University of California, Santa Cruz

Baskin School of Engineering

Long Range Plan

2001-2011

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BASKIN SCHOOL OF ENGINEERING
MISSION STATEMENT

The mission of the Jack Baskin School of Engineering at the University of California, Santa Cruz is to develop and sustain first-rate education and research programs that integrate the fundamental principles and sound practice of science and engineering. The School strives to serve the needs of the greater Silicon Valley region and the State of California by creating and disseminating knowledge through research and teaching, and by offering curricula that nurtures creative thinking and prepares our students for productive careers at industrial and academic settings in rapidly evolving areas of science and engineering.

Table 1 Engineering Faculty at a Glance in 2011

Department or Program	Ladder Rank Faculty
Applied Mathematics & Statistics	**17**
Applied Mathematics - BS, MS, PhD	
Statistics/Envirometrics - BS, MS, PhD	
Biomolecular Engineering	**14**
Bioinformatics - BS, MS, PhD	
Biomolecular Engineering - BS, MS, PhD	
Computer Engineering	**27**
Computer Engineering - BS, MS, PhD	
Network Engineering - MS	
Computer Science	**37**
Computer Science - BA, BS, MS, PhD	
Software Engineering - MS	
Web and Internet Engineering - MAS	
Electrical Engineering	**21**
Electrical Engineering - BS, MS, PhD	
Environmental Engineering - BS, MS, PhD	
Multidisciplinary Engineering Programs	**10**
Information Systems Management - BS	
Information Systems and Technology Management - MS, PhD	
Total Ladder Rank Faculty	**126**

Table 2 Baskin School of Engineering at a Glance

	2000-01	2005-06	2010-11
Faculty FTE			
Ladder Faculty	59	103	126
Lecturers/Adjuncts	6	14	3
Research Scientists	2	18	39
Enrollment - FTE			
Undergradute	758	1,414	1,535
Graduate	131	462	696
Total FTE	889	1,876	2,231
Majors - Headcount			
Undergraduate	952	1,735	1,990
Graduate	137	510	773
Total Majors	1,089	2,245	2,763
Workload Ratio	20.0	16.9	17.7
Total Awards (in millions)	$5.0	$24.5	$36.1
Total Expenditures (in millions)	$3.7	$24.2	$36.8
Indirect Cost Recovery (in millions)	$0.74	$4.36	$8.09
GSRs (quarters)	130	722	970
Teaching Assts (quarters)	101	192	208
Teaching Assistant FTE	16.8	32.1	34.9
Campus Fellowships (quarters)	16	80	120
Student/TA Ratio	45.0	44.0	44.0
Staff			
Technical	12	20	22
Administrative	27	55	64

EXECUTIVE SUMMARY

LONG-RANGE PLAN: EXECUTIVE SUMMARY AND HIGHLIGHTS BASKIN SCHOOL OF ENGINEERING, UC SANTA CRUZ

The mission of the Jack Baskin School of Engineering at the University of California, Santa Cruz is to develop and sustain first-rate education and research programs that integrate the fundamental principles and sound practice of science and engineering. The School strives to serve the needs of the greater Silicon Valley region and the State of California by creating and disseminating knowledge through research and teaching, and by offering curricula that nurtures creative thinking and prepares our students for productive careers at industrial and academic settings in rapidly evolving areas of science and engineering. In the next decade, the School of Engineering will be a distinctive knowledge creator and educator in its chosen fields. We will provide an excellent education for all students, regardless of major, so the campus's graduates become contributing citizens in a high technology society.

Now in its fourth year, the School of Engineering has reached many significant milestones. The School's reputation and visibility have risen nationwide. The student enrollment has doubled and the School now has 49 faculty members, almost doubling the faculty size in 1997. Over the next 10 years, the School will continually raise its reputation and impact while more than doubling its enrollment. By 2011, the School plans to educate approximately 15% of the campus's students, a total of 2,231 FTE students comprising of 1,535 undergraduate majors and 696 graduate students with 126 faculty members.

In November 2001, in its Monthly Labor Review, the Bureau of Labor Statistics (BLS) projected that by 2010, there will be 168 million jobs in the United States, an increase of 15% over the year 2000. However, the School of Engineering is preparing students to enter a more robust job market than the average. According to the survey, "Computer and mathematical occupations are projected to add the most jobs, and grow the fastest among the eight professional and related occupations subgroups. The demand for computer-related occupations will continue to increase as a result of the rapid advances in computer technology and continuing demand for new computer applications." In fact, of the 30 fastest growing occupations of all types between 2000 and 2010, BLS lists eight occupations for which UCSC graduates are educated (including the planned Information Systems and Technology Management program). Of the eight occupations, the single highest rate of growth for a particular occupation is Computer Software Applications Engineer which is forecasted to grow by 100% and the lowest is 40% for Computer and Information Research Scientist. All jobs are in the highest quartile of salaries.

Even with 126 ladder rank faculty members, the Baskin School of Engineering will remain small compared to our counterparts at other UC campuses. However, we have a unique opportunity due to our regional advantages to develop a truly distinctive School of Engineering that is committed to excellence and uniquely tailored to promote technological innovation to meet the grand challenges of our nation.

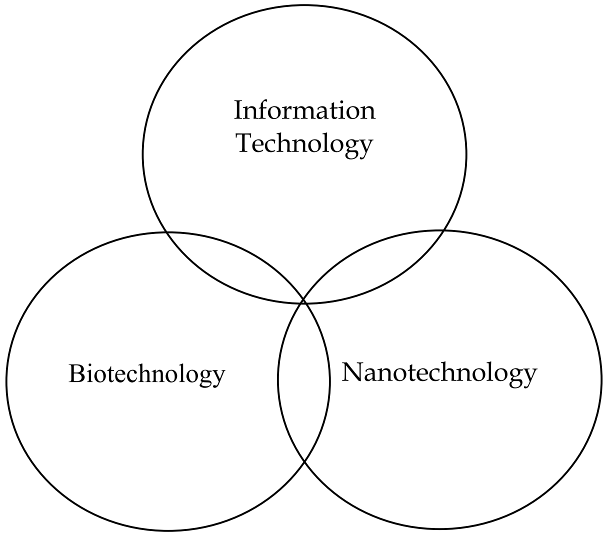
Our goal is to develop a school that stands out in every aspect of teaching, research, and service to the profession. We shall provide ***Impact*** of the highest ***Quality (IQ)*** with **FIRST-rate** faculty, who are ***F**orward-looking* and frontiering, ***Innovative*** and impacting through excellence in ***R**esearch,* ***S**ervice* and ***T**eaching*.

To achieve this goal, the School must recruit excellent and visionary faculty and staff, in the face of the enormous challenges in offering competitive salaries. We plan to pursue strategic "target of excellence" (TOE) hires and recruit eminent scholars who are of the caliber of national academy members. Senior leadership is a critical requirement for starting new programs, and we will strive to attract renowned candidates to ensure our success in our target areas of excellence (see page 5). In the past year, we were successful in recruiting a senior leader in computer security, Professor Martin Abadi, under the TOE program. TOE hires are critical for establishing key strategic areas such as nanotechnology, biomolecular engineering, and information systems and technology management.

The School of Engineering is committed to building interdisciplinary programs across divisional boundaries, linking to other divisions and colleges at UCSC and UCSC Extension. We envision campus-wide benefits as the joint research collaborations grow. In particular, we plan to develop and offer joint degree programs at both the undergraduate and graduate levels with departments in the Natural Sciences, Social Sciences, Humanities, and Arts divisions. Examples include Environmental Engineering (with the Institute for Innovation in Environmental Research in collaboration with Natural Sciences, Humanities, and Social Sciences), Biomolecular Engineering (with MCD Biology, Chemistry, and Biochemistry), Information Systems and Technology Management (with Economics and Psychology), and Applied Mathematics and Statistics (with Mathematics, Economics, Earth and Ocean Sciences). Also, active collaboration already exists with faculty members in the Arts Division on music synthesis, new media and digital arts and animation. Research collaborations will be further strengthened through the NSF S&T Center for Adaptive Optics, Center for Biomolecular Science and Engineering (CBSE), and new institutes such as California Institutes for Science and Innovation's (California ISI) Bioengineering, Biotechnology and Quantitative Biomedical Research Institute (QB3) and the Center for IT Research in the Interest of Society (CITRIS) as well as STEPS Institute for Innovation in Environmental Research. Finally, as we develop international programs in the information technology and biotechnology areas, such as the Pacific Rim Roundtable and its related programs and courses, UCSC Extension will have opportunities to participate by offering short courses, such as English, sustainable technology and product design, and courses directed toward international venture capitalists.

The Baskin School of Engineering will build and promote excellence in three major areas: information technology (IT), biotechnology (BT), and nanotechnology (NT). These three areas are closely linked and synergistic in nature, and activities in each area are supported and enhanced by contributions from the others. Applied mathematics and statistics research makes critical contributions to all three of these areas and it will also enrich other campus programs, in particular those in Social Sciences and Natural Sciences Divisions.

AREAS OF EXCELLENCE



Information Technology

Information technology has been the focus of the School's founding programs—Computer Science and Computer Engineering—along with information systems and technology management (ISTM) and the developing program in software engineering. As our most evolved area, the School promotes several areas of excellence in its information technology programs. Our participation in CITRIS opens exciting opportunities in IT research and education programs in close collaboration with UC Berkeley, UC Davis and UC Merced, and California's IT industry.

Biotechnology

Recent worldwide developments in biotechnology have accelerated our plans for the Department of Biomolecular Engineering. Research in biotechnology has rapidly advanced, introducing the need for more scientists and engineers. Under the leadership of CS Professor David Haussler, the School has established an international reputation for its bioinformatics research. This recognition has resulted in Prof. Haussler's Howard Hughes Medical Institute Investigator award, the School's participation in QB3—one of the Governor's first California Institutes for Science and Innovation—and extensive media coverage. The School plans to establish the Department of Biomolecular Engineering that will offer several interdisciplinary academic programs in bioinformatics, molecular level bioengineering, microarrays and microfluidics. Currently, bioinformatics is our strongest area of emerging research excellence. Starting in Fall 2001, we offer a BS degree program in bioinformatics and subsequently will offer MS and PhD programs.

Nanotechnology

Nanotechnology is an enabling technology for both information technology and biotechnology. Sheer size minimization for portability and energy savings requires nanotechnology. Further, nanoscale devices and process technology are key to the advancement of intelligent biosensors and biomolecular engineering. The continuing trends in device feature size scaling (Moore's law) enable nanoelectromechanical systems (NEMS) that will further enhance the advantages of the current microelectromechanical systems (MEMS). This is an area that our School is currently lacking and yet cannot be overlooked in engineering disciplines. The Electrical Engineering Department already has a strong research program that uses a molecular beam epitaxy (MBE) technology. However, strategic hiring of key senior faculty members will provide the required skill sets to improve our position in this very important area. In the coming year, the EE Department will search for a senior leader in nanotechnology. Concurrently, the Physics Department plans to hire a lead faculty member in this field, which will accelerate UCSC's program development in this area. The School of Engineering and Natural Sciences Division have been approached by National Laboratories for future research collaboration.

In order to establish the three Areas of Excellence, we plan to build interdepartmental collaborations with the focus on eleven sub-areas shown below.

Target Areas of Excellence by Department

K = Key departments *Proposed

	AMS	BE*	CE	CS	EE	ME*
Bayesian statistics and dynamic mathematical modeling	**K**	X	X	X	X	
Bioinformatics and biomolecular engineering	X	**K**	X	X		
Communications, signal and image processing	X		**K**	X	**K**	
Database & Storage, networks, and computer security			**K**	**K**	X	
Embedded systems design			**K**	**K**	X	
ISTM Management	X		X	**K**	X	**K**
Machine learning, human-computer interface, scientific visualization		X	X	**K**	X	
Optoelectronics and optical systems			X		**K**	X
Remote sensing and environmental technology	**K**		X	X	**K**	X
Software engineering			X	**K**		
VLSI, nanosystems, MEMS/NEMS		X	**K**		**K**	X

AMS – Applied Mathematics and Statistics
BE – Biomolecular Engineering
CE – Computer Engineering
CS – Computer Science
EE – Electrical Engineering
ME – Multidisciplinary Engineering Programs (not dept.)

ACADEMIC PROGRAMS

Since the School's formation in 1997, we have introduced three new undergraduate programs: electrical engineering, information systems management, and bioinformatics. Engineering majors have increased by more than twofold since 1996-97 with over 1100 majors this year. The campus's commitment to the School has enabled our rapid growth in both program quality and size, and we ask Chancellor Greenwood, Campus Provost Simpson and the Academic Senate to continue their commitment to the School's development. This commitment is critical to our success in establishing a prominent and distinctive School of Engineering. Through active outreach, the School will attract students with strong academic preparation from diverse backgrounds, and at the same time manage the enrollment growth such that faculty teaching load can be reasonably distributed across all departments in the School of Engineering. The curriculum committee of the School of Engineering has proposed a new plan to promote well-balanced enrollments across all engineering disciplines such that each department can achieve its prominence in both teaching innovation and leading edge research.

In this decade the School will develop multidisciplinary engineering research and instructional programs, which include environmental engineering, materials engineering, and information systems and technology management (ISTM). The environmental engineering program will provide synergistic alliances with environmental science and policy programs in the Natural Sciences, Humanities, and Social Sciences divisions as manifested in the overarching STEPS program goals. The ISTM management graduate program will promote strong interdisciplinary interactions with the Economics and Psychology departments in the Social Sciences Division. Continued collaboration with the Arts Division will promote interdisciplinary education and research in new media and digital arts. Our faculty's interactions with Prof. Dom Massaro in the Psychology Department on human-computer interface and with Prof. Jorge Hankamer in Language Engineering (CS 168A/B, Linguistics 160A/B) will further enhance excellent interdisciplinary programs.

With the Natural Sciences Division, we plan to establish a Center for Innovative Materials, Sensors and Systems (CIMSS) that address both biomaterials and novel functional materials critical for biotechnology, information technology and nanotechnology. We plan to build multidisciplinary academic research programs in materials engineering and environmental engineering following the example of biomolecular engineering program through the Center for Biomolecular Science and Engineering (CBSE).

