on the interface between computer science and entertainment technology, and (3) the Integrated Media Systems Center (IMSC), the National Science Foundation Center of Excellence in multimedia. IMSC is an on-campus center, and many of its researchers are also Computer Science Department faculty, including the Director. ISI and ICT are located in Marina del Rey. More than 30 ISI and ICT researchers hold Computer Science Department faculty positions as Research Assistant Professor, Research Associate Professor, or Research Professor. Some 80 Computer Science PhD students are supported by ISI and ICT. It is important to note that many Research Faculty members, both on and off the downtown campus, are deeply involved in the life of the Computer Science Department. They serve as chairs of doctoral committees, as members

on a variety of departmental committees, and they have the same voting privileges as tenure track faculty (except for voting on tenure issues). Details of the rights and responsibilities of Research Faculty are documented at http://www.isi.edu/touch/resfac/. This unique and close working relationship is one of the sources of strength of the Computer Science department.

These institutes also broaden the resource base of the Department, provide additional areas of strength, support different kinds of research experiences -- such as very large scale system development -- and supply an additional pool of potential instructors. Total faculty, including tenure-track and Research faculty, makes us one of the largest Computer Science departments in the country.

The Department also has very close working relationships with the Department of Electrical Engineering-Systems. As indicated later, we jointly support an undergraduate program in Computer Science and Engineering. We also collaborate on a number of research grants and contracts. For example, Prof. Kai Hwang from EE-S and Prof. Clifford Neuman from Computer Science have an NSF Information Technology Research (ITR) grant on computer security. Additionally, two of our professors, Govindan and Papadopoulos, collaborate with EE-S faculty in networking research. Moreover, several of our faculty hold joint appointments with EE-S.

3. Interdisciplinary commitment

The Computer Science Department is deeply committed to interdisciplinary research, involving joint projects with faculty members in other departments of the School of Engineering and throughout the University. Many of these interactions take place in a large number of Research Centers and Institutes, as detailed below in Section III.C.4. Many of our faculty have strong research connections with other schools and departments, both within and outside of these Centers; 16 of our faculty have joint appointments with other schools and departments, as shown in Appendix II (Section 6). As examples of these connections we cite the following collaborations:

- *Chemistry and Material Science*: Prof. Requicha, the Director of the Nanorobotics Laboratory in the Computer Science Department, has close collaborations with faculty in the departments of Material Science and Chemistry.
- *Neuroscience*: Prof. Arbib was the first professor hired in the Neural, Informational, and Behavioral Sciences (NIBS) program. Professors Arbib, Itti, Schaal, and von der Malsburg have labs in the Hedco Neuro Science Building, where they pursue research that bridges the fields of computer science and neuroscience.
- *Biology and Medicine*: Numerous joint projects include faculty from the College of Letters, Arts and Sciences and the Health Sciences campus. For example: Prof. Arbib has collaborators from medicine and biology in his studies of information processing in the brain; Prof. Lewis Johnson has worked on continuing education programs for the Keck School of Medicine; Prof. Schaal is co-PI on an NSF ITR grant with Prof. Winstein from the Department of Physical Therapy; Profs. Requicha, Matarić, and Sukhatme collaborate with Prof. Caron in biology on monitoring marine microorganisms using sensor networks. ISI now houses a group of Medical School (and BME) faculty concerned with archiving and communicating medical images. These examples are illustrative of a wide range of linkages.
- *Education*: Prof. Johnson works extensively on computer-based instruction, jointly with faculty in the Rossier School of Education.
- *Physics and Mathematics*: The Computer Science Department participates extensively in the University's high-performance computing program, which also involves faculty from Material Sciences, Physics, Mathematics, Chemistry, the Annenberg School, CNTV, the Keck School of Medicine, Geology, and others. Prof. Medioni participates in the Center for

Applied Mathematics (CAMS) in the Mathematics department. Prof. Nakano also holds a joint appointment with Physics.

- *Neural Networks:* In the area of neural networks, we interact with Mathematics, Electrical Engineering, Physics and other departments. Professors Arbib, Schaal, Itti, and Blum are widely recognized experts in these areas.
- *Robotics:* Robotics brings together faculty from CS (Howard, Matarić, Requicha, Schaal, and Sukhatme) and ISI (Lerman, Shen, Will), and involves active collaboration with faculty from Biology (Caron), Chemistry (Koel), Medicine (Cunningham), Kinesiology (Winstein), LAS (McNitt-Gray), and other departments within the School of Engineering.
- *Cinema/Television, Computer Graphics and Animation:* Prof. Ulrich Neumann and other faculty members associated with IMSC interact with the School of Cinema/Television. Prof. Weinberg from Cinema/TV has close ties with IMSC. CS faculty at ICT necessarily have close links with Cinema/TV, and Lewis Johnson at ISI often works with their students.
- *Geosciences and Earthquake Engineering*: Carl Kesselman, Ann Chernavak, and some AI faculty interact with faculty in geosciences and Civil and Environmental Engineering.
- *Civil Engineering:* Profs. Govindan and Sukhatme are working with Profs. Masri and Johnson from Civil Engineering on the monitoring of structures using networked sensing.
- *Petroleum Engineering:* IMSC and ISI faculty are participating in CiSoft, a new Chevron-Texaco Center for Interactive Smart Oilfield Technology.

The examples listed above are not exhaustive, but illustrate the breadth of involvement of Computer Science faculty involvement in a broad range of disciplines throughout the University. It is also important to point out that many of our faculty have joint appointments and cooperative projects with our sister department (Electrical Engineering) and its Computer Engineering Program.

Interdisciplinary programs require effort and dedication on the part of the faculty, but the support for such efforts from the Provost and the increasingly close working relationship between the Engineering and LAS Deans have greatly increased the chances of success in recent years.

4. Makeup of our student body

Enrollment in the Computer Science Department is divided almost equally between undergraduate and graduate students. As shown in Appendix II (Section B 2a), undergraduate students have made up between 53% and 56% of our student body over the past years. In the current year, undergraduates make up 41% of Computer Science enrollment, due to a decline in the number of students majoring in computer science. This is a national trend, and no surprise given the recent "dot com bubble burst." We will continue to be proactive in our approach to curriculum development. Moreover, we need to communicate to potential students and their parents that there are still many challenging careers for CS majors.

D. **Relationship to the University's Strategic Plan**

The Computer Science Department's programs have strong relationships with two aspects of the University's strategic plan: (1) Communications and computing and (2) Life Sciences, as well as some connections with the Urban Paradigm, as detailed below. We do not have strong connections with the Plan's initiatives in the Arts, although Emeritus Prof. George Bekey initiated a joint course with the School of Fine Arts called "Art and Technology," which includes participation from our robotics, computer vision and other laboratories.

- *Relationship to the Communications track of the Strategic Plan.* Communication and computation are inextricably linked. Thus, some goals of the Computer Science Department overlap those of the Communications Initiative. The overlap is greatest where communications depends on technology (and computers), and weakest where it concerns

human variables. However, even in the latter case, the research area of Computer Science known as Human-Computer Interfaces (HCI) bears directly on certain elements of the Communications track. Agents and robotics research have very integral communications components involving human-robot/agent interaction. Furthermore, natural language processing, networking, and elements of the immersion research area are poised to play an important role in communication.

- *Relationship to the Life Sciences track of the Strategic Plan.* The Computer Science Department faculty have strong interactions with Life Science faculty members, including Professors Arbib, Bekey, Itti, Mataric, Medioni, Requicha, Neumann, Nevatia, Schaal, and von der Malsburg. Prof. Arbib has a continuing research interest in various aspects of the brain as a computer and information processor; in this respect he interacts with faculty members in the Neurosciences. Prof. von der Malsburg also works on brain processing as well as on models of human vision. Other faculty members studying human vision as a model for computer vision include professors Itti, Medioni, Nevatia, and Neumann. Prof. Blum and Prof. von der Malsburg study artificial neural networks as models for information processing in the nervous system. Prof. Mataric studies human-robot communication. Both she and Prof. Arbib have strong interests in brain structures known as "mirror neurons", which are active in aspects of imitation. Prof. Schaal has a joint project with the ERATO brain project in Japan, builds humanoid robots, and has a joint information processing grant with Prof. Carolee Winstein in the Physical Therapy Department. Prof. Bekey has a joint project with Prof. Loeb in Biomedical Engineering concerning the nature and measurement of human falling. These examples make it clear that our department has significant interaction with the Life Sciences Track. Prof. Arbib has been active with the planning of this track within the University's strategic plan.
- *Relationship to the Urban Paradigm track of the Strategic Plan*. Some ISI faculty are collaborating with faculty from Geography and School of Policy Planning and Development (SPPD) on issues of urban transportation. Also, a major goal of the Center for Research on Unexpected Events (CRUE) is the development of detailed models of cities.
- *Nanotechnology.* While this field is not explicitly identified as an element of the University's Strategic Plan, it figures prominently in the areas of research emphasis of the National Science Foundation and the Department of Defense (particularly DARPA). Nanotechnology is the modern version of miniaturization and promises to have an even greater impact than its predecessors. Control of the structure of matter at the molecular scale will have revolutionary consequences. Microtechnology was completely ignored in USC's last strategic plan. We must not ignore nanoscience and nanoengineering in the current planning effort, or an extraordinary opportunity will be missed. A university without a strong presence in nanotechnology will almost surely not be recognized as a top tier school. USC is fortunate to have very strong groups working in the area, but as an institution we lack critical mass and a firm commitment to this emerging field. USC's CS department is one among very few CS departments with a strong presence in nanotechnology, based on the department's expertise in robotics. Assembly of nanostructures from the bottom up, either by direct manipulation or by exploiting self-assembly, has a strong computational flavor, which has not been recognized yet by most computer scientists. It also has important theoretical aspects, which are being addressed by our theory group under Len Adleman. The nanorobotics effort here is highly regarded worldwide. It should be developed further, jointly with other disciplines such as Biomedical Engineering, Electrical Engineering, Chemistry and Physics, because the field is inherently interdisciplinary.

E. Recommendations of Previous Reviews

The last review took place more than 15 years ago (in 1986), when the department and its faculty were dramatically different from today, so we do not believe that their recommendations are relevant to our current situation.

III. ASSESSMENT OF QUALITY

A. Current Academic Stature

There are a number of metrics for estimating the current stature of the department. We report here on four such measures: the rankings from *US News and World Report (USNWR)*, the quality of our new junior faculty, faculty, retention and elected membership in the elite groups of professional societies.

1. USN&WR rankings

The most recent rankings in *US News and World Report* were as follows:

Year	Scope of evaluation	Rank
1999	"Computer Science - Ph.D.(1999)"	21
2000	"Engineering Specialties: Computer (2000)" (combined CS and CENG)	15
2002	"Graduate programs in Computer Science"	27

We believe that these rankings (which put us among the top 30 departments in the country) do not reflect the current quality and strength of the department. It is clear that the strongest Computer Science departments in the country are Carnegie Mellon University, University of California at Berkeley, MIT, Stanford, Cornell, and the University of Illinois (Urbana-Champaign). We believe that the USC CS department should be ranked consistently in the top 10 nationally. The Department has improved dramatically over the past 20 years, but there is a lag between improvement and perception of improvement in the academic community. In particular, not all evaluators have recognized the tight integration of the Computer Science Department with ISI, IMSC and ICT, which contributes to our strength. Current efforts at disseminating information about the department, its faculty, and academic programs should be reflected in the next set of evaluations.

2. Quality of new Assistant Professors

An excellent measure of the quality of the department is its ability to recruit outstanding Junior Faculty. During the past decade nearly every new Assistant Professor in Computer Science has won an NSF CAREER award (or its predecessor, a Presidential Young Investigator award), as detailed in Appendix I (Section1a). This is an enviable record for any research university.

3. Faculty Retention

Our retention rate for faculty is almost perfect. We have lost a single faculty member, Ashish Goel, to Stanford over the past 5 years Appendix II (Section 4b). He left for personal reasons, making his choice Northern California, he continues to actively collaborate with USC faculty.

4. Membership in the National Academies

The department has three National Academy of Engineering members: ***Leonard Adleman, George Bekey, and Barry Boehm.***

This is a relatively high number for a Computer Science Department. Comparable data are difficult to obtain, since the NAE specialty section combines Computer Science and Computer

Engineering, and many schools have combined Departments of Electrical Engineering and Computer Science.