The School also plans to offer new 3/2 programs enabling students to complete two baccalaureate degrees in both engineering and another discipline, while remaining on the UCSC campus. The current 3/2 programs will continue so that students interested in Civil Engineering or Mechanical Engineering, or other engineering program not offered at UCSC, can pursue their engineering degree at UC Berkeley. The combined BS/MS program in Computer Engineering has proven to be effective and popular among USCS students and its extension to other disciplines, such as Electrical Engineering and Biomolecular Engineering, would serve the needs of many students. This program will provide a highly educated workforce to the high tech industry in this region and further strengthen UCSC's ties to industry and government laboratories.

By 2011, the School will have a comprehensive set of engineering degree programs that cover information technology (IT), biotechnology (BT), and nanotechnology (NT) disciplines. We plan to offer the following degree programs:

	CURRENT	*PROPOSED*	*PLANNED*
Applied Mathematics			BS, MS, PhD
Biomolecular Engineering			BS, MS, PhD
Bioinformatics	BS	MS, PhD	
Computer Engineering*	BS, MS, PhD		
Computer Science	BA, BS, MS, PhD		MAS**
Electrical Engineering	BS	MS, PhD	
Environmental Engineering			BS, MS, PhD
Info Systems and Tech Management	BS		MS, PhD
Software Engineering			MS
Statistics			BS, MS, PhD

* Includes MS with emphasis on Network Engineering
** Web and Internet engineering

This document focuses on new programmatic initiatives, since they will require significant new resource commitments. Below is a description of those new initiatives beyond the new Department of Applied Mathematics and Statistics. However, resources to meet enrollment growth in our existing programs in Computer Engineering, Computer Science, and Electrical Engineering are equally important and the School looks forward to a budget process that reasonably addresses workload growth and recognizes differential workload measures for engineering.

Bioinformatics and Biomolecular Engineering
The School will establish a Department of Biomolecular Engineering that houses the bioinformatics and biomolecular engineering programs and their faculty. It is a top priority of our School to hire a senior lead faculty member who can serve as founding chair of the department similar to the hiring of Prof. David Draper for our AMS Department. Fourteen faculty positions are planned to support the growth and development of these programs.

Information Systems and Technology Management
Information systems and technology management is the School's next priority, and we plan to recruit a senior leader to begin this new graduate program. Along with software engineering, we envision this program as a critical aspect of our involvement with the Silicon Valley Center. A total of ten faculty members are planned for the program, with a potential for additional growth from enrollments at the Silicon Valley Center. As we develop this new program we will work in close collaboration with the Social Sciences Division, in particular the Economics Department. The Social Sciences Division plans to add four faculty members in support of this program. It is envisioned that the success of ISM and ISTM programs will eventually lead to a new academic unit. Until that time, these programs will be categorized as multidisciplinary engineering programs.

Software Engineering
The School is in the third year of a five-year implementation plan for software engineering. Although the current economic downturn is providing an opportunity, software engineering faculty recruiting has been challenging since we compete both with industry and other universities located in lower cost areas. We plan to hire several faculty members of the highest caliber in the next few years. Software engineering is an important component of our Silicon Valley Center plan.

Multidisciplinary Engineering Programs
Our School's vision has had foci on information technology and biotechnology. For significant research and education in nanotechnology areas with strong interdisciplinary education, we plan to establish new Multidisciplinary Engineering Programs in Environmental Engineering and Materials Engineering in addition to the existing ISM and planned ITSM programs. Initial hiring of key faculty members in these areas will be through AMS, BME, EE departments in concert with institutes and centers such as the STEPS Institute for Innovation in Environmental Research, and Center for Innovative Materials, Sensors and Systems.

These programs will be administered by program directors with assistance from existing engineering departments. The ISM/ISTM program will grow eventually to form an independent academic department. However, we do not envision academic departments for other multidisciplinary programs, although BS, MS, and PhD programs are planned for Environmental Engineering.

INITIATIVES

In addition to our plans for new academic programs, the School plans to engage in several new initiatives and contribute to the campus's goals.

UCSC SILICON VALLEY CENTER
Our program initiatives at the UCSC Silicon Valley Center (SVC) are aimed to achieve two goals:

1) Make pertinent undergraduate and graduate study more convenient to students and professionals who live and work in Silicon Valley; and
2) Increase the campus' visibility and impact in Silicon Valley in the process.

The ISTM and software engineering programs are high priorities for the School's SVC program because these programs cater to working professionals who wish to update and augment their skills. As such, the programs will attract more working students to SVC if they can be easily accessed. As students explore the educational opportunities at the Silicon Valley Center, they will become familiar with the programs offered on campus and highly-qualified, motivated students may choose to pursue advanced degrees at UCSC.

The School anticipates SVC will enable the discovery of more opportunities to further our goals. In research, many of NASA's goals match our Areas of Excellence vision. We will link our research programs in California ISIs (CITRIS and QB3) and research centers (iNIST, CBSE, Center for Innovative Materials, Sensors and Systems, and STEPS Institute for Innovation in Environmental Research) to promote strong research collaborations with NASA, and national laboratories such as Lawrence Livermore Laboratory, Lawrence Berkeley Laboratory, Los Alamos Laboratory and the technology industry in the region.

PACIFIC RIM ROUNDTABLE FOR TECHNOLOGY AND SOCIETY

The regional advantage of the Pacific Rim will continue to be dominant in this decade. It is important that technologies be developed in the interest of society and its environment. A Roundtable Consortium for technology development in harmony with society and the environment will serve well the Pacific Rim industry and nations. The program goal resonates with UCSC's initiative for STEPS program and it will strengthen the UC's CISI initiatives CITRIS and QB3. This forum will also serve as an important gateway for UCSC to the Silicon Valley region and Pacific Rim countries including Japan, China, Korea, Singapore, Taiwan, India, Canada and Mexico among others. The School has been approached for potential collaboration and exchange programs in recognition of our regional advantage and promise for innovative digital engineering leadership. It is envisioned that a lead professor in the ISTM program can head this program in close consultation with the Dean of Engineering, Dean of Social Sciences Division, and Director of the Silicon Valley Center. We also expect that as we establish relationships, there will also be new opportunities at UCSC Extension to offer English and other courses.

SUMMER SESSION

The School will participate in the year-round operation with proper allocation of the State budget. At the Silicon Valley Center, we can offer courses to non-UCSC students returning home to the Silicon Valley region for summer break. We can also offer research/design internship programs and senior thesis courses for UCSC students and bridging courses for transfer students, especially those from this region's community colleges. Although the program goals are well justified, faculty are concerned about the negative impact of summer sessions. Without adequate resources for additional staff and faculty compensation, realization of a full-fledged summer session will be a major challenge. Alternatively, the basic courses usually taught during regular quarters can be offered during summer sessions and taught by dedicated, experienced lecturers.

RESEARCH EXCELLENCE

The School's reputation will be based on our excellence in research. In addition to particular areas of research excellence, the School of Engineering has a unique culture of collaboration, which is reflected in our interdisciplinary partnerships. As the School grows, we will build upon our areas of excellence and expand into new areas that further collaboration across departmental boundaries, forming new interdisciplinary connections between Engineering, Arts, Humanities, Social Sciences and Natural Sciences.

The School plans to have three organized research units (ORU): the Center for Biomolecular Science and Engineering (CBSE), the Institute for Networking, Information Systems, and Technologies (iNIST), and a third ORU, the Center for Innovative Materials, Sensors and Systems (CIMSS) which will be centered around interdisciplinary science and engineering, including materials and environmental engineering. Each Center encompasses a set of research activities founded on our current and planned areas of excellence.

Center for Biomolecular Science and Engineering (CBSE)
Directed by Dr. David Haussler, the Center for Biomolecular Science and Engineering is one of 20 centers around the world that make up the International Human Genome Sequencing Consortium, a crucial component of the Human Genome Project. The Center's affiliates represent a multitude of disciplines: biology, chemistry and biochemistry, computer engineering, computer science, applied mathematics and statistics, environmental toxicology, environmental studies, and physics. The CBSE has been very successful in achieving an international reputation for their work on the human genome. The Center will host Santa Cruz's component of the California Institute of Science and Innovation, QB3, a venture shared with UC San Francisco and UC Berkeley. The School of Engineering is committed to developing the CBSE and plans to have 14 BME faculty who will further the work and reputation of the Center.

Institute for Networking, Information Systems and Technologies (iNIST)
The Institute for Networking, Information Systems, and Technologies will serve as an umbrella organization for several centers of research excellence. The centers will each focus on an area of systems or networking, supporting technologies, or on applications related to the Internet and data-intensive systems. The new electrical engineering program has brought expertise in areas of communications, opto-electronics, packaging and instrumentation. The Institute will be closely affiliated with CITRIS and STEPS Institute and also play a key role in the Silicon Valley Center program development.

Center for Innovative Materials, Sensors and Systems (CIMSS - proposed)
A third ORU in the School of Engineering will promote innovative research in novel and smart materials, biomaterials, nanomaterials, smart sensor development, environmental sensing and engineering, nanoelectromechanical systems, and microrobotics. These areas contain enormous opportunities for synergy with the two other ORUs in the School, Division of Natural Sciences and also potentially with NASA, National Laboratories and Monterey Bay Aquarium Research Institute (MBARI) among others. Biomaterials will be critically important, not only for biomolecular engineering but also for sustainable technology and systems development and intelligent biosensory development. Sustainable technology will enable product and services that are ecologically balanced, environmentally sound and socially responsive to ensure mankind's future. The Center will provide excellent research collaboration among researchers and graduate students in biomolecular engineering, electrical engineering, physics, biology, chemistry, and environmental toxicology.

ADMINISTRATION

Developing a new School of Engineering, especially the campus's first professional school, represents a significant investment in resources and planning efforts. Our major challenges in meeting our operational requirements include a severe space shortage, and several funding challenges.

Capital Program and Space

The School currently has a space shortage that became more difficult in fall 2001. We have outgrown our space in Baskin Engineering and do not have offices for new faculty and research labs for both current and new faculty. The first relief will come with the Physical Sciences Building, scheduled to open in winter 2003. Until that time, our space situation will progressively worsen. Associate Vice Chancellor Michaels and Capital Planning are working with Engineering to provide temporary on-campus space until PSB comes on-line. This temporary space will be available by early summer 2002. Also, the planning for the Engineering II building is well underway. When the new building is completed in 2004 or 2005, it will provide a relief for several years. However, it is expected that with growth of our graduate student enrollment and research staff, the School of Engineering will require exclusive occupancy of the Baskin Engineering and Engineering II buildings near the end of this decade. Before the end of the decade, a new plan should be drafted for additional space, depending on the success of the growth in our programs.

Major Resource Issues

The School currently has three primary operational resource issues: funding for faculty, funding for staff, and funding for furnishing and refurbishing new space.

- Funding for Faculty

  The quality of faculty recruited to the University has a direct impact on our ability to maintain and promote California's competitive advantage in technology-related industries. Competition for qualified faculty remains high. We face three challenges in faculty recruitment: salaries, housing, and start-up packages.

  The current engineering salary scale impairs our ability to make competitive offers, even to junior faculty. Upgrade funding is also an issue for the School. Until the School's faculty reaches a size that yields normal turnover, and resulting salary turnover savings, we are unable to fund all of our upgrades and will need to request Campus Provost Simpson to provide additional funds. This problem is not a local issue—Dean Kang has requested a revised Systemwide IT faculty salary scale. A separate scale will improve our efforts to compete with industry, peer institutions and attract quality candidates. Without such rectification, we will not be able to meet our recruiting needs. Additionally, housing cost is a major recruiting issue, particularly with UCSC's location near the highest priced housing in the nation. Many midwestern universities are offering higher salaries and start-up funds to prospective faculty even though costs are lower.

  Start-up funding has fallen far behind competitive levels, and we hope the Office of the President will make a case to the Governor to increase the State's support for this item.

Additionally, we recognize the need to embrace opportunities to raise extramural funding to enhance start-up packages, and we are committed to searching out these opportunities.

- Funding for Staff
  This year, the School's staffing budget went into deficit. In the same way faculty salaries have fallen behind, so have staff salaries. Engineering is a new division hiring its initial complement of staff employees. Consequently, the School does not have an existing staff salary turnover savings pool to draw upon. Additionally, filling existing vacancies and hiring new staff is more expensive than campus expectations because UCSC compensation packages significantly lag the market and new personnel must frequently be offered salaries higher than their predecessor. Finally, this scenario also results in inadequate resources to address salary equity issues for existing staff. Recruiting and maintaining technical staff is especially challenging, and this group places the largest demand on our staffing budget. We are investigating mechanisms for extramurally funding portions of the research infrastructure; however, all of the options will take several years for full implementation.

  New initiatives also necessitate additional staff resources. Year-round operations, the decentralization of graduate admissions, and our involvement in the Silicon Valley Center will increase our workload, and the School will need additional funds to meet these staffing needs.

- Furnishing New Space
  During the coming ten years, Engineering will be in its rapid growth phase. In order to accommodate the doubling of its students, faculty and staff, the School will gain about 100,000 asf in new and released space—which will generate one-time furniture and office equipment expenses of approximately $1.5 million. The School anticipates working with the central administration to create strategies for funding this start-up expense.

ACCOUNTABILITY

Our goal is to achieve an internationally eminent and distinctive School of Engineering that provides significant impact to industry, academia and the society. Our target areas of excellence will promote active collaborations across departmental boundaries and achieve its reputation as one of the top five nationally by any measure. We expect that the School's reputation will follow once our areas of excellence are well established. By the end of this decade, each department should be counted in the top 25 or higher of engineering schools in the nation.

In its first meeting on November 29, 2001, the Dean's Advisory Council (DAC) recommended to aim for being the first in a smaller number of target areas. At the same time, DAC emphasized the importance of providing broad basic education. This recommendation is seemingly contradictory, but strongly supports our goal for building truly outstanding focused engineering programs with significant impact at UCSC. In reality and to be accountable, it is important to realize that quality and reputation building requires time.

For strategic management of enrollment growth and promotion of excellence, annually, each department will be asked to justify additional resources based on its research productivity, program strength and outcome assessment in addition to the enrollment count. The School of Engineering will develop and use a transparent metric for teaching load, research load, and service load to ensure fair and rewarding resource allocation. The School will also encourage and support team proposals for increased extramural research funding from Federal funding agencies, industry and Federally supported research laboratories such as Lawrence Livermore National Laboratory, Lawrence Berkeley Laboratory, JPL and NASA Ames Research Center. Individual departments in the School have provided their target goals on yearly basis to increase research funding. In this long term planning document, the School also presents a timeline for program development.