5. IEEE Fellows

The Institute of Electrical and Electronics Engineers, as the name implies, is an Engineering (rather than a Computer Science) professional society. Its Computer Society is the largest group with the IEEE, and many computer scientists are members of this society, as well as the Association for Computing Machinery (ACM), the primary Computer Science professional organization. The following faculty have been elected to the rank of Fellow of the IEEE Computer Society: ***Leonard Adleman, George Bekey, Barry Boehm, Gérard Medioni, and Ramakant Nevatia.***

6. AAAI fellows

Our department has a strong national reputation in Artificial Intelligence, due to the many well-recognized programs in the field at ISI, as well as on-campus programs in robotics, intelligent agents and other areas. As a result, several members of our faculty have been elected to the rank of Fellow of the American Association for Artificial Intelligence, the primary professional organization in the field, including the following: ***Michael Arbib, George Bekey, Jerry Hobbs, Ramakant Nevatia, Paul Rosenbloom and William Swartout.***

7. ACM Fellows

The Department has one Fellow of the Association for Computing Machinery: ***Barry Boehm.*** We plan to nominate other faculty members for this honor in the future.

The ACM also awards the highly-coveted ***Turing Award,*** often cited as "the Nobel Prize for Computer Science". This award was received by ***Leonard Adleman*** this past year, as described in more detail in Section III.C.1 below.

8. Other honorary memberships

Carl Kesselman has recently been elected a Fellow of the British Computer Society, and ***Gérard Medioni*** is a Fellow of the International Association for Pattern Recognition.

B. Quality and Diversity of Students and Placement of Graduates

1. UG Students

We have become increasingly selective in our freshman admissions criteria, partly as a result of a major university initiative led by President Sample to improve freshman quality. The School of Engineering provides minimum admission criteria to the Office of Admission for the University. For Fall 2002, these criteria included a minimum of 650 on the SAT Math, 4 years of a lab science in high school, and calculus either completed or in progress during the senior year of high school.

Each year, the Provost's Office assigns enrollment targets to each of the schools within the University, including the School of Engineering. Academic units are expected to meet these enrollment targets as related to numbers and academic quality. For the fall 2002, the School of Engineering had 3884 applications, of which 1,479 were admitted to the School of Engineering, with 367 students enrolling (about 10% of the applicants). Of those 367 enrolled freshmen, 57 designated themselves as CECS majors, with an average GPA was 3.92 and an average SAT of 1352. Appendix II (Section B 2a) shows the SAT and ACT composite scores for newly enrolled CECS Freshmen from 1997 to 2002. The improvement in quality is dramatic, as summarized

below, where CECS refers to students in the dual Computer Engineering/Computer Science program, while CSCI refers to students majoring in Computer Science alone:

Year	Average SAT composite score		Number of new Freshmen	
	CSCI	CECS	CSCI	CECS
1998	1286	1273	80	60
2002	1388	1352	54	57
2003	1364	1362	50	51

A more detailed breakdown of freshman admissions is shown in Appendix II (Sections 2a-h). It can be seen in this Table that the number of entering Freshmen decreased significantly in 2002. This is a national trend, related to the collapse of the "dot-com" economy. It is also noteworthy that the SATs of our entering freshmen are higher than the University average.

2. Diversity

Diversity in our undergraduate student body is described in Appendix II (Section 2b). The percentage of women is currently about 11%, having fallen slightly in recent years. This appears to be a national trend. While the number of Hispanic students has grown, the number of African American students has remained approximately constant. We are not satisfied with the diversity of the student body, but we are aware that the high tuition of a private university makes it difficult for some minority students to attend. We believe that recent improvements in the number of scholarships will make it easier to attract female students as well as students from under-represented communities in the future. We also plan to address retention of female students, by such methods as periodic department-sponsored meetings of women CS students at all levels to address issues related specifically to women in academia.

The Center for Engineering Diversity (CED) is an academic support program dedicated to promoting scholastic and personal excellence among under-represented (African American, Native American, and Hispanic) Engineering and Computer Science students. CED provides a variety of services and programs to foster a community of scholars and to prepare students to succeed as Engineering professionals or graduate students. The CED offers a number of services, including academic and career counseling, academic and professional development workshops, employment placement (internships and full-time positions), and an Industry Advisory Board. As part of the School of Engineering, Computer Science students participate in CED activities.

3. MS Students

The mean quantitative GRE score of our MS students for the current academic year was 1285, as compared to 1258 five years ago, as shown in Appendix II (Section B 3a). The MS student enrollment has grown significantly in size. This was achieved without lowering admission standards. Many students receive their MS degree on-line, via the School of Engineering Distance Education Network (DEN). DEN has progressed from a microwave satellite to an internet-based delivery method. It is acknowledged as one of the most advanced such programs in the country.

4. Ph.D. students

An excellent quality measure of our PhD program is the size of the applicant pool and the corresponding number of doctoral students admitted. The numbers are as follows:

	Nb. of applicants	**Nb. admitted**	**Nb. actually enrolling**
2000	546	351	38
2001	665	411	61
2002	859	75	33
2003	854	116	50

The data from 2000 and 2001 shows that we were admitting between 62% and 64% of applicants, but that fewer than 16% of those admitted actually enrolled. It became clear that many applicants were using USC as a "back-up school," assuming a high probability of admission. The admission standards were raised significantly for the 2002-03 academic year, with the effect that the number of applicants doubled, but we admitted fewer than 10%; almost 50% of those admitted actually came as shown in Appendix II (Section B 3a). This is a dramatic change, which is also clear in the 2003-4 admission data. The net effect is a significant increase in the quality of the doctoral students, and in the perception of our Ph.D. program as a selective one.

5. *Placement of our graduates*

For advisement on career choices, students have a number of options. First, students may meet with a professor or graduate student working in a related area. Second, students may seek advice from the university career center where qualified career counselors can work with the students on topics like resume writing and interview skills and offer diagnostic testing to help target appropriate career choices. Similarly, Engineering Career Services offers support specific to the needs of engineering students. Computer Science majors may take advantage of an array of support activities including Career expos, job fairs, announcements for internships and engineering co-ops, and related speaking engagements. Our students are successfully obtaining jobs in companies like Microsoft, Intel, Hewlett Packard, or Sun Microsystems, even in the present downturn.

Our Ph.D. students are now pursuing academic careers in increasing numbers. The majority of our Ph.D. students have gone to industry, but a growing percentage are now pursuing academic careers. This year, 10 out of 21 went into academia. A list of our graduates for the past 5 years is given in Appendix II (Section 3 h), with information on their current employment.

C. Quality and diversity of faculty, including recent achievements, research strengths, sponsored research support, patents and service

1. Faculty honors

Our faculty have garnered a number of honors in recent years, including the following:

2003	L. Adleman	Turing award from Assoc for Comp Machinery*
2003	M. Desbrun	ACM Siggraph New Significant Researcher Award
1999	M. Mataric	Early Career award in robotics from IEEE

*The Turing Award from the Association for Computing Machinery is the highest honor a computer scientist can receive. Prof. Len Adleman received this award for his work on Public Key Cryptography, jointly with Professors Shamir and Rivest at MIT. For a complete list, see Appendix I (Section 1a).

Other honors of note: Prof. Arbib and Prof. Bekey are University Professors. Prof. Adleman is a Distinguished Professor, Profs. Arbib, Matarić and Requicha together make up fully 25% of the

recipients from across the entire university who have been awarded a fellowship by the USC Center for Interdisciplinary Research.

2. Best paper awards

One of the clearest marks of peer recognition is the receipt of "Best Paper" awards from professional societies at major conferences. Many of our faculty and students have been so honored. Following is a sample of these awards:

2003: Monica Nicolescu & Maja Matarić – Hawaii International Conf. on Computer Science
2002: Mircea Nicolescu & Gérard Medioni – Piero Zamperoni Best Student Paper Award, International Conference on Pattern Recognition
2001-3: Tambe and Associates – Researchers at USC won the "Best Paper Award" and "Best Innovative Systems Award" at the major Agents conference. The complete list is provided in Appendix I, (Section 3).

3. Faculty diversity

We are not satisfied with the diversity of our current faculty, which is Caucasian and Asian American, Appendix II (Section A 2). We have neither African Americans, nor members of any other underrepresented minority groups on the CS faculty. Clearly, this is a complex social problem, since the available pool of candidates in these groups is very small. To help address this problem, in the past we have participated in joint programs with Tennessee State University (a school with a high proportion of African-Americans), California State University at Los Angeles (CalState LA), CalState Long Beach, and LATrade Tech College, all three of which have large Hispanic populations.

We have a number of women on the faculty, compared to most other Computer Science departments, and we continue vigorous recruiting to further increase this number. The current female faculty members are:

Maja Mataric	(Associate Professor)	Leana Golubchik	(Associate Professor)
Banu Őzden	(Gabilan Assistant Professor)	Ann Chervenak	(Res. Asst. Professor)
Eva Deelman	(Res. Asst. Professor)	Yolanda Gil	(Res. Assoc. Professor)
Mary Hall	(Res. Assoc. Professor)	Jihie Kim	(Res. Asst. Professor)
Kristina Lerman	(Res. Asst. Professor)	Claire Bono	(Lecturer)

4. Research strengths

The USC Computer Science Department is a research-oriented department, thus our major strength comes from our research programs. Most research is carried out in a number of Centers, Institutes and Laboratories, listed in Appendix II (Section B 4f). The number and diversity of the laboratories listed in this Table demonstrate the richness of the research programs in this department. Recent prominence has been achieved by the following programs:

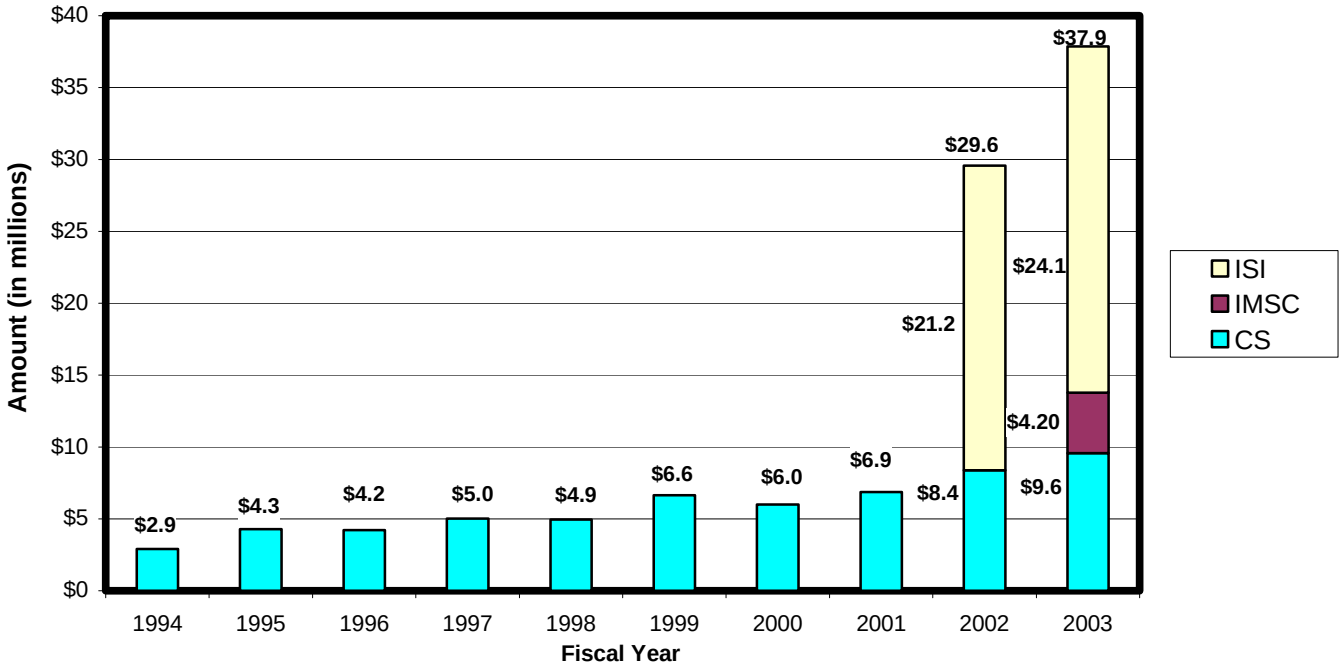
- The Grid Computing Program (directed by Dr. Carl Kesselman) is concerned with the integration of large numbers of computing resources and, by analogy with the electrical power grid, making various nodes on the grid available as the need arises.
- Development of miniature robotic helicopters (directed by Prof. Gaurav Sukhatme) capable of flying autonomously and in formation.
- The High Performance Computing Program at USC, with major support from the School of Engineering and the University's ISD, is leading USC to becoming one of the major centers of research in the area of parallel, high-speed processing. The HPCC center had the 8th most powerful academic supercomputer as of June 2003.
- The Natural Language Group is one of the strongest in the world.