Despite our ambitious and concerted best effort, our goal cannot be achieved in the absence of proper resource allocations for faculty and staff recruitment, adequate space provision and infrastructure support for both research and instructional laboratories. In this regard, the accountability should be mutual between the Baskin School of Engineering and UCSC as provider of the resources from the State of California.

COMPREHENSIVE DIVISIONAL PLAN

SECTION 1 – ACADEMIC PROGRAMS

The goal of the proposed academic programs is to create nationally recognized centers of excellence for the School of Engineering while providing a significant contribution to other academic areas and the UCSC campus as a whole. Senior leadership will be an essential element for starting and driving new and several existing programs. We will strive to attract renowned candidates to ensure successful achievement of our target areas of excellence.

By the end of year 2011, the School will have a comprehensive set of engineering degree programs at the cutting edge of technology, and be recognized as a leading research center and engineering school. During the period of the ten-year plan, the School will develop research and instructional Programs in Multidisciplinary Engineering, initially including Information Systems Management and Information Systems and Technology Management. In addition, the School will develop research programs in Engineering that encompass innovative biomaterials, nanomaterials, biosensors and systems. We also plan to cooperatively develop an Environmental Engineering research and instructional programs encompassing Envirometrics and Environmental Technology; which will interact extensively with other departments including environmental studies, earth and marine sciences, mathematics, biology, physics, and environmental toxicology.

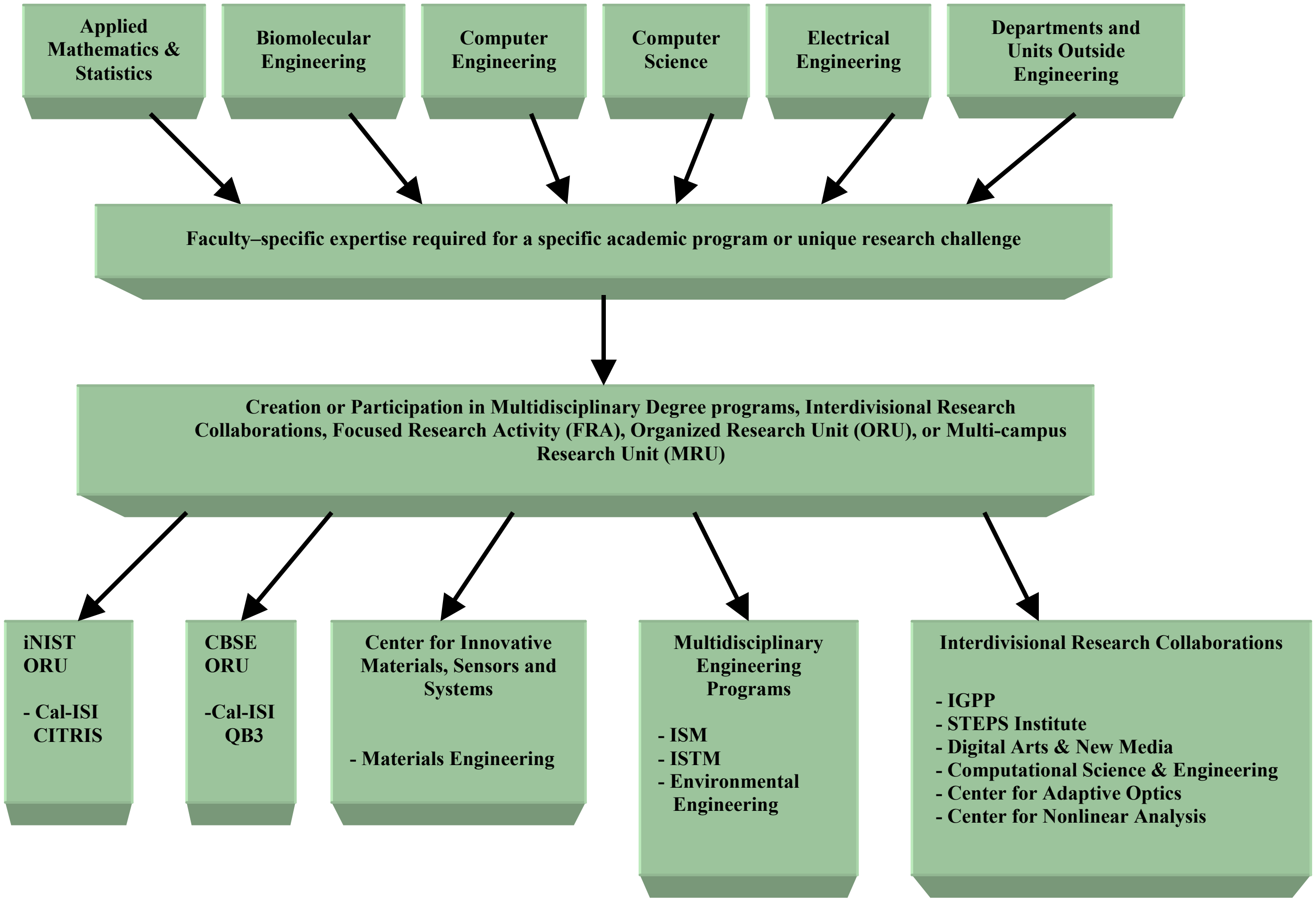
The proposed undergraduate programs reflect the rapid growth of the School as well as the need to fulfill student curriculum expectations of a world-class Engineering School located near Silicon Valley. In undergraduate education, our goal is to prepare engineering majors by providing an extensive array of lateral and integrated degree programs. This approach, which allows specialized areas of study for the undergraduate in a rapidly changing field of study, coupled with education in other disciplines, benefits both the undergraduate student and the UCSC campus.

In graduate education, the School of Engineering's primary objective is to prepare students to assume leading roles in industry and academia. Our graduate degree programs are designed for the pursuit of scholarly accomplishment by the active encouragement of both interdisciplinary and specialized areas of study, so that our students are equipped with fundamental skills and the ability to meet the demands of the ever-changing technical fields. The School will actively advance the pursuit of excellence in our graduate degree programs with the introduction of innovative teaching methods, industry internships and research partnerships. This will be achieved through new and pioneering academic venues including the Silicon Valley Center, Pacific Rim Roundtable, summer sessions, distance learning and company internships.

The School of Engineering maintains a commitment to building bridges to other parts of the academic community at UCSC. Specifically, our plan includes the formation of joint degree programs at both the undergraduate and graduate levels with departments in the Natural Sciences, Social Sciences, Humanities and Arts divisions. An example of this is the

Bioinformatics and Biomaterials joint program with Natural Sciences. Other possible joint programs with Natural Sciences may be remote sensing with Environmental Studies, Earth Sciences, and Ocean Sciences. Other joint programs contemplated include Engineering Ethics with Philosophy, Computational Linguistics with Linguistics, History of Science, Technology, and Medicine with History, and Information Systems and Technology Management with Economics and Psychology. In the area of research, many bridges currently exist between the School and other divisions, notably the departments of Physics, Biology, Chemistry and Biochemistry, Earth and Ocean Sciences and Arts. In the next ten years, more joint research efforts will be created as a result of the growth of multidisciplinary research collaborations.

Table 3 Creating Multidisciplinary and Interdivisional Academic and Research Programs



APPLIED MATHEMATICS AND STATISTICS ACADEMIC PROGRAM

The Department of Applied Mathematics and Statistics (AMS), which expects to receive formal departmental status in the academic year 2002-03, was established to promote the sound use of theories, methods, and applications in applied mathematics and statistics on the campus of the University of California, Santa Cruz, and to provide service to the campus, the surrounding community, the state of California, and the professions of applied mathematics (AM) and statistics (S), through excellence in research and teaching. With close collaboration with the Mathematics Department, AMS will promote excellence in mathematics at UCSC. We believe that both applied mathematics and statistics are best learned through a case study orientation, in a four-step process:

1. The real-world problem in science or decision-making at the heart of the case study is described in sufficient detail that students understand the practical goals of solving the problem and are engaged by the effort to solve it.

2. Methods appropriate to the solution of the problem in step (1) are developed interactively (in real time) with the students. The idea is to share some aspects of the discovery process in the classroom, so that more goes on than simple note-taking.

3. The methods developed in step (2) are applied to the problem in step (1) to produce a complete solution, with the real-world implications of that solution fully explored.

4 Now the instructor and students step back a bit, noticing that the methods developed in step (2) are more widely applicable than just in the solution to the problem in step (1). The final step involves exploration of the general characteristics of the "new" methods—under what conditions do these methods work best? When do they fail? How can they be refined? By linking methods together across several case studies, does the outline of a theory emerge?

This approach can be used successfully at all levels of teaching and learning in AMS, from lower-division undergraduate introductory courses to the most advanced graduate seminars. We intend to explore opportunities for team-teaching our classes with faculty from other Departments on campus, to ensure that the case studies we present retain their timeliness and vitality.

Undergraduate Teaching

In 2001-02, AMS will teach approximately 110 undergraduate FTE, increasing to 250 FTE in 2010-11. We intend to have our BS degrees in AMS approved by academic year 2004-05, with undergraduate majors beginning their study in AMS in 2003-04; by 2010-11 we forecast 80 undergraduate majors per year in AMS, 40 in each of AMS. The draft BS degree in AM has 18 core courses in the AMS, Computer Science, Mathematics, and Computer Engineering Departments, and 4-8 electives in those Departments plus Astronomy, Earth Sciences, Electrical Engineering, Physics, and Chemistry. The draft BS degree in S contains 20 core courses in AMS, Computer Science, Mathematics, and Computer Engineering and 2-4 electives from a list similar to that for AM.

AMS has already begun to do a large amount of service teaching for the rest of the Engineering School and other Departments on campus, mainly at the lower-division undergraduate level, and we expect this role to grow substantially over the next 10 years. On the AM side, we will be offering a variety of required courses on pre-calculus, calculus, linear algebra, differential equations, and Laplace transforms for all engineering students; on the S side we will expand our existing offerings in introductory statistics and biostatistics to include (a) new introductory statistics courses which will be team-taught with members of other departments, (b) managerial statistics courses for Information Systems Management students, and (c) jointly-taught courses on discrete mathematics and stochastic systems analysis with members of the Computer Engineering Department.

Graduate Teaching
We expect our MS and PhD degrees in AMS, with AM or S options, to be approved by autumn 2003. Until then we have established cooperative agreements with the Departments of Physics and of Computer Science to admit PhD students in AMS, respectively; our first PhD student enrolled in this way began study in fall 2001. By 2010-11 we expect to be working with approximately 51 PhD students and 38 MS students per year.

In 2001-02 we will offer two graduate courses with a total of approximately 80 enrollments. By 2010-11, we expect to offer approximately 20 graduate courses per year with a total of roughly 500 graduate enrollments. The AMS options of our draft PhD each involve 18 courses in the first two years; in the AM option these will be offered by the AMS and Mathematics Departments, and in the S option the courses will be given by the AMS, Economics, and Computer Science Departments (see AMS Departmental Long Range Plan in the appendices for a more detailed summary of the AMS 10-year plan). PhD students will then take a set of comprehensive examinations, after which it is expected that they will finish their dissertation research in two years (for a total expected length of study for the PhD in AMS of four years). Our draft MS degree, also with AMS options, is one year long and involves nine courses and either a thesis or a project.

BIOMOLECULAR ENGINEERING ACADEMIC PROGRAMS

A formal proposal to form the Biomolecular Engineering (BME) Department will be submitted in 2002. The following programs are underway or planned:

The department will offer BS, MS, BS/MS and PhD degree programs in Bioinformatics. UC Santa Cruz is known internationally in the field of bioinformatics for the pioneering work of CS Professor Haussler on applications of hidden Markov models to biological sequence data, for the development of software tools and hardware for sequence analysis by CE Professors Karplus and Hughey, and more recently for Haussler's contributions to the public Human Genome Project. Since the introduction of our first graduate level Bioinformatics course in 1996, we have successfully trained many students from the Computer Science, Computer Engineering, Mathematics, Molecular, Cell and Developmental Biology, and Chemistry and Biochemistry Departments. We wish to take advantage of our unique competitiveness in this area by offering first-rate programs of study in bioinformatics, with emphasis on molecular biology, biochemistry, mathematics and computer science.

A new BS degree program in Bioinformatics has commenced as of Fall 2001, currently offered through the Computer Engineering Department. The program will see its first graduate in 2002. This program will be administered by the BME Department upon its inception. A proposal to establish the Bioinformatics Graduate programs has been completed and is being submitted for campus consideration in Fall 2001. We expect the program to begin no later than Fall 2003. At that time, students who are specializing in bioinformatics while enrolled in other programs, primarily Computer Science, may choose to transfer into the new program. A Bioinformatics BS/MS honors program is also planned, modeled after the Computer Engineering program. Students admitted to this program will be able to use up to two graduate courses taken for the BS degree in satisfying the course requirements of the MS degree.

The objectives of the Bioinformatics Graduate programs are to:

- Provide new career opportunities for students with computer science, engineering and math backgrounds who wish to extend their abilities into the life sciences, and for students with appropriate science and computer backgrounds who wish to cross into computational biology
- Educate a new generation of scientists and engineers with the interdisciplinary perspective needed to realize the potential of this new field
- Perform fundamental research leading to the development of new bioinformatic methods and technologies aimed at understanding human disease and improving human health

An optional industry internship program is planned for the MS and PhD programs in Bioinformatics, and under consideration for the BS program. Biotechnology industry leaders were provided a draft of the graduate program proposal, and asked to comment on their interest in an associated internship program. The majority expressed a strong interest in participating in such a program. This program will contribute substantially to the recruitment of high quality students, provide a practical dimension to their academic experience, enhance their preparation for professional careers, and assist them significantly in securing a first position following graduation.

The BME Department also plans to offer MS and PhD programs in Biomolecular Engineering, and will consider a BS degree program in this field. The Biomolecular Engineering Graduate program will be developed first, potentially as soon as 2004-5. Development of a BS degree program will depend on the measured need for such a program, and on the interests of the faculty that have joined the department.

Interdisciplinary activities will be an area of great strength for the BME Department, as biomolecular engineering itself is based on interdivisional disciplines. Existing collaborations occur at several levels: the academic program level (both graduate and undergraduate programs), the Multi-Campus Research Unit (MRU) and Organized Research Unit (ORU) levels, the project level, and the individual investigator level.

All of the academic programs offered by the BME Department will be highly interdisciplinary. For the Bioinformatics programs, the curricula are comprised of approximately half Engineering courses and half Natural Sciences courses. The Biomolecular Engineering graduate program will most likely be a similar blend of courses from the two divisions.

Many of the BME faculty will be affiliated with QB3 contributing research that cuts across traditional boundaries. The BME Department (currently through the auspices of the CBSE) is also part of an MRU proposal for a UC-wide Bioengineering Institute of California, an initiative led by Prof. Shu Chien of UCSD. The CBSE itself is a proposed ORU that is administratively housed in the School of Engineering and will be closely tied to the BME department, but has members and fosters research across three divisions: Engineering, Natural Sciences and Social Sciences. BME Department faculty and students will be involved in large interdivisional projects (such as those currently underway), and BME faculty will also undoubtedly form individual collaborations with faculty from other divisions and other campuses.

COMPUTER ENGINEERING ACADEMIC PROGRAMS

Computer Engineering (CE) academic programs focus on the definition, design, and creation of computers and computer-based systems to solve problems. At the undergraduate level, our program begins with a foundation of mathematics, physics, and programming. Students then develop skills in the core areas of hardware and software system design, and move on to one of four specialty tracks. As part of their course requirements, all students complete a senior design project, integrating their mathematical, technical, and technical writing skills into a single quarter-long project. At the graduate level, we have a flexible program based on showing prior mastery of undergraduate computer engineering topics, graduate courses in computer architecture and computer algorithms, and additional elective courses within the School of Engineering. The highlight of a graduate degree is, of course, the MS thesis or PhD dissertation, which study such areas as network protocols and hardware; computer system design; software tools for computer or VLSI system design; software, algorithms and hardware for signal and image processing and understanding; and many other areas.

The undergraduate program in Computer Engineering was founded in 1984, and accredited by the Accreditation Board for Engineering and Technology (ABET) in 1988. The CE graduate program was established in 1989, and saw its first graduates in 1992. Annual enrollments, which more than doubled in the previous five years, are now nearly 350 student FTE. Last year, we granted 47 BS degrees and 25 MS and PhD degrees. Over the next 10 years, we expect our enrollments to double again.

Computer Engineering faculty have taken leading roles in many academic innovations within the School of Engineering, including the creation of the 3-2, ISM, and EE BS programs, the distance learning MS in CE, and the BS/MS program in CE. Most recently, we revised and refocused the CE undergraduate curriculum enabling students to specialize in computer systems, networks, systems programming, or digital design; began a minor in Computer Engineering; and introduced one of the country's first undergraduate degrees in bioinformatics. In the coming decade, we expect to continue innovation in engineering education in several ways, as discussed below, with an emphasis on rigor and flexibility

We will continue to review and refocus our undergraduate curriculum; in the near future, we expect to add a new BS track in signal, image, and video processing. We will additionally work with ABET to enable the accreditation of bioinformatics programs, allowing us to seek accreditation for our own. We hope to work with Computer Science to design and accredit a program in systems or software engineering. We will continue our particularly strong commitment to undergraduate research. This summer, we worked to develop a sense of community among undergraduate summer researchers and sponsored the first Engineering Undergraduate Research Poster Symposium. We have proposed a school-wide NSF Research Experiences for Undergraduates summer institute for underrepresented students.

In graduate education, we are working with the CBSE and the Biomolecular Engineering faculty (some of whom are housed in CE) on the creation of the Bioinformatics MS and PhD degrees. We are considering creating graduate tracks, for example in VLSI (in collaboration with EE) and in networks. We are working with CS to design a graduate technical writing course. We are eager to assist Computer Science in the creation of software engineering graduate degree programs. Our distance learning program, the MS in CE with an emphasis in Network Engineering, is a healthy and innovative program that brings University of California education directly into Silicon Valley. We hope to expand this program and work with other faculties within the School to provide a wide range of graduate education to working professionals. The stature of our graduate program will depend on the stature of our graduates and our research. We are strongly encouraged by our recent placements at research universities and top industrial laboratories, and also the rapid growth in research activity brought about with the recent expansion of the faculty from 12 to 18.

COMPUTER SCIENCE ACADEMIC PROGRAMS

The Computer Science Department was established in 1968 with three faculty as the Board of Studies in Information and Computer Science. The department now has 17 permanent ladder rank faculty and offers five different undergraduate and graduate degrees. The educational mission of the Computer Science Department includes preparing students for productive careers in industrial and academic settings as well as offering a range of courses designed to expose the general UCSC student population to the main aspects of computer science and information technology. The Computer Science Department will continue to meet these missions by maintaining a quality program that exploits innovative instructional methods.

Computer Science Undergraduate Programs
At present, the Computer Science Department offers a minor in Computer Science as well as three different undergraduate degree programs: the BS in Computer Science, the BA in Computer Science, and (jointly with Economics) the BS in Information Systems Management. The three undergraduate degrees currently offered by Computer Science all serve different needs. The BA in Computer Science is a flexible program designed to allow students time to explore interests beyond the School of Engineering and/or a double major. It requires a set of lower division core courses, completion of a depth sequence, and additional upper division electives. The Computer Science BS degree gives students more exposure to the central aspects of Computer Science, and is the more popular degree program. Its more focused nature makes it a natural candidate for accreditation, which the CS department plans to pursue in conjunction with Computer Engineering's accreditation renewal in 2003. The BS in Information Systems Management was recently established (1999) and is a truly interdisciplinary degree that is administered by Computer Science and sponsored jointly with the Economics Department. This program teaches students about the collection, manipulation, storage, distribution, and utilization of information in support of a business or public sector institution, and requires courses from four different departments in three different divisions (Math, Economics, Computer Science, and Computer Engineering).

The Computer Science undergraduate programs are extremely successful, and they attract significantly more students than can be accommodated while maintaining the high quality of the programs. The enrollments in upper division CS classes have risen by 19%, 13%, 24%, and 27% over the last four years so that (with compounding) the 2000-2001 enrollments are 213% of the 1996-1997 numbers, a shocking increase for a mature program. Limited teaching resources (such as declining TA ratios) reduce the department's ability to continue offering a quality CS program to everyone, and it appears necessary to selectively admit the most qualified students to the majors.

Even with the tremendous success of the CS undergraduate programs, the exploration of innovative ways in which they can be improved continues. One example is the successful introduction of "pair programming" by CS Professor Charlie McDowell (Carnegie Scholar and a winner of the 2000-01 Excellence in Teaching Award). Curriculum extensions and improvements on the horizon include creating an honors sequence, the addition of a Software Engineering depth sequence to the BA degree, exploring the possible creation of a BS degree in Software Engineering, and the development of additional upper division electives. Computer

Science is also exploring ways to enhance its offerings for non-majors. For example, Professor Jane Wilhelms is working on a version of the computer graphics course for majors designed to be accessible to students studying arts and digital media.

Computer Science Graduate Programs

The Computer Science Department currently offers both the MS and PhD degrees in Computer Science, with the MS degree having both a thesis and a project track. The planned expansion of the graduate program will involve a critical review of the existing requirements. This is likely to lead to a revision of the breadth and depth requirements for the MS and the PhD degree programs. New graduate courses will be introduced in several key areas related to the department's research foci as well as a new course on graduate-level technical writing and presentation skills.

The development of a MS in Software Engineering is an item of top priority for the Computer Science Department. We envision the development of a proposal during the academic year 2001-02, campus and systemwide review during 2002-03, and establishment of the program in the fall of 2003. However, this timetable may be delayed to allow input from the lead Software Engineering faculty member to be hired in 2002. Although this degree program will originate on the Santa Cruz campus, it is a good candidate for distance delivery to the Santa Clara area, and could be part of the Computer Science Department's participation in the Silicon Valley Center.

The Computer Science Department is in the process of evaluating a MAS degree program in Web and Internet Engineering, and a feasibility study will take place during 2001-02. This degree program is intended to be self-supporting and is to be originated at the Silicon Valley Center with distance delivery to the Santa Cruz campus. The Computer Engineering Department experience—as a result of their Master of Science in Network Engineering Program—will help us plan and implement this effort.

The CS faculty continue to be interested in collaborating with faculty from other departments and divisions in offering innovative graduate curriculum. One example is the interdisciplinary course on evolutionary game theory to be co-taught by Professor Manfred Warmuth in Winter 2002.

ELECTRICAL ENGINEERING ACADEMIC PROGRAM

The academic program in electrical engineering (EE) features an existing undergraduate program and a proposed graduate program. Within the School of Engineering the mission of these programs is to build a high-quality, sustainable teaching and research effort that will inspire undergraduate and graduate students in the theory and practice of electrical engineering with special emphasis on photonics and electronics, communications, signal and image processing, VLSI design, micro- and nanotechnology, electromagnetics and environmental technology. The summary below presents key features; further examples are in the more detailed EE Dept. Strategic Plan included in the Appendix.

Undergraduate Program

The undergraduate program is based on students with strong backgrounds in mathematics, physics and chemistry with a generous admixture of humanities and social sciences. The core of the EE undergraduate's training is in digital and analog electronics, properties of materials, electromagnetics, signals and systems and computer skills. In their final two years undergraduates may specialize in the photonics and electronics track, the communications track, or the signals, systems and control tracks. A senior design project gives the student an intensive experience in either an individual construction project or a team design project. An accreditation ABET review is planned for 2004.

In the strategic plan Electrical Engineering looks forward to very strong growth in both EE majors and students taught on a division wide basis. Over the ten years of this plan EE majors are projected to grow by almost four-fold to a total of over 450 by 2010. With a strong recruiting effort the average analytical and quantitative SAT scores of entering freshmen are projected to rise from the current 620 level to well over 700. Thus, the EE department plans to grow to excellence in both size and quality.

Over the next ten years a number of initiatives are planned for improving undergraduate EE education. Two key features in this process are integration of research and teaching and learning outside the classroom by involvement of students "out in the real world." In the classroom setting an EE design course is planned in which students construct a wireless link and apply it to a practical design problem, such as communication with a sensor inside the human body. Involvement of undergraduates in research is to become the rule rather than the exception. Research opportunities with ladder and research faculty are planned to increase rapidly as undergraduate numbers grow. Many students will get their research experience in industry via internships. The undergraduate program will benefit from a summer session that will have courses integrated with the faculty and internship research programs.

Graduate Program

A department in a research university cannot function effectively without an exceptionally strong graduate program. Hence, the first order of business of the new EE program at UCSC was to develop a graduate program proposal. This proposal was developed by the EE Dept., approved by the School of Engineering and submitted to the Faculty Senate in 1999. The proposal was approved by Provost's Simpson's Office and submitted to the Office of the President of the University of California (UCOP) in Sept. 2001. It is now under review by the UCOP's

Coordinating Committee of Graduate Activities (CCGA) and we anticipate final approval this year. Graduate students working with EE faculty are temporarily, but generously, housed under Computer Engineering. EE graduate students will conduct research with faculty in the following key areas: photonics and electronics, communications and signal and image processing and VLSI design, micro- and nanotechnology. In addition, STEPS Institute will promote innovative programs in environmental sensing and environmental technology.

Over the next ten years EE looks forward to rapid growth in the number of EE graduate students. A total of about 100 are projected for 2010, supervised by 21 ladder faculty and about a dozen research and adjunct faculty. EE plans to make extensive use of adjunct and 'research faculty' who will play a strong role in the research and academic life of the EE Department community.

Innovations planned for the graduate program include specially designed masters programs and joint degrees in environmental technology. The Silicon Valley Center provides an excellent venue for MS and PhD students who work part time in industry. Attention is particularly directed to an MS program in which students in industry can attain a masters over a number of years – the Stanford University Honors Co-op Program is a very successful program of this type. Especially important bridges to the UCSC campus outside of engineering are joint MS and PhD programs planned for environmental technology. Natural Science Departments, such as Physics, Chemistry, Biology and Earth and Ocean Sciences, and Environmental Toxicology Studies in the Social Sciences Division are expected to participate.

INFORMATION SYSTEMS AND TECHNOLOGY MANAGEMENT ACADEMIC PROGRAMS

In the past, The School of Engineering planned to offer an Engineering Management graduate program. Its focus was not tightly aligned with the existing undergraduate Information Systems Management program. We plan to align the foci of both graduate and undergraduate programs by offering Information Systems and Technology Management program instead of Engineering Management program.

The new graduate program in Information Systems and Technology Management program is targeted to meet the needs of high tech workforces in Silicon Valley and other high tech regions. This program is synergistic with our undergraduate ISM program and will uniquely provides a tight integration between information systems and business processes in close collaboration among School of Engineering, Social Sciences Division, and high tech industry in the Silicon Valley region. The combined strength from computer science and engineering, electrical engineering, statistics, economics, and psychology departments, and selected executives will make this program unique with high quality and significant impact. An associated PhD program, in concert with participating departments, will provide opportunities for rigorous, scholarly frontier research in areas of increasing importance such as information security and privacy, business value of information technology, software productivity, software value chain, operational integration of B2B exchanges, and computer support for real-time dynamic decision making. Integration of graduate programs in alignment with the ISM undergraduate program is considered a must to attract top quality faculty members who excel in both research and teaching. Full time graduate students in ISTM can be asset to ISM faculty in both teaching and research assistantships. The ISTM graduate program will further enhance the interdivisional collaboration between School of Engineering and Social Sciences Division and potentially the Arts Division for its new media and digital arts programs.

For broad educational impact, students with different backgrounds can be admitted and educated by using two tracks; those with IT technical knowledge and work experience will take more business management focus courses than IT courses while those with business education and work experience will take more IT focus courses than business courses.

The principal location of this program is envisioned to be at the Silicon Valley Center to attract students from high tech companies and also to provide students unique opportunities for internship and dynamic interactions. With advancement of distance learning technologies, it would be possible to offer educational opportunities to students on UCSC campus and other remote sites in the future as the program expands.

Through this ISTM program, we also plan to co-develop and realize our vision for Pacific Rim Roundtable for Technology and Society in Silicon Valley. With senior members of high tech companies enrolled in the ISTM program, their strength can be harnessed to help develop various programs for the Pacific Rim Roundtable for Technology and Society. It is envisioned that the uniqueness of this program will attract high tech workforces from Pacific Rim countries such as India, China, Japan, Korea, Singapore, Canada and Mexico among others. For instance Korea is known to have high bandwidth infrastructure and is keenly interested in fostering the future workforce through Silicon Valley experience. Switzerland is also interested in linking to Silicon Valley university programs such as the ISTM program. Representatives from both countries have already made visits and discussed the potential for international collaboration. Hokkaido Information University has also shown strong interest in both ISTM and the Pacific Rim Roundtable programs during its recent faculty visit to UCSC. In addition to the degree program, it can be beneficial to offer certificate programs in this area in close collaboration with

SECTION 2 - INITIATIVES

UCSC SILICON VALLEY CENTER

The UC Santa Cruz Silicon Valley Center (SVC) will enhance the impact of research collaboration by contributing to the economic growth and intellectual vitality of the region and providing new educational opportunities for residents and employees living in the Silicon Valley region. We anticipate approximately one third of our faculty members will be actively engaged in programs at SVC.