- The Center for Robotics and Embedded Systems, CRES, (directed by Prof. Maja Matarić) is a new, highly interdisciplinary Organized Research Unit (ORU) within the School of Engineering. CRES focuses on the science and technology of effective, robust and scalable robotic systems, including such areas as biomedical engineering, networks, biomimetic robotics, controls, nanotechnology, and others.
- Research in agents and multiagent systems at USC has achieved significant national and international recognition. For several years, we have had the highest number of accepted papers when compared to any other university at the main international Agents conference. USC researchers founded the "Americas School on Agents and Multiagent Systems" in 2002.
- The Institute for Robotics and Intelligent Systems (IRIS) was established to coordinate research in related topics in the School of Engineering. The current areas of research include computer vision, multi-media systems, 3D modeling and multi-agent systems. IRIS receives funding support from a number of government agencies and industry sponsors.

5. Sponsored research support

Sponsored research in the CS Department now exceeds $13 million annually in addition to ISI's contribution of $24 million, representing an average of almost $500,000 per tenure track faculty member. This level of support indicates the research strength of the department. Figure 1 below shows the total research expenditures in the Department during the past 10 years. This is also shown in Appendix II (Section 4c).

Figure 1: Research Expenditure History



6. Patents

The following is a sample list of patents issued to CS faculty:

- Adleman, Leonard, September 20, 1983 *Cryptographic Communication System & Method*
- Medioni, Gérard, July 25, 1995 *Video Processing System for Modifying a Zone in Successive Images*
- Ozden, Banu, December April 29, 2003 Early *Fair Drop Buffer Management Method*

The complete list is given in Appendix I, (Section 4).

7. Service

Computer Science faculty are very active in professional societies, including service as Chairs of Program Committees for major conferences and holding elected positions in the societies. In addition, a number of our faculty are active on various governmental boards and committees. While an exhaustive list is not currently available, the following are illustrative examples:

Professional society service

George Bekey	President, IEEE Robotics and Automation Society (1996-98); National Administrative Committee, 2002-05
Eduard Hovy	President, Association for Computational Linguistics President, International Assoc. for Machine Translation
Yolanda Gil, Craig Knoblock and Maja Matarić	Executive Council, American Assoc. for Artificial Intelligence
Jeff Rickel	Executive Committee, International AI in Education Society:

Governmental agency service

George Bekey	NSF CISE Committee of Visitors (2003)
Joseph Bannister	NSF CISE Advisory Committee
Robert Neches	Program director at DARPA (1994-1997)
Paul Rosenbloom	Member of DARPA Information Science and Technology (ISAT) Advisory Group

8. Ties to Commercial Ventures

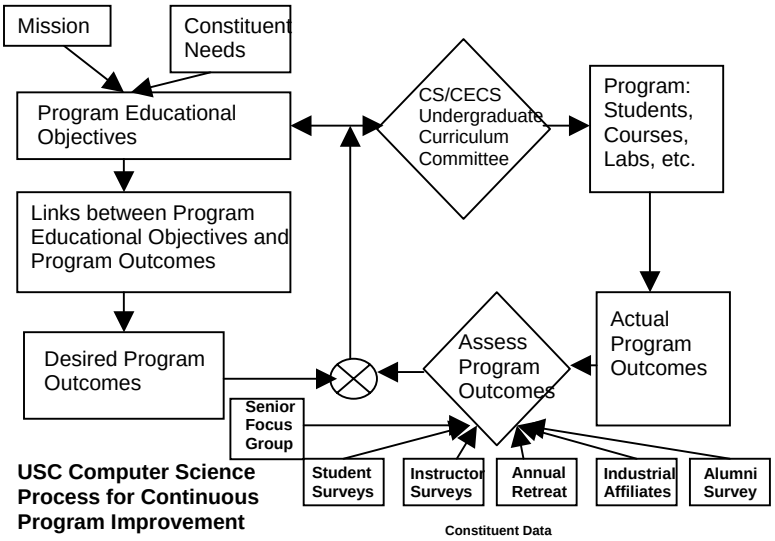
Many of our faculty members are involved in technology transfer, serving as consultants on advisory boards. Language Weaver at http://www.languageweaver.com was founded by CS faculty. A full list of such activities is given in Appendix I (Section 5).

D. Quality of Teaching and Evaluation of Educational Programs

Student evaluations of faculty and courses are an essential part of the USC experience. The Computer Science Department takes these evaluations very seriously and uses them in the annual evaluation of faculty in connection with salary reviews, and in tenure considerations. While in the past teaching was considered to be at most 25% of the total evaluation score, we currently base our faculty evaluations on research (50%), teaching (30%) and service (20%). The rest of the School of Engineering evaluates using a proportion of (40%, 40%, 20%).

At the undergraduate level, the department has put in place a comprehensive process for evaluating and improving the quality of instruction. The process for continuous improvement of the program, as developed by the CS/CECS Curriculum Committee, is shown schematically in Figure 2 below. The driver for this process is the program educational objectives, as determined by the mission of the School and constituent needs. The desired program outcomes are determined by the links between educational objectives and the program outcomes. Through the assessment procedures, actual program outcomes are compared with desired program outcomes. This comparison provides data to indicate the improvements that are needed. The faculty can utilize this data to carry out the necessary actions. This feedback loop periodically produces the data to facilitate the re-evaluation of educational objectives and program outcomes.

Figure 2: Schematic of process by which assessment results are applied to improve the program.