The School plans to offer both undergraduate and graduate students programs at the Silicon Valley Center. These programs will provide bridging courses for community college graduates and help working professionals to update and augment their technical knowledge. Students can pursue academic degrees while working part-time in Silicon Valley industry. The School will take an active role in UCSC's Higher Education Collaborative with other regional institutions such as San Jose State University and DeAnza/Foothill Community Colleges to improve math, science and engineering education. The School's participation with the Higher Education Collaborative will lead to an increase of the number of eligible community college students transferring to UC. Graduate students will be offered opportunities to complete a significant part of their research at SVC, in collaboration with scientists and engineers from other UC campuses, NASA Ames Research Center and Silicon Valley companies. As the development of several programs and many of the initiatives at SVC come into fruition, the location of SVC would naturally lend itself to summer session offerings and further increase visibility of the UCSC campus. Finally, the establishment of state-of-the-art distance education facilities at SVC and the UCSC campus will enable faculty to teach from either location with students at both sites.

Although planning for the Silicon Valley Center is still in the formative stages, we plan to offer the following over the next ten years:

APPLIED MATHEMATICS AND STATISTICS

In conjunction with the UC formed Collaborative with other educational institutions, AMS will offer courses in mathematics, applied mathematics, statistics, calculus designed for engineers and other courses at SVC. It is envisioned that some of these courses will be offered on a distance-learning basis, applying innovative teaching methods to allow greater accessibility to working professionals and transferring students. In addition, AMS will engage in collaborative consulting projects with industry in both the applied mathematics and statistics areas. AMS will also offer collaborative statistical consulting and the development of Biotechnology and Statistical Consulting Centers. Further offerings may include courses and/or research projects in the area of biometrics.

BIOMOLECULAR ENGINEERING

As a growing department, Biomolecular Engineering's primary academic efforts will be aimed at developing the curricula of required and elective courses for new undergraduate and graduate programs. Many courses will be of great interest and value to students located in Silicon Valley, such as part-time students who work in the computer or biotech industry, and students working towards a transition from a community college, a prior career, or a different academic background. We see our participation in SVC to initially take the form of distance learning classes, after the required infrastructure has been put in place to broadcast courses taught live on the Santa Cruz campus. We will also take advantage of opportunities in which adjunct faculty and lecturers choose to offer relevant courses from SVC, particularly for courses that would not otherwise be offered on campus.

CENTER FOR BIOMOLECULAR SCIENCE AND ENGINEERING

Joint ventures with industry such as QB3 may serve as the primary vehicle for a CBSE/Biomolecular Engineering research presence at SVC. If appropriate laboratory space is available, certain research projects involving industry partners and QB3 students and faculty may be housed there, as a central location between the three UC campuses and the biotech industry. The SVC location may also be convenient for partnerships with companies outside of the Bay Area, thus allowing collaborations that may not otherwise have been possible. SVC may be particularly appropriate for projects involving new product development and testing activities (in contrast to basic research), which may not be allowed on certain tax-exempt financed QB3 spaces on campus (which is constrained by IRS rules on private business use).

COMPUTER ENGINEERING

The Masters of Science in Network Engineering program, currently housed at the UCSC extension Cupertino site, may be offered at SVC. The planned development of research laboratories at the Silicon Valley Center will enable a fuller curriculum within network engineering and computer engineering in general. The establishment of distance learning facilities, both at SVC and on campus, will enable a much wider range of courses during the prime offering period for part-time study (morning, evening, and night). The Computer Engineering Department (CE) plans to offer several entry-level courses for transfer students live and via distance learning to the Silicon Valley Center and possibly other locations. We propose to develop at SVC a Center on the Design of Complex Systems, an idea and supported by faculty in EECS at UCB and in CE at UCSC. The goal is to build on the overarching theme of managing complexity in systems that are designed by humans (such as software, hardware, mechanical, and hybrid, mixed discrete-continuous systems), as opposed to analyzing complexity in systems that occur in nature, as in UCSC's seminal work on nonlinear dynamics. Among the obvious target applications are embedded systems, microprocessors, networks, and large software systems. The focus would be around design goals such as scalability, reliability, evolvability, which are very difficult to obtain with current design practices as the average system complexity keeps growing.

COMPUTER SCIENCE

Degree Programs
MAS-Web & Internet Engineering is anticipated at SVC with distance delivery to UCSC. The proposal for the program has been approved by UCOP with full proposal and feasibility study expected during 2001-02. The program is intended to be self-supporting.

MS-Software Engineering program will originate at the UCSC campus with distance delivery to the Santa Clara County area. Proposal development is anticipated during academic year 2001-02 campus and systemwide review in 2002-03. Establishment of program is expected in the fall of 2003.

Other Planned Programs
MAS – Advanced Studies that encompasses Computer Security, Data Mining, Software Reuse, Human-Computer Interaction, Information and Technology Management, Virtual Reality and Digital Media will also be offered at SVC for computer professionals seeking expertise in specialized areas of computer science and information technology.

Bridge Courses
Computer Science bridge courses will enable preparation of transfer students to upper divisional level. Computer Science will target participation with research projects in the areas of data systems, computer security, software engineering and human-computer interface.

ELECTRICAL ENGINEERING

Electrical Engineering plans to contribute to and make use of the Silicon Valley Center. In the EE academic program the focus will be on making EE programs available to part-time students from Valley industry as well as using the Center to allow EE students to have practical engineering experience, through internships, while living and studying at the Center. The former idea has proven very viable for Stanford in their Honor's Co-op Program. The latter idea will be attractive to EE students in the same vein as “year abroad programs” are currently. In the research program of electrical engineering the Silicon Valley Center location offers very attractive opportunities for research collaborations with Valley industry and the NASA Ames Research Center. Silicon Valley industry has many facilities, such as integrated circuit fabrication equipment, that are of great use in graduate research, but are generally out of reach in terms of cost for most universities. Collaboration with NASA Ames in the major EE research focus areas is envisioned, especially in the areas of sensors, robotics and robust electronic and photonic systems. Many EE department faculty live in the Valley and so working and teaching there is an advantage rather than a burden.

MULTIDISCIPLINARY ENGINEERING PROGRAM

Information Systems and Technology Management is a current focus of the School of Engineering for a new graduate program. Our program will be unique in its dual emphasis of honing technological skills, knowledge and learning the principles of management and finance. Faculty members Richard Hughey and Pat Mantey from computer engineering have been asked by Dean Kang to take leading roles in the definition of this program and the recruitment of its founding program director. Through formation of the Center for Innovative Materials, Sensors and Systems and active participation in STEPS Institute in Environmental Research, the School plans to develop innovative programs in materials engineering and environmental engineering.

SUMMER SESSION

To participate in year-round operations, several possibilities have been explored. We approach our role in year-round operations with commitment. We recognize the need to explore and resolve compensation and support issues with the other divisions as the campus implements an expanded summer session. To ensure smooth organization and coordination of the planning and implementation of a summer session, we recommend an academic administrator as well as additional resources to address faculty compensation issues.

The School anticipates that re-entry and transfer students will be particularly interested in summer session as they are more strongly focused on completing their university education to start their career. Summer session offerings and consequently finishing their degree more quickly, may result in an acceleration of income earnings by approximately 25% for a student pursuing completion of an undergraduate degree. This is a significant incentive for students on financial aid or having a family to support. Summer offerings will also accelerate the completion of major degree programs and transitioning students from community college to the University of California.

The Silicon Valley Center presents enormous opportunities to attract students situated or returning to the Silicon Valley region. Courses will be offered to students returning home to the Silicon Valley area for summer break. The site can also offer bridge courses for transfer students.

Particular courses include stochastic methods, computer organization, discrete mathematics, introduction to networks and the internet, among others. Other summer session offerings could include courses in senior thesis, research and design internship with future expansion into basic undergraduate and special graduate courses.

PACIFIC RIM ROUNDTABLE FOR TECHNOLOGY AND SOCIETY

The regional advantage of the Pacific Rim will continue to be dominant in this decade. It is important that technologies be developed in the interest of society and its environment. A Roundtable Consortium for technology development in harmony with society and environment will serve well the Pacific Rim industry and nations. The program goal resonates with UCSC's initiative for the STEPS program and will complement the UC's California ISI initiatives for CITRIS and QB3. This forum will also serve as an important gateway for UCSC to the Silicon Valley region and Pacific Rim countries including Japan, China, Korea, Singapore, Taiwan, India, Canada, and Mexico among others. The School has been approached for potential collaboration and exchange programs in recognition of our regional advantage and promise for digital engineering leadership. It is envisioned that a lead professor in ISTM program can lead this program in close consultation with the Dean of Engineering, the Dean of Social Sciences Division, and the Director of the Silicon Valley Center.

Below we summarize some ideas for taking advantage of the opportunities available in the Pacific Rim:

- Develop research and intern relationships with industries that are based in the Pacific Rim
- Develop relationships with educational and research institutions in the Pacific Rim, for example the Center for Remote Imaging, Sensing and Processing headed by Prof. L. K. Kwoh at the National University of Singapore.
- Develop student exchange programs with Pacific Rim Universities
- Target professional meetings in the Pacific Rim for participation

3-2 PROGRAMS

The 3-2 programs were designed to offer undergraduate students the opportunity to begin study at UCSC and finish their undergraduate engineering degree at UC Berkeley in disciplines not offered at UCSC. We plan to expand and offer new 3-2 programs so that students can benefit from UCSC engineering programs as well. The 3-2 program will be particularly helpful for attracting top entering students who later may decide to get a computer or electrical engineering degree at UCSC.

INTERNSHIP/CO-OP PROGRAMS

Much of the true education of an engineer takes place outside of the classroom and university. For many engineers the motivation to excel in academic engineering derives from initial contact and involvement with actual engineering projects in an industrial setting. Engineering projects in an industrial setting allow exploration and specialization of career choices as well as gaining valuable practicable experience. In addition, students who have work experience also have more appreciation for classes and often do better than other graduates in career development.

We propose the development of internship programs in partnership with industry as a way to participate in this important process of academic and career development. Corporate internships and other incentives will benefit both the School and industry by encouraging enrollment in our programs. An optional industry internship program is planned for the graduate program in Bioinformatics and under consideration in the undergraduate program.

In Computer Engineering, we have begun considering plans for a formalized field study course. With the normalization of summer session, this is a particularly appealing possibility. An effective intern program coupled with regular group meetings discussing the way the commercial world works could be an excellent means of providing advanced education and training for our students. With an assigned and appropriate internship project from industry, student groups may be created to tackle a specific project as part of a senior design experience.

The Electrical Engineering discipline will offer three levels of summer internships: sophomore year as entry-level technician, junior year as technician, senior year as engineer. An internship of three summers in a company adds appreciably to the quality of project work as it allows students more involvement with the project and the industry environment.

ASML (formerly Silicon Valley Group) and National Semiconductor have encouraged the School to develop programs aimed directly at specialties of Electrical Engineering design that are in short supply. In addition, the School will actively develop and publicize Internship opportunities at other industrial concerns and the National Laboratories at Los Alamos and Livermore.

SECTION 3 – RESEARCH EXCELLENCE

Our reputation will be based on our reputation for research excellence. In the next ten years, we seek to advance and exceed our current level of research excellence. The School has an exceptional position in that its field of study naturally lends itself to key contributions to various fields of study throughout the campus. We have a unique spirit of collaboration throughout the campus, reflected in our interdisciplinary partnerships. As the area of engineering research grows, we will build upon our existing collaborative partnerships and venture into dynamic related fields where opportunities for further collaborations and new interdisciplinary connections will thrive. Total awards are anticipated to grow to almost $25 million by 2005, and over $36 million in 2010, resulting in indirect cost recovery projections for the university of over $4 million and $8 million by 2005, and 2010, respectively.

APPLIED MATHEMATICS AND STATISTICS RESEARCH PROGRAMS

AMS strives to achieve research excellence in two general areas: dynamic mathematical modeling of complex natural phenomena, and Bayesian statistical methods of inference, prediction, and decision-making, in both cases with applications in engineering and the sciences. Our focus is on modeling of the world around us (we are methodologists who like to develop new methods in the process of solving real-world problems), and our approach is computationally intensive (through the numerical solution of systems of partial differential equations in AM and the use of Markov chain Monte Carlo (MCMC) methods and other techniques for approximating high-dimensional integrals in S). We are committed to full interdisciplinary collaborations in which we serve as co-PIs on grants with investigators from other fields, so that our publications are a mix of methodology articles in leading AMS journals and substantive articles in leading journals in the fields in which we collaborate.

After reflection and consultation with colleagues in other Departments around campus we have arrived at the following plans for subgroup areas of research concentration.

Applied Mathematics
Mathematical physics and geosciences: The expertise in this subgroup will be in theoretical fluid mechanics and the application of applied mathematics techniques in geophysics problems. Initially this subgroup will establish strong links with the Institute of Geophysics and Planetary Physics (IGPP)—of which Balmforth is already a member— and several departments in Natural Sciences (including Astronomy, Earth Sciences, and Ocean Sciences). If, as is currently under discussion, the campus creates a center for the environmental sciences, this subgroup will play a significant role in developing some of the theoretical aspects of the research. Members: Balmforth and 2-3 new hires.

Mathematical Biology
This subgroup will provide a theoretical counterpart of the existing and developing Engineering groups in bioinformatics, computational biology, and envirometrics. Key mathematical developments in biomolecular engineering are both deterministic (involving PDEs) and stochastic, leading to collaborations both with researchers in the Center for Biomolecular Science and Engineering and in the Statistics Group. Members: Wang and 2-3 new hires.

Solution of Partial Differential Equations
This subgroup will be the methodological backbone of Applied Mathematics on campus, and its goal will be the development of practical methods for solving the classes of partial differential equations (PDEs) which arise frequently in engineering and the natural sciences. The aim is to create a subgroup of researchers with expertise in deriving the solutions of PDEs (using numerical, analytical, or perturbation techniques, for example); this contrasts with, but complements, researchers in the Mathematics Department who deal with the purer side of PDEs (focusing, for example, on questions of existence of solutions rather than how to find them). Members: 3-4 new hires.

Statistics
Bayesian nonparametric methods: The wave of the future in Bayesian methods is nonparametrics, which involves placing probability distributions on functions (the statistics of the 21st century) rather than on scalars or vectors (the statistics of the 18th through 20th centuries). This has significant applications in many Engineering disciplines, including bioinformatics, machine learning, nanotechnology, and uncertainty visualization, and is also relevant to the research in a number of departments outside Engineering, including Astronomy, Earth Sciences, and Ocean Sciences. Members: Draper and 2-3 new hires.

Computationally Intensive Bayesian Inference, Prediction, and Decision-Making
Modern methods of Bayesian statistics employ Markov chain Monte Carlo techniques to draw inferences and make predictions and decisions. These methods are highly computationally intensive, and are crucial to the continued success of the Bayesian approach in applied problem-solving in a number of Engineering disciplines (including computational biology, modeling of remote sensing data, and signal and image processing) and non-Engineering Departments (including Biochemistry and Molecular Biology, Physics, and Sociology). Members: Prado and 2-3 new hires.

Envirometrics
Bayesian statistics will play a leading role in this important interdisciplinary effort. Examples include spatio-temporal modeling of pollution data, decision analysis for environmental policy based on maximization of expected utility, and stochastic optimization as a tool for finding new solutions that increase energy efficiency in applications as diverse as power plant design and home heating and cooling. Members: 3-4 new hires.

Interdivisional Collaborations
AMS envisions at least the following three opportunities for interdivisional collaborations over the next ten years:

1. The envirometrics program within Engineering, which will have strong support from within the Statistics Group, will also involve significant participation by researchers in other Departments across campus, including Earth Sciences, Environmental Studies, and Ocean Sciences.

2. We are interested in reviving the Center for Nonlinear Analysis, an existing ORU which will involve significant participation by researchers in Earth Sciences, Mathematics, and Physics.

3. The Statistics Group intends to launch a Statistical Consulting Service (SCS) for Engineering and the rest of campus, perhaps as soon as 2002-03.

By its very nature all of the contacts in this Service outside Engineering will involve interdivisional collaboration. Short consultations in the SCS would be free; medium-length consultations would involve a transfer of funds from a grant held by the person initiating the consultation. (Long-term consultations are better viewed as research collaborations, as described above.)

BIOMOLECULAR RESEARCH PROGRAMS

The goal of the new Biomolecular Engineering Department is to achieve a level of excellence that will place us among the top five similar departments. Distinct from traditional bioengineering departments, the UCSC BME department will develop a new blend of engineering, biology and chemistry that draws on current strengths at UCSC and reflects our vision of an important direction that biological and medical discovery should take. The target areas of excellence, highlighted below, intersect with all three areas of excellence identified for the Baskin School of Engineering—IT, BT and NT—and will allow the department to play key roles in new campus initiatives, such as the biomedical research focus of Molecular, Cell, and Developmental (MCD) Biology, and the STEPS Institute. A table accompanying the BME Department Long Range Plan lists the general research areas of the faculty hires for this new department.

Bioinformatics/Computational Biology
With the transfer of Profs. Haussler, Karplus, and Lowe into the BME Department, we will immediately have achieved international prominence in bioinformatics. Our current strengths include genomic sequence alignment and assembly, gene-finding, RNA and protein sequence alignment and structural prediction, and microarray data analysis. These are areas of critical importance as world-wide sequencing projects are completed and become available for analysis. New areas in bioinformatics that the department may focus on include comparative genomics, human variation, pharmacogenetics (the influence of genetic factors on drug activity and metabolism), and pharmacogenomics (the variability of patient responses to drugs due to genetic differences).

Computational/Experimental Systems Biology
The availability of complete genome sequences has also brought about a new paradigm in which entire systems—for example, genetic regulatory pathways and intracellular signaling pathways—are investigated as a whole. It is these networks of genes, gene products, and other cellular components that orchestrate the development of an organism and all of its systems, and allow those systems to function in concert. This was a predominant theme at the 2001 UCSC Human Genome Workshop attended by many of the world's top scientists in the fields of genomics, bioinformatics, and molecular biology. This area is a very good fit for the BME Department, because it builds off of the bioinformatics strengths described above, and is a natural progression from the more basic studies of genome structure and function. Microarray technology will play a key role in understanding systems biology, as will newly developed proteomics techniques. With the first hire for the BME Department, Prof. Todd Lowe, and through collaborations with MCD Biology, we have already begun building expertise in microarray technology. With new hires planned in systems biology, laboratory automation, microarray/microfluidics and proteomics, the BME Department will have a strong presence in this area.

Technology Development
Another focus of the BME Department will be on the development of technology and informatics methods for basic biological and biochemical discovery, medical applications, biodetection and environmental monitoring. We will build strength in developing both

laboratory devices and analytical tools for areas such as: detecting genetic polymorphisms, diagnosis of infectious agents, identification of biohazards and environmental toxins, and environmental population surveys to detect environmental threat.

A fourth possible area of research excellence is proteomics—the application of computational methods to study the full complement of proteins in a cell, their modifications, and their interactions or protein engineering—the computational design of proteins to enhance or modify their functions. BME Department hires in any of the proposed areas could potentially focus on proteins, and our searches will be broad enough to include protein researchers in our pools. This area would fit well with and compliment the other research targets of the department—in fact, a proteomics focus will develop to some extent from the other target areas. Whether this area is further developed or not depends in part on the pool of applicants and the direction and interests of the early hires.

COMPUTER ENGINEERING RESEARCH PROGRAMS

We are presently focused on four core areas of computer engineering, and are collaborating with faculty in other departments on two additional areas. During the next ten years, we expect to strengthen these existing areas and also emphasize the area of Embedded and Autonomous Systems. We propose to have approximately five faculty in each of our areas of excellence (not all in CE) to provide critical mass for strong research programs able to present and fund focused large projects with multiple PIs. The existing areas include:

- **Computer System Design** studies the creation of computer and digital systems to solve problems. We currently perform work in parallel and distributed computation, performance modeling, field-programmable gate array (FPGA) and very large scale integration (VLSI) system design, and storage systems. Research strengths in computer science complement several of these areas. We are particularly interested in a senior recruitment in the area of Reconfigurable System Design. Computer System Design is a subfield of the SoE target area of computer and embedded system design.
- **Design Technologies** includes both the hardware and software technology needed to design and build complex digital systems. Our current research includes Computer Aided Design (CAD) for nanoscale system design, CAD for FPGA design, and CAD for VLSI design and testing. Research strengths in electrical engineering complement several of these areas. Design Technologies is a subfield of the SoE target area of VLSI and nanosystems technology.
- **Computer Networks** includes the technology, software, and algorithms required to make large networks of computing devices. Research areas presently include design and evaluation of protocols for wired and wireless networks, network switching, and internetworking research. Computer Networks is a subfield of the SoE target areas of information technology and of communications.
- **Digital Media and Education Technology** has an emphasis on computer systems and technologies for video processing. One of the most important uses of this technology for UCSC will be in distance education. Our current research includes image storage and retrieval, data and image compression, multimedia systems, image and video reconstruction and modeling, human-computer interaction, machine vision. In education technology, CE faculty have taken leading roles in the use of distance learning and Web tools for courses, and are collaborating with the EE and Education departments in studying the teaching of undergraduate engineering. Research strengths in electrical engineering and in computer science complement several of these areas. Digital Media and Education Technology is a subfield of the SoE target areas of human-computer interface and information technology.
- **Software and Systems Engineering** includes the design of complex software (software engineering) and hybrid hardware/software (systems engineering) systems. Computer Engineering faculty are collaborating with Computer Science faculty to create new academic and research programs in this area. Present strengths in Computer Engineering include formal methods for system design and analysis and embedded software. This is one of the SoE's target areas of excellence.

- **Bioinformatics and Biomolecular Engineering** study the application of computers and technology to biomolecular data gathering and analysis. Computer Engineering is taking a major part in the development of new degree programs and the Department of Biomolecular Engineering, to which the programs and some of the faculty will transfer on creation. Present strengths within Computer Engineering include, protein structure prediction, high performance computing for computational biology, genomics, and microarrays. This is one of the SoE's target areas of excellence.

And the new area:

- **Embedded and Autonomous Systems** will focus on three related areas: embedded systems, sensor nets, and autonomous systems. Embedded systems include the ubiquitous computers in aircraft, automobiles, and microwaves. Although the systems range from simple to complex, the integration of physical, electronic, and computer components into a working computer-controlled system is a very difficult problem and a growing area of research. Sensor nets are collaborative networks of tiny, inexpensive sensors that could enable smart highways, sophisticated environmental monitoring, and systems for enabling remote interplanetary virtual presence. The systems integrate many areas already studied or to be studied within the School, including low-power system design, computer system design, architectures for wireless systems, and networking. Autonomous systems are mobile embedded systems that are able to sense and interact with the environment. Autonomous systems will have a major social and technological impact, with applications encompassing medical robots, interplanetary exploration, aid for the motion-impaired, and unmanned rescue missions. Embedded and Autonomous systems is a subfield of the SoE target area of computer and embedded system design.

COMPUTER SCIENCE RESEARCH PROGRAMS

The Computer Science Department carries out a substantial research program that focuses on selected key areas of computer science and strives for synergistic interaction with other disciplines in science and engineering. The Computer Science department already contributes strongly to the campus's research excellence in several key areas, including:

- Bioinformatics,
- Computer Systems (especially storage systems),
- Machine Learning,
- Visualization, Graphics, and Human-Computer Interfaces.

The Graham-Diamond survey ranks graduate programs by citation density, and places our Computer Science Department in the top twenty nationally, and third in the UC system. Computer Science will expand its areas of excellence by using the Computer Systems focus as the base for a broader Information Technology Infrastructure initiative and adding a new area of emphasis in Software Engineering.

Under the leadership of Computer Science Professor David Haussler, the interdisciplinary **Bioinformatics Group** has received national and international recognition at the highest levels of academia, government, and industry for its pioneering work and its crucial contributions to the human genome project. As in the past, the Computer Science Department will continue to advocate and support the development of bioinformatics at UCSC.

In the 1980s much emphasis was placed on high performance computing, but the past decade has seen a shift in emphasis to what could be described as "information technology infrastructure". This encompasses the storage, maintenance, manipulation, transmission, and retrieval of information in an efficient and secure way. In addition to established areas like operating systems, distributed systems, relational database systems, and networks, the emerging areas of storage systems, heterogeneous databases, data mining, and computer security play a significant role in this information technology infrastructure area.

The Computer Science Department will build on its excellent **storage systems group** led by Professor Darrell Long and capitalize on its recent recruitment of world-class security expert Professor Martin Abadi to become a top department in this information technology infrastructure area. With the strong computer networks group in the Computer Engineering department, the main area needed to complete this concentration of emphases is **Database Systems**, an area in which the Computer Science Department is recruiting for a senior lead faculty member this year. This information technology infrastructure area achieves synergy with the other research foci of the department and school, as well as between its component areas. Not only is the Bioinformatics Group interested in both genomic databases and data mining of genomic data, but **Data-mining and the Machine Learning** area have significant synergy and many Graphics applications can benefit from efficient large storage systems.

The Machine Learning group is led by Professor Manfred Warmuth and is recognized as one of the leaders in developing and explaining some of the most successful machine learning algorithms and paradigms, such as: Boosting, On-line Learning Algorithms, Adaptive Algorithms, and Support Vector Machines. The Computer Science hiring plan includes adding applied learning faculty who will help put into practice the fundamental advances generated by our strong group of learning faculty and increase our visibility in the more empirical learning communities. In addition to the synergies between Machine Learning and the areas of Computational Biology, Bayesian Statistics, and Artificial Intelligence, there is a strong synergy between the Machine Learning faculty and the Storage Systems group as the adaptive algorithms developed by the Machine Learning group can be used to improve performance on a variety of systems tasks.

Visualization has emerged as one of the most important ways to assimilate data or information that has traditionally been presented in the textual or tabular form. The importance of utilizing other senses such as sound, gesture, pose, haptics and smell, in order to create a compelling scenario for learning, exploring, and discovery has given rise to fervent research activities in the area of virtual reality interfaces. Related challenges spur research activities in visualization, graphics, human-computer interaction, collaborative/distance learning, user interfaces and digital media. The Computer Science Department currently has a group of three strong graphics faculty (Professor Jane Wilhelms and Associate Professors Alex Pang and Suresh Lodha), one of the best graphics groups in the UC system. This group has close working ties with several agencies within the Silicon Valley, and has worked with other groups within the department for, e.g., visualizing protein alignment data and real time environmental data. Careful hiring in the subareas of **human-computer interaction** and virtual reality along with the development of a top-notch display showcase/virtual reality lab will allow UCSC to become a national leader in this field.

Software Engineering is one of the major programmatic initiatives of the School of Engineering; as such, it is a planned area of excellence of both the Computer Science Department and the School of Engineering as a whole. The Computer Science Department is taking the lead to successfully develop software engineering at UCSC with the help of the CE department. Our initial hire in the area, Assistant Professor Jim Whitehead, has just had his NSF CAREER proposal recommended for funding by the program director. We see an opportunity for UCSC to achieve national eminence in this area by hiring outstanding software engineering faculty, developing first-rate graduate programs, and establishing a high-profile research and educational presence at the Silicon Valley Center.

ELECTRICAL ENGINEERING RESEARCH PROGRAMS

The general areas of excellence in the Electrical Engineering strategic plan cover a set of important areas on the forefront of electrical engineering with excellent opportunities in research and funding. The targeted areas of research respond to the needs of industry, especially in Silicon Valley. Our major areas of research in both undergraduate and graduate education are as follows:

- Photonics and Electronics
- VLSI, MEMS and Nanotechnology
- Communications, signal and image processing.

EE also supports the campus wide environmental initiative through research in environmental technology. The teaching and research areas listed above will provide the ‘critical mass’ for strong graduate and research programs in electrical engineering. Future growth is currently focused on VLSI design and nanotechnology with the arrival of Prof. Steve Kang as the new Dean of Engineering and a new leadership position authorized for hire next year. The EE department also has a state-of-the-art molecular beam epitaxy (MBE) machine as the basis for research into optoelectronics and nanodevices. We review these focus areas briefly below and in more detail in the EE Strategic Plan in the Appendix.