E. Comparative Strengths, Distinctiveness, and Weaknesses

1. Strengths

The major strengths of the department are the:

- Quality of research produced by our tenure track faculty
- Breadth and quality of our research faculty at ISI, ICT and IMSC
- Special role of the research faculty in the life of our department
- Emphasis on interdisciplinary research and teaching
- Leadership of our faculty in directing several of USC's most highly recognized research institutes and laboratories listed in Appendix II (Section B 4f).

    - ❖ Prof. Herb Schorr directs the Information Sciences Institute (ISI).
    - ❖ Prof. William Swartout is Associate Director of the Institute for Creative Technology (ICT).
    - ❖ Prof. Ulrich Neumann directs the School of Engineering's Integrated Media Systems Center (IMSC), an NSF Engineering Research Center where many CS faculty members participate. Our Software Engineering Center (directed by Prof. Barry Boehm) is nationally recognized, as are our centers and laboratories in such areas as robotics, brain theory, computer vision, and nanotechnology.

- Honors and recognition received by a substantial number of our faculty, both nationally and internationally. Most participate actively in professional societies, such as IEEE and AAAI.
- Close connections and excellent collaborative relationship with the Electrical Engineering. Systems Department. Of particular note is the jointly administered undergraduate program leading to a BS in Computer Science-Computer Engineering.

2. Distinctiveness

The distinctive features of our department discussed previously are summarized below. They include:

- Emphasis on emerging and growth areas in the field, as manifested in the recent reorganization of the faculty into four non-traditional groups: Computation, Interaction, Autonomy, and Immersion.

- A substantial number of Research Faculty members, which contributes to the overall department and makes us one of the largest department in the US.
- An unusually strong interdisciplinary focus.
- Three major institutes, the Information Sciences Institute, the Institute for Creative Technology and the Integrated Media Systems Center, add distinctiveness to our program and provide considerable research output. Both IMSC and ISI are directed by members of our faculty.
- CRES, the Center for Robotics and Embedded Systems, is the Department's newest Organized Research Unit. We have the second largest robotics research program in the country, now unified under this interdisciplinary umbrella with faculty from many fields.
- A large pool of qualified outside instructors. This may be viewed both as a strength (because of its quality) but also as a weakness, since it indicates an inadequate number of full-time faculty in certain areas.

3. Weaknesses

Our weaknesses include the following:

- A national perception of our department (and hence our ratings) that does not reflect our current strengths. In particular, the perception that our Research Institutes (especially ISI) are disconnected from the Department diminishes the appearance of our Department as an integrated and diverse research entity.
- Communication channels, in particular our website, that need great improvement.
- An undergraduate program with a retention problem (fewer than 66% of entering freshmen graduate in Computer Science). This is a nationwide problem with complex roots, but we believe much can be done to improve the rate.
- Challenges in the MS program due to high enrollment. A large MS program creates the following issues:
    - ❖ Many students wish to attend the same class, leading to larger sessions, or multiple sessions for a given class
    - ❖ Students need to be advised that they are not competing for access to classes
    - ❖ Advising a large student population requires an efficient process.
- Research involvement by undergraduate students that could be increased.
- Diversity in the faculty, including further increase in the number of female professors (currently only we have 3 tenure track plus several research faculty and lecturers).
- Ratio of international to domestic graduate students (over 75%) is too high.
- Senior faculty should receive greater recognition for outstanding research.
- Reliance on full-time lecturers and part-time lecturers needs addressing.
- Larger support staff to maintain our computational infrastructure and serve the needs of faculty and students is needed.
- Physical distance between the main campus and Marina del Rey creates challenges, reducing the impact of off-campus centers as a key asset.
- Space for labs, faculty and graduate students is inadequate, both in quantity and quality. The total CS Department space available on campus is 27,383 sq. ft., roughly half of it in the Salvatori Building (14,837 sq.ft.). The rest is scattered across 6 other buildings, sometimes as very small and isolated outposts (318 sq. ft. in BHE, 254 sq. ft. in KAP and 774 sq. ft. in PCE). The space for graduate student offices is 5,089 sq. ft., clearly insufficient for over 200 Ph.D. students. We do not have dedicated Teaching Assistant Offices. The front office is on the third floor of Salvatori, with no waiting room space for visitors and students, and is served by a small elevator. A full description of the space currently allocated to the CS Department is given in Appendix II (Section 4g).

IV. COMPREHENSIVE PLAN FOR THE FUTURE

A. Integrated plan for improvement over the upcoming five-year period to increase the program's stature and increase eminence.

We propose to address all the areas listed above as "weaknesses" over the next few years. We believe that the CS Department should be ranked in the top 10 nationally, a belief supported by visitors from major research universities. Below we list our "weaknesses" and indicate how we propose to address them.

- "The national perception of our department (and hence our ratings) do not reflect our current strengths. In particular, the failure to perceive our Research Institutes (especially ISI) as integrated with the CS Department, reduces general perception of our true strength."
  This is a large, unresolved problem. We will develop a highly pro-active plan to publicize our department with a new Website, brochures, and targeted visits to key campuses in order to inform key decision makers of the changes and improvements we have made in recent years. This public relations effort will emphasize our close working relationships with ISI and other Institutes.
- "The undergraduate program has a retention problem."
  Retention is a complex problem, including misconceptions about the subject and its overall level of difficulty. We are addressing these issues both at the school and departmental levels. At the school level, we are introducing freshman academies to provide a broad and comprehensive view of Engineering; we are cooperating with the Mathematics department to ensure that courses are being taught with an emphasis on topics relevant to CS; we are introducing a Biology course to complement the Physics and Chemistry science requirements. At the department level, in connection with an ABET review, we are reviewing the entire undergraduate curriculum and adding courses. We have developed a "Research Fair" to match students with faculty. Through this event the chair is actively working with faculty members to develop research opportunities for undergraduates. The SoE provides financial support for undergraduates involved in research. Funding for graduate students who supervise undergraduates is being sought. Also, we are developing a CS Minor for students outside of the School of Engineering (but certain Minor courses, such as a proposed "Computers and Society" that will be open to our students as an elective). We are finalizing a new Minor in Computer Game Development, with one track for School of Engineering students and another for non-SoE students.
- **"**The MS program faces challenges due to high enrollment."
  In order to offer a quality program to the large population of MS students (currently more than 700), we need to create an efficient and organized infrastructure. We have already migrated the admissions process to a central office administered by the School of Engineering. We have made the process of registration much less cumbersome and less time consuming by offering online D clearances. We are planning to design and display sample semester-based study profiles to answer common questions. Also, when more space becomes available, we wish to move into better quarters to better serve the students. Our pledge is to avoid restricting access to any class for capacity reasons, but to offer additional sections instead. We intend to limit class size to approximately 70 students. We are also offering new "Specialty MS Programs" in areas such as Computer Security. The MS Thesis option has been revived and is being encouraged with a "Chair's Excellence Award" for MS students involved in research. We are actively investigating a new 4+1 option for a combined BS and MS degree, as well as a joint program with Physics, leading to a PhD in Physics and a MS in CS.
- "There is a need to improve diversity in the faculty and further increase the number of female professors (currently 3 tenure track plus several research faculty and lecturers)."