Photonics and Electronics

Photonics and Electronics are strongly represented within our current faculty, covering a broad range of research interests from LCD displays and analog circuit design, to integrated optoelectronic and photonic devices. Proposed growth in the photonics/electronics area will further strengthen our existing faculty. Fiber optic communication and optoelectronic circuits have expanded rapidly in the last decade due to the very large increase in Internet and wireless traffic. This trend is likely to continue to expand. A new professor this year is Dr. Holger Schmidt, whose research in optically controlled optical switches will greatly strengthen the department. We hope to hire a world-class researcher for the endowed Kapany chair in optoelectronics in the near future. Faculty research in the photonics/electronics group will complement the effort in VLSI/Nanotechnology and will create a bridge with the more theoretical research in signal and image processing and communication.

VLSI/MEMS/Nanotechnology

Micro-nanotechnology is one of the key engineering areas for the 21st century. In nanotechnology there have been several initiatives at the National Science Foundation and Department of Energy (the Scientific American, September 2001). Although other institutions are investing in nanotechnology, a strategic niche available for UCSC would be to link non-conventional areas of nanotechnology to the California Center of Excellence in Biotechnology at UCSF/UCSC. UCSC’s EE department can have a significant impact in this center with the recruitment of key people at the interface of electronics, nanomechanics, chemistry, optics and biology areas. This would complement the bioinformatics field of the School under Prof. David Haussler. EE would focus on topics, such as, novel sensors, intelligent chips (labs on a VLSI chip), novel imaging techniques and the use of chemistry/bio for new devices and IC’s. Micro-electro-mechanical devices (MEMS) are a related area of interest with nearer term prospects for applications and hence of more interest to industry. In the VLSI design area we are developing a Center for Integrated Circuit Design that we hope will supply the VLSI circuit designers (especially analog) so needed in industry. To ensure success and recognition in this area, the recruitment of a world-class professor in the field is required with strong attributes in research and teamwork to lead this focus area.

Communications, signal and image processing
Communications, signal and image processing combines a group of closely related fields, all important to communications systems as well as other fields. Wireless communications is experiencing explosive growth that is expected to last for a decade or more. In the future there will be increased integration of various sensors with communication devices and networks. As an example, small low cost cameras are used extensively for monitoring, recording, and surveillance. The communication, processing and managing of information from a large number of distributed sensors presents many challenging research problems and is an exciting high growth field of study. The communication, signal and image- processing group will focus on the engineering challenges and opportunities arising at the confluence of these three sub-disciplines. Dr. Hamid Sadjadpour, a new faculty member specializes in information coding and the design of related hardware, such as DSL modems. There is significant opportunity for interplay between this focus area and the MEMS and the nanotechnology area mentioned above, i.e. VLSI/MEMs/nanotechnology for communications and signal processing. This interplay provides a useful niche in which the EE department can prosper. Examples of this type of work would be the use of MEMS in wireless applications (mechanical resonators, capacitors and inductors for high Q filters), and radio frequency and optical switches.

Science, Technology, Engineering, Policy & Society (STEPS)
Environmental technology, remote sensing in particular, is the EE Department’s participation in the campus wide environmental initiative using the STEPS approach (Science, Technology, Engineering, Policy and Society). Prof. Vesecky has specific interests in remote sensing instrumentation systems, electromagnetics and wave scattering. As a result, he is very well suited to contribute to the engineering aspects of this initiative and the related campus institutions, such as the newly formed Institute for Geophysics and Planetary Physics (IGPP). Joint degree programs emphasizing environmental technology are anticipated.

ORGANIZED RESEARCH UNITS (ORU)

The focus of Organized Research Units is the fostering of interdivisional interactions through joint research projects, coordinated faculty hiring, and the development of joint academic programs designed for a better understanding of information technology, engineering and industry.

The School plans to have three organized research units. These are: Center for Biomolecular Science and Engineering (CBSE), Institute for Networking, Information Systems, and Technologies (iNIST) and the creation of a third ORU, the Center for Innovative Materials, Sensors, and Systems, centered on multidisciplinary science and engineering including materials, mechanical and environmental engineering. Each unit encompasses a set of research activities with focus on our targeted areas of excellence.

The Center for Biomolecular Science and Engineering
The Center for Biomolecular Science and Engineering (CBSE) is a Focused Research Activity (FRA) housed within the Baskin School of Engineering and spanning to two other divisions: the Division of Natural Sciences, and the Division of Social Sciences. The CBSE currently has 43 faculty members from nine departments: Computer Science (4), Computer Engineering (4), Applied Mathematics and Statistics (2), Molecular, Cell and Developmental Biology (14), Chemistry and Biochemistry (12), Environmental Toxicology (4), Environmental Studies (1), Community Studies (1), and Physics (1).

Directed by CS Professor and Howard Hughes Medical Institute (HHMI) investigator David Haussler, the CBSE first took shape in 1999 and became an official FRA early in 2001. The CBSE is poised to become an Organized Research Unit (ORU) with submittal of a formal proposal in 2002. The interdisciplinary research and faculty recruitment efforts of the CBSE have paved the road for the creation of a new Biomolecular Engineering department in the School of Engineering, and it is working diligently to establish new interdisciplinary academic programs.

Mission: To foster interdivisional interactions through joint research projects, coordinated faculty hiring, and helping to develop joint academic programs and courses aimed at a better understanding of biology and human health. These efforts are unified by the common theme across the divisions of approaching problems in biology and medicine through the study of human and model organism genomes. The DNA code of life is amenable to intense study by both computational and experimental approaches, and will be best understood when these complementary approaches are coordinated to tackle specific problems. Such coordination is a primary goal of the CBSE. Specific functions of the CBSE are to:

- Facilitate interdisciplinary research that supports the study of genomic information and structural biology
- Create a stimulating research environment for training in interdisciplinary fields of study that are critical to biomedicine in the post-genomic era
- Seek extramural funds in support of our research and teaching missions
- Support a core of instrumental and computational facilities

- Cultivate productive relationships and collaborations between the divisions and with high-tech and biotechnology industries and with other research institutions

Target Areas of Research Excellence: Highlighted below are a few of the areas of research excellence supported by the CBSE. We will broaden our scope as new faculty are hired into areas that are consistent with our mission.

- **Human Genome Project:** The Human Genome Project, initiated in 1990, is a publicly funded, international collaboration to fully sequence a reference human genome. Prof. David Haussler leads a team of students and technical staff in generating up to date assemblies of the human genome sequence for the Human Genome Project. They have created and maintain a web browser that displays the genome sequence aligned and annotated with additional data, including information on human genes and their variation in the population, their locations in the maps of inherited human diseases, their relation to corresponding genes from other species, and many other kinds of information. The UCSC Human Genome web pages receive over 30,000 requests per day and transmit an average of 8.4 gigabytes of data on a daily basis.

- **Mammalian Gene Collection:** The Mammalian Gene Collection is an NIH-sponsored project to generate a complete set of full-length sequences and cDNA clones of expressed genes for human and mouse—a "gold standard set of mammalian genes". Professor Haussler and a team of UCSC researchers have been contracted to provide informatics expertise for this project.

- **Gene Splicing:** One gene can generate multiple forms of protein products through a process called alternative splicing. CBSE members Manny Ares and Alan Zahler of MCD Biology study several aspects of splicing. Computational approaches are coupled with the laboratory work of Ares and Zahler to identify and validate alternate splice forms of genes. Graduate student Jim Kent developed a program for identifying alternatively spliced genes in the roundworm *C. elegans*; further development of this program by Kent led to the UCSC Human Genome Browser.

- **Molecular Nanopore Technology:** Chemistry faculty member David Deamer, HHMI Research Specialist Mark Akeson and their team have developed a nanopore constructed of a biological molecule that is able to discriminate between different DNA sequences as they pass through the pore. Haussler and graduate student Stephen Winters-Hilt are developing a machine learning algorithm capable of identifying single DNA base pairs in real time. This device, when fully developed, should have many possible uses such as DNA fingerprinting, detection of disease genes, and pathogen identification.

Interdivisional Collaborations: Interdivisional and intercampus collaborations are the primary focus of the CBSE. In 2000, the School of Engineering and the Division of Natural Sciences submitted a joint initiative proposal requesting support for the CBSE in the form of new, interdisciplinary faculty positions, the consideration of new academic programs and a new Biomolecular Engineering Department, and funding for equipment and personnel. This proposal resulted in four new faculty FTE—two each in Engineering and Natural Sciences. The CBSE is continuing its work to establish new interdivisional academic programs, recently submitting a proposal for Graduate Studies in Bioinformatics, and a Biomolecular Engineering Department Long Range Plan that will serve as the springboard for development of a formal department proposal within the coming year.

The CBSE coordinates and obtains funding for large interdisciplinary, interdivisional research projects. Two of the current projects—"Bioinformatics and Microarray Expression Analysis of Nervous System Function" and the "UCSC Center for Genomic Sciences"—involve seven faculty from Natural Sciences, six from Engineering, eight staff positions, and students and post docs from both divisions. The CBSE will continue to coordinate and obtain funding for such projects. In addition, many individual CBSE members have formed collaborations with faculty and researchers from other departments and divisions.

Participation in QB3, a California Institute for Science and Innovation: The CBSE coordinates UCSC's participation in the "Institute for Biotechnology, Bioengineering, and Quantitative Biomedicine (QB3)" one of the Governor's first California Institutes of Science and Innovation (Cal ISIs). A cooperative effort between UCSF, UC Berkeley, UCSC and industry, QB3 endeavors to harness the quantitative sciences to create fundamental new discoveries, products, and technologies for the benefit of human health. Current major efforts of the CBSE for QB3 include coordinating internal research groups in the areas of Structural and Chemical Biology, Experimental Genomics/Proteomics Biochemistry, Bioinformatics and Computational Chemistry, and Bioengineering and Biotechnology. The CBSE also serves as primary consultant in the design of QB3-funded space in the new Physical Sciences and Engineering Building and the new Engineering II Building.

The CBSE is also coordinating the participation of UCSC in a proposal for a UC-wide MRU entitled the **"Bioengineering Institute of California"**. Two of the primary goals of the MRU are to establish a modern information infrastructure with facilities and staffing for broadband inter-campus transmission, and to make possible the sharing of databases, broadcasting of teaching materials, tele-operation of specialized instruments, video conferencing, and telecommunication.

CBSE Funding: Most of the major funding agencies and private foundations allocate substantial portions of their budgets to research awards in areas relevant to the CBSE—bioinformatics, proteomics, and various types of technology development. The CBSE faculty are strong candidates for such awards, and individually and through collaborative projects organized by the CBSE, have had extraordinary success in obtaining extramural funds. Considering CBSE faculty as a whole, approximately 74% (or 32 faculty) have active extramural research funding. According to reports generated by the Office of Sponsored Projects on November 5, 2001, current year funding for these 32 faculty totals approximately $15.2 million, of which approximately 19%, or $2.9 million represents indirect costs. Annual awards for CBSE-submitted proposals have increased approximately 10-fold from roughly $0.5 million in 1999-00 to close to $5 million in 2003-04. The CBSE will also work closely with the new Director of Development in Engineering to seek out other public and private sources of support.

Operating Expenses: CBSE funds are allocated for capital projects, equipment, undergraduate and graduate student support, postdoctoral fellows, technical and administrative staffing, travel, publications, and other general operating expenses. The CBSE currently employs a full-time staff of two administrators, two technical staff, two researchers and one postdoctoral fellow; several other research staff work on a part-time basis. Research funds are available for nine more research staff positions and three postdoctoral fellows, and recruitments are underway for some of these positions. The need for one more administrative staff and one web designer/technical staff by 2003-4 are projected. In addition, QB3 funds are creating space for an additional 30 positions (visiting scholars, adjunct faculty, staff, and postdocs) that will be funded from extramural sources.

The CBSE is currently very close to being self-sustaining, in that all staff, except one administrator and two future positions, are funded from extramural sources. The CBSE's goal is to become entirely self-sustaining by recovering a percentage of the indirect costs it generates to fund these three positions.

INSTITUTE FOR NETWORKING, INFORMATION SYSTEMS, AND TECHNOLOGIES (iNIST)

The Institute for Networking, Information Systems, and Technologies (iNIST) was created in 2001 to serve as an umbrella organization for several planned centers of research excellence. Its primary purpose is to advance research, related systems that are data-intensive and to the Internet. iNIST is organized as a federation of research centers, each focusing on an area of systems or networking, supporting technologies, or applications related to the Internet and data-intensive systems.

iNIST targets research in an inter-related set of areas of interest to faculty coming from a variety of disciplines including Computer Science, Computer Engineering, and Electrical Engineering (as well as some from Physics, Chemistry, and Applied Mathematics). Areas of emphasis include:

- Internet and information systems: architecture, performance and applications
- Multimedia systems and applications in education, telecommuting, and distance learning.
- Design and development of complex networked systems and software technologies
- Storage systems and databases
- Communications,
- Opto-electronics (including nanotechnology devices)
- VLSI design, packaging, testing, Sensors and Internet appliances

The iNIST will provide the organizational and management structure to support large and interdisciplinary projects. It will also facilitate the sharing of resources and staff (especially computing and networking), as well as engaging in research in applications of the emerging capabilities of the Internet to such exciting areas as distance education, telecollaboration and telecommuting. A major function of the iNIST is the coordination and management of interactions and cooperation with industry. These include management for arrangements for industry research staff working at iNIST on cooperative projects with industry and the use by iNIST of facilities and equipment in local industrial laboratories, including capabilities for fabrication of devices, nanotechnology, etc.

iNIST will promote and administer the participation with other research partnerships of its faculty, including the activities of the UCSC School of Engineering in the California ISI CITRIS (with UC Berkeley, UC Davis and UC Merced); NPACI and the San Diego Supercomputer Center; the High Dependability Computing Consortium (with NASA Ames and Carnegie Mellon and other universities); and MBARI; and local universities with mutual research interests including the Naval Postgraduate School, San Jose State University, California State University at Monterey Bay, and MBARI.

The faculty participating in this ORU will be mainly from Computer Science, Computer Engineering and Electrical Engineering. In the areas of opto-electronics, faculty from Physics and Chemistry will participate in joint research with Engineering faculty. Storage research may involve faculty from Physics and Chemistry as well as Computer Science, Computer Engineering and Electrical Engineering. Research in instrumentation and remote sensing is expected to develop with participation of faculty from the Natural Sciences and Environmental Studies. Work in multimedia networking applications should lead to research partnerships with the Digital Arts–New Media, which already has close ties to the Engineering faculty in computer graphics and computer systems.