This issue is being mandated by the Provost and is already being addressed by vigorous recruiting, taking into account available funds for this purpose. We are currently in active discussions with at least two female faculty candidates.

- **"**The ratio of international to domestic graduate students (over 75%) is too high.**"**
  For Ph.D. students, the high reputation of our program, together with the current trend of our graduates pursuing academic careers, should help rectify the situation. Furthermore, the availability of prestige fellowships, such as the Provost Fellowship program, is already making a strong impact. For MS students, we intend to continue our strong growth in the internet delivery of our programs, offered through the Distance Education Network. This is achieved by an active marketing campaign targeting US companies. Finally, some of our top undergraduate students are now considering USC for either the MS or Ph.D. degrees.
- "Senior faculty should receive better recognition for their outstanding research."
  This issue is currently being discussed with the Dean. The creation of endowed chairs for outstanding faculty should be pursued.
- "Our reliance on full-time lecturers and part-time lecturers needs to be addressed."
  We consider full-time lecturers a significant asset of the department. These faculty members focus on teaching only, with a load of 6 courses per year. They deliver on the promise of high quality education for the benefit of our students. Most part-time lecturers have a full-time job outside USC, and we face uncertainties and staffing challenges every semester. We propose to hire more full-time teaching faculty to remedy this situation. We also propose to encourage more of our Research faculty members to teach within the 1 course per year limitation of their status.
- "The department would benefit from a larger support staff to maintain our computational infrastructure and serve the needs of faculty and students."
  As we expand and obtain high quality infrastructure, we cannot rely on the University's Information Services Division (ISD) to provide quality service. Our current staff of 2 IT professionals can barely keep-up with our current needs. Furthermore, using the CS website as a primary communication portal requires full time attention.
- "The off-campus centers add considerable strength, but the physical distance between the main campus and Marina del Rey creates a challenge."
  We need to establish an easier, remote, communication link, such as a teleconference facility, so that faculty at ISI and ICT can participate in more meetings. Students who do not have a car currently waste considerable amounts of time commuting with the public transportation system. The establishment of a regular and frequent shuttle service between the main campus and ISI/ICT would go a long way towards reducing this problem.
- "The space for labs, faculty and graduate students is inadequate both in quantity and quality."
  Both of the above critical issues require additional resources and they are considered below in Section IV.F.1 *below. In the short term, high quality space in the new Tutor Hall and additional space in Powell Hall will help, but we need to start planning now for a new CS building, as did most of the other CS departments in the country* Appendix II (Section 4h - 4i).

B. Core objectives and priorities; sequence of actions of accomplishment

Our highest priority is to "stay the course": continue to attract outstanding students, recruit the best possible new faculty, perform first class teaching and research (and thus bring substantial research funding to the department). If we continue on this course, implement the improvements discussed above, and obtain adequate resources from the University, our goal of national distinction and placement among the top 10 Computer Science Departments should follow.

The next clear priorities are the tasks described in Section IV.A, above. As indicated, all except the planning for a new building are in process. Some issues, like increased diversity in both

students and faculty, are a continuing process to which we are committed. Issues involving additional resources are described in Section IV.F, below.

C. Directions for Computer Science in the next 5 years and our department's response

The field of Computer Science is changing and we plan not only to embrace new advancements, but also to help lead from the forefront. At its core, Computer Science is about computation (C)--architecture, languages, compilers, algorithms, and theory of computation. This was the field's initial focus. However, Computer Science is also fundamentally about the relationship of computation with both humans (H) and the world (W); that is, the environment in which computation occurs. So Computer Science entered a second, binary phase, with a focus on the interactions between computers and computations (C and C) [e.g., networks and distributed computing]; , human-computer interaction, or HCI, (C and H), and, increasingly, the relation of computing to the physical world (C and W) [e.g., embedded computing and robotics].

The third phase, which has just recently begun, concerns the mutual interactions among all three (C, H, and W) [e.g., intelligent robotics, virtual humans, ubiquitous computing, virtual and augmented reality, smart spaces, and lifelogs]. Independently, other trends include continued scaling to the very small (e.g., quantum computing and nanorobotics) and the very large (e.g., models of natural phenomena integrated across an increasing number of length scales, with a wider diversity of phenomena, and covering greater areas at higher fidelity; such as the coupling of ocean and atmospheric models, multiscale models of aquatic microbial systems or hybrid multiscale models of the interactions among billions of atoms and models of the interactions among millions of simulated people and vehicles distributed across the Pacific Rim).

Our active leadership in these trends in the field has been formalized by the new organization of our faculty and research areas, and by trying to understand where each of these areas should proceed in the future. Our organizational structure is directly related to the trends in the third phase of Computer Science.
Computation: concerns C above, i.e., computing in isolation, which focuses on computing at the extremes of the very small with special attention to neural, molecular and quantum computing, and the very large scale;
Interaction: concerns C-C, phenomena connected with interactions across more than one computer, which focuses on increasing scale and diversity while providing simpler, safer and more uniform ways of using computers;
Autonomy: concerns C-W, i.e., computers interacting directly with environments, which focuses on safe and effective operation with little or no human intervention; and
Immersion: concerns C-H, i.e., the relationship between people and computation, which focuses on natural embedding of people in computational environments through interaction modalities at least as natural and effective as those used between people.
Computer Science as a whole involves C-H-W; which is also included in the four new areas and their interactions and overlap. It is these three-way interactions that will provide some of the most exciting topics for Computer Science over the next 5 to 10 years.

It is abundantly clear that, as the field changes, our department must be agile and adaptable. While our current structure appears to be responsive to current trends, we must be alert to changes and be willing to adapt rapidly. We will form a Long Range Planning Committee whose goal is to monitor the changes in the field and present the faculty with suggested responses. We cannot sit back and wait, or the field will pass us by.

D. Opportunities for extension of existing strengths, and major obstacles

1. Extension of existing strengths

Our major strengths are presented above in Section III.E.1. We do not plan to rest on our laurels in any of these areas. The department is committed to increasing the research strength and productivity of our faculty, finding new ways to increase cooperation with IMSC, ISI and ICT, and exploring new ways of connecting our work with that of other schools and departments. All these areas are "works in progress," and we plan to continue to cultivate and strengthen them.

2. Major obstacles

Two major issues stand in the way of achieving the level of recognition we seek. Our competition is not standing still, so we must improve more rapidly than them or risk slipping behind.

- ***Managed Growth***

A number of universities have announced very large allocations of new faculty slots to computer science. For example, it is our understanding that UCLA plans to increase its tenure track faculty from 25 to at least 40 or 45. We, too, expect to grow by adding a dozen or so faculty within the next 5 years. Our hiring plan will emphasize faculty who can help us build on our strength, and fit along the research foci we have formulated. We will continue to rely on highly qualified full-time instructors to teach some of our classes, instead of hiring faculty to fill teaching gaps.

- ***Facilities***

Within the past 5 years, nearly every major Computer Science department has announced a new building program, and increases in resources for laboratories, faculty and staff. This includes Stanford, MIT, Cornell, Washington, and the University of Michigan. We provide in Appendix II (Section 4h – 4i) a list of new buildings completed in the recent past, or about to be completed, at other institutions. It is absolutely critical to our success that we start planning for a new building and associated resources now, as it will take a few years to the process. Obtaining large gifts for new "bricks and mortar" may be difficult in the current climate. We hope that part of the School of Engineering $300M fundraising campaign recently announced by Dean Nikias will assign the relevant priority to this goal.

E. Possible improvements from reallocation of existing resources

Our needs for additional facilities cannot be met by reallocation of existing resources, except in the short term, and will require new and significant funds, either from outside or within the University, as discussed in Section IV.F.2 below. For the near future, upon completion of the new Tutor Hall, we anticipate receiving a major space allocation in Powell Hall of Engineering. While this space will be invaluable for our immediate needs, this building does not have the infrastructure needed to support high-quality research and teaching in Computer Science and does not solve our long-term needs. Several of our faculty members are likely to obtain space in the new Tutor Hall building. This is definitely a high quality space, and a welcome improvement. However, it makes the department even more scattered across more buildings.

We have made a number of changes to make our operation more productive:

- MS admission is now administered centrally from the Dean's office. This allows our Graduate Office to spend more time advising our MS students.
- We have made and continue to make a number of processes online, such as the D Clearance system, Ph.D. Application and Junior Faculty Application.
- As we move into Powell Hall, we intend to set up the entire CS office on the ground floor, in a space that is larger and more appropriate than the current space, in order to better serve our students.

F. Improvements requiring additional resources:

1. Space

Space is a critical element for the success of any program. The current situation with faculty and research labs scattered across more than half a dozen buildings is not satisfactory. The department is woefully short of space for new faculty, graduate students and laboratories:

- Recruiting for new faculty will be very difficult since we have no spare office space, no space for laboratories, and no office space for teaching and research assistants.
- There is a need for lounges and libraries to provide informal spaces for faculty and students to meet and exchange ideas.
- As the reputations of the School of Engineering and the department grow, we receive increasing offers of equipment donations from industry. We are finding it difficult to accept these gifts due to a shortage of space.
- There is a need for a sufficient number of fully electronic classrooms, lecture halls, and laboratories to support computer science instruction.

Upon completion of the Tutor Engineering Building we expect to expand the department into Powell Hall of Engineering, which will provide a partial (much appreciated) solution to our problem**.** We firmly believe that we need a dedicated building of approximately 100,000 square feet of usable space. The building should be able to accommodate the needs listed above, as well as provide space for visitors and sufficient space to administratively manage the three academic programs, the BS, MS, and Ph.D. in Computer Science.

If this space is provided, it will be more than just a solution to our current space limitation. It will serve as a valuable catalyst to enhancing our research and teaching obligations. By way of comparison, 9 out of the top 10 Computer Science departments have obtained new buildings in the past few years. Further details of comparable buildings are given in Appendix II (Section 4h-4i). Obtaining funding and starting construction of a new building should be the major priority during the next five years.

2. People

In addition to the need for space, we believe that in order to achieve major national distinction and become competitive with other major Computer Science departments, we need:

a) Faculty

Continued recruitment of outstanding faculty. We anticipate growing by a dozen or so in the next 5 years.

More endowed chairs for full professors, to enable the recruitment of a small number of "star" faculty, and to recognize existing successful faculty.

Additional chairs for Assistant Professors, as a way of recognizing leaders among the Junior Faculty. The Gabilan Chair is an example. Such chairs also make it easier to recruit the best available faculty candidates.

a) Lecturers

More recruitment of top quality fulltime lecturers, instead of relying on part-time lecturers, whose primary responsibility rests with their full time job.

b) Technical Staff

As we expand and obtain high quality infrastructure, we cannot expect the University's Information Services Division (ISD) to provide quality service. Our current staff of 2 IT professionals can barely keep-up with our current needs. Furthermore, using the CS website as a primary communication portal requires full time attention.

Support for all these requests can be derived from an increased endowment to the School of Engineering. The Dean is actively pursuing this goal, as part of the $300M fundraising campaign he unveiled in November 2003.

We believe that the administration, in particular the Dean of the School of Engineering, shares our vision and strongly supports our plans, just as we support the Dean's ambitious plan to bring the School of Engineering to the elite level. A top 10 Computer Science Department is a cornerstone of a School of Engineering ranked 8th and rising, and fulfills the "Building on Excellence" mission of the University as expressed by our president, Dr. Steven B. Sample.