Projected Ten-Year Growth

Tenure-track faculty of iNIST are members of academic departments of the School of Engineering. Today we count approximately 30 faculty in the research areas covered by iNIST, and expect to participate over the next ten years 50 or 60 ladder-rank faculty. Research areas in iNIST will influence academic departments in their hiring and allocation of FTE to those departments but iNIST will not recruit ladder-rank faculty of its own.

Research faculty or non-tenure-track can be recruited, managed and employed via iNIST. The research faculty are primarily funded with extramural and other sources and therefore generally do not count as FTE in the School of Engineering faculty. With the success of CITRIS, the HDCC, the development of the various centers of iNIST and anticipated industrial partnerships, the number of research faculty required for these programs can bring an additional 20-25 researchers to iNIST over the next ten years. It is envisioned that some of these iNIST researchers will come directly from industry, on an assignment basis to participate in joint research projects with iNIST. In addition, a staff of 10-20, including programmers, system managers, technical and clerical assistants will be part of the iNIST organization. We anticipate that extramural funds developed by research staff will provide sufficient resource for required space and infrastructural support.

CENTER FOR INNOVATIVE MATERIALS, SENSORS AND SYSTEMS (CIMSS)

The Center for Innovative Materials, Sensors and Systems (CIMSS) will promote research in both biomaterials and novel functional materials critical for biotechnology, information technology, nanotechnology, smart sensor development, environmental sensing, and environmental technology, nanoelectromechanical systems, microarrays and microrobots. Technology development for sustainable products can also be an important research mission in order to ensure that future industrial products and services are ecologically balanced, environmentally sound, and socially responsive to ensure a collective future for all mankind. We plan to build multidisciplinary academic research programs in materials engineering and environmental engineering following the example of the biomolecular engineering program through the Center for Biomolecular Science and Engineering (CBSE).

Potential participants include professors Ali Shakouri, Ken Pedrotti, and chair of Electrical Engineering John Vesecky; Susan Carter of Physics, David Deamer of Chemistry, and Todd Lowe of Biomolecular Engineering and Russ Flegal of Environmental Toxicology. Additionally, the new senior Sensors and Systems hire in Electrical Engineering will play a key

TABLE 4 Engineering Program Funding Uses

		Proposed Changes						Projected
	2000-01	2001-02		2005-06		2010-11		2010-11
Primary Cost Components:	**Existing Base**	**One-time**	**Ongoing**	**One-time**	**Ongoing**	**One-time**	**Ongoing**	**Base Budget**
Applied Mathematics and Statistics								
Faculty								
FTE	6.00				7.00		11.00	17.00
Salaries	428,800				560,900		904,600	1,333,400
Start-up		40,000		745,000		1,301,000		0
Teaching Assistants								
FTE	0.00		2.17		5.45		5.68	5.68
Salaries			61,389		154,181		160,687	160,687
Administrative Staff								
FTE	2.25		0.50		1.25		1.75	4.00
Salaries	91,722		15,498		41,771		56,873	148,595
Benefits			3,897		9,808		13,206	13,206
I&R Support	8,475	(560)	4,500	41,440	55,500	65,440	89,500	97,975
AMS Subtotal	**528,997**	**39,440**	**85,284**	**786,440**	**822,160**	**1,366,440**	**1,224,866**	**1,753,863**
Biomolecular Engineering								
Faculty								
FTE			3.00		11.00		14.00	14.00
Salaries			193,200		907,900		1,195,000	1,195,000
Start-up		160,000		3,157,000		4,500,000		0
Teaching Assistants								
FTE	0.00		0.22		1.70		2.39	2.39
Salaries			6,224		48,093		67,613	67,613
Administrative Staff								
FTE	1.00				2.60		2.60	3.60
Salaries	51,218				94,576		94,576	145,794
Benefits					21,281		21,281	21,281
I&R Support		(1,500)	4,500	46,500	64,000	64,500	89,500	89,500
BME Subtotal	**51,218**	**158,500**	**203,924**	**3,203,500**	**1,135,850**	**4,564,500**	**1,467,970**	**1,519,188**
Computer Engineering								
Faculty								
FTE	14.00		4.00		9.00		13.00	27.00
Salaries	1,266,795		277,500		712,300		1,032,300	2,299,095
Start-up		140,000		1,334,000		2,086,000		0
Teaching Assistants								
FTE	6.33		0.00		0.49		0.49	6.82
Salaries	178,183				13,862		13,862	192,045
Administrative Staff								
FTE	2.25		0.50		2.75		3.75	6.00
Salaries	86,968		21,250		95,243		130,274	217,242
Benefits			4,495		21,143		29,025	29,025
I&R Support	53,225	28,580	18,000	58,580	60,500	82,580	94,500	147,725
CE Subtotal	**1,585,171**	**168,580**	**321,245**	**1,392,580**	**903,048**	**2,168,580**	**1,299,961**	**2,885,132**
Computer Science								
Faculty								
FTE	17.00		5.00		16.00		20.00	37.00
Salaries	1,465,695		391,150		1,357,450		1,702,850	3,168,545
Start-up		156,500		2,822,500		4,058,500		0
Teaching Assistants								
FTE	10.17		1.16		1.19		1.19	11.36
Salaries	286,275		32,816		33,665		33,665	319,940
Administrative Staff								
FTE	2.25		0.50		3.25		3.25	5.50
Salaries	91,722		15,498		113,930		113,930	205,652
Benefits			3,897		26,044		26,044	26,044
I&R Support	48,025	23,870	8,500	89,870	93,500	113,870	127,500	175,525
CS Subtotal	**1,891,717**	**180,370**	**451,861**	**2,912,370**	**1,624,589**	**4,172,370**	**2,003,989**	**3,895,706**
Electrical Engineering								
Faculty								

FTE	10.00				7.00		11.00	21.00
Salaries	832,450		21,200		642,100		951,700	1,784,150
Start-up		200,000		1,559,000		2,636,000		
Teaching Assistants								
FTE	0.33		0.50		3.74		4.90	5.23
Salaries	9,289		14,145		105,805		138,621	147,910
Administrative Staff								
FTE	2.25		0.50		2.75		3.75	6.00
Salaries	86,968		21,250		95,243		130,274	217,242
Benefits			4,495		21,143		29,025	29,025
I&R Support	35,250		8,500	42,000	59,500	66,000	93,500	128,750
EE Subtotal	**963,957**	**200,000**	**69,590**	**1,601,000**	**923,791**	**2,702,000**	**1,343,120**	**2,307,077**
Information Systems Management								
Faculty								
FTE					6.00		10.00	10.00
Salaries					584,300		889,900	889,900
Start-up				1,171,000		2,023,000		0
Teaching Assistants								
FTE	0.00		0.78		2.73		3.41	3.41
Salaries			22,066		77,232		96,469	96,469
Administrative Staff								
FTE	0.00		0.00		1.00		2.50	2.50
Salaries					35,032		72,586	72,586
Benefits					7,882		16,332	16,332
I&R Support				36,000	42,500	60,000	76,500	76,500
ISM Subtotal	**0**	**0**	**22,066**	**1,207,000**	**746,946**	**2,083,000**	**1,151,787**	**1,151,787**
Graduate Advising								
Administrative Staff								
FTE	1.50		0.50		1.50		2.50	4.00
Salaries	57,166		16,170		58,470		96,895	154,061
Benefits			1,682		10,651		19,217	19,217
I&R Support			3,500		7,500		11,500	11,500
Subtotal	**57,166**	**0**	**21,352**	**0**	**76,621**	**0**	**127,612**	**184,778**
Undergraduate Advising and MEP								
Administrative Staff								
FTE	5.50		0.75		4.25		5.25	10.75
Salaries	200,214		30,459		180,272		218,697	418,911
Benefits			7,738		39,314		47,880	47,880
I&R Support	6,300		1,200		15,200		19,200	25,500
Subtotal	**206,514**	**0**	**39,397**	**0**	**234,786**	**0**	**285,777**	**492,291**
BELS Instructional Lab								
Technical Staff								
FTE	2.00		0.00		3.00		4.00	6.00
Salaries	111,997				164,975		221,375	333,372
Benefits					30,867		41,303	41,303
I&R Support	47,000		5,000		28,248		32,248	79,248
Equipment					507,395		507,395	507,395
Subtotal	**158,997**	**0**	**5,000**	**0**	**731,485**	**0**	**802,321**	**961,318**
Technical Support								
Technical Staff								
FTE	9.75		0.00		5.00		6.00	15.75
Salaries	589,334				290,954		332,708	922,042
Benefits					53,109		62,021	62,021
I&R Support	238,875		6,865		124,785		220,040	458,915
Equipment					662,539		1,114,989	1,114,989
Subtotal	**828,209**	**0**	**6,865**	**0**	**1,131,387**	**0**	**1,729,758**	**2,557,967**
Facilities								
Administrative Staff								

FTE	1.50		0.50		1.50		1.50	3.00
Salaries	74,642		9,088		48,838		48,838	123,480
Benefits			945		9,649		9,649	9,649
I&R Support	25,000		17,000		21,000		21,000	46,000
Subtotal	**99,642**	**0**	**27,033**	**0**	**79,487**	**0**	**79,487**	**179,129**
Development and Industrial Relations								
Administrative Staff								
FTE	0.49		0.49		2.49		2.98	3.47
Salaries	30,883		13,959		136,509		165,260	196,143
Benefits			3,691		25,576		30,805	30,805
I&R Support					8,000		9,960	9,960
Subtotal	**30,883**	**0**	**17,650**	**0**	**170,085**	**0**	**206,025**	**236,908**
Dean's and Business Offices								
Administrative Staff								
FTE	8.50		1.00		4.50		6.50	15.00
Salaries	572,381		28,488		163,006		233,068	805,449
Benefits			7,533		37,517		53,943	53,943
I&R Support	25,000				14,000		22,000	47,000
Divisional-Other	1,032,183	(50,390)	(187,239)	(50,390)	(187,239)	(50,390)	(187,239)	844,944
Temporary Academic Staffing	384,946		(281,300)		(281,300)		43,591	428,537
Staff Salary Collection	(66,702)							(66,702)
Subtotal	**1,947,808**	**(50,390)**	**(432,518)**	**(50,390)**	**(254,016)**	**(50,390)**	**165,363**	**2,113,171**
Furniture *								
Graduate Students				504,700		934,267		0
Staff				56,525		75,833		0
Researchers				59,850		129,675		0
Subtotal	**0**	**0**	**0**	**621,075**	**0**	**1,139,775**	**0**	**0**
Total School of Engineering								
Faculty								
FTE	47.00	0.00	12.00	0.00	56.00	0.00	79.00	126.00
Salaries	3,993,740	0	883,050	0	4,764,950	0	6,676,350	10,670,090
Start-up	0	696,500	0	10,788,500	0	16,604,500	0	0
Temporary Academic Staffing	384,946	0	(281,300)	0	(281,300)	0	43,591	428,537
Teaching Assistants								
FTE	16.83	0.00	4.83	0.00	15.30	0.00	18.06	34.89
Salaries	473,748	0	136,641	0	432,837	0	510,917	984,665
Administrative Staff								
FTE	27.49	0.00	5.24	0.00	27.84	0.00	36.33	63.82
Salaries	1,343,884	0	171,660	0	1,062,890	0	1,361,271	2,705,155
Benefits	0	0	38,373	0	230,008	0	296,407	296,407
Technical Staff								
FTE	11.75	0.00	0.00	0.00	8.00	0.00	10.00	21.75
Salaries	701,331	0	0	0	455,929	0	554,083	1,255,414
Benefits	0	0	0	0	83,976	0	103,324	103,324
I&R Support	487,150	50,390	77,565	314,390	594,233	452,390	906,948	1,394,098
Equipment	0	0	0	0	1,169,934	0	1,622,384	1,622,384
Divisional - Other	1,032,183	(50,390)	(187,239)	(50,390)	(187,239)	(50,390)	(187,239)	844,944
Staff Salary Collection	(66,702)	0	0	0	0	0	0	(66,702)
Furniture *	0	0	0	621,075	0	1,139,775	0	0
SOE Grand Total	**8,350,280**	**696,500**	**838,750**	**11,673,575**	**8,326,218**	**18,146,275**	**11,888,036**	**20,238,316**

* Faculty and department staff furniture included in departmental I&R support.
** Figures above for FY 2005-06 and 2010-11 are reflected in FY 2001-02 dollars.

TABLE 5 ENGINEERING PROGRAM FUNDING SOURCES

	2005-06		2010-11	
Proposed Funding Sources:	**One-time**	**Ongoing**	**One-time**	**Ongoing**
Existing Divisional Resources	See Table 1		See Table 1	
FY 2002 Funding:				
Faculty FTE		6.00		6.00
Upgrades/Merits		86,350		86,350
Start-up	696,500		696,500	
Growth Funding		752,400		752,400
Central Resources:				
Faculty FTE		44.00		67.00
Upgrades		1,035,100		1,458,400
Start-up	10,092,000		15,908,000	
Growth Funding		5,079,426		7,622,824
Furniture	885,075		1,541,775	
Office of the President				
Multicultural Engineering Program		114,623		114,623
SOE Generated Funding:				
Extramural Awards		86,016		98,682
Opportunity Funds		491,306		995,364
Development		488,029		532,445
Industrial Affiliates		144,435		144,435
STIP		48,533		82,513
Support from other Campus units ***		0		0
Total	**11,673,575**	**8,326,218**	**18,146,275**	**11,888,036**

** Figures above are reflected in FY 2001-02 dollars.

*** The School of Engineering's interdivisional collaborations will not require outside contributions, except for the case of strategic hires. When multiple divisions have an interest in a particular candidate, upgrade and start-up costs should be fairly shared.

TABLE 6 PLANNING PROFILE - ALL SCHOOL

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Ladder Faculty FTE	59.00	64.00	76.00	86.00	97.00	103.00	111.00	116.00	121.00	125.00	126.00
Less: Open Positions	(21.00)	(16.00)	(13.00)	(10.00)	(8.00)	(6.00)	(5.00)	(5.00)	(5.00)	(5.00)	(3.00)
Plus: Lecturers/Adjuncts	6.42	12.00	13.50	13.00	13.50	14.00	12.50	11.75	9.00	6.00	3.00
Total Faculty FTE	**44.42**	**60.00**	**76.50**	**89.00**	**102.50**	**111.00**	**118.50**	**122.75**	**125.00**	**126.00**	**126.00**
Enrollment Targets											
Enrollment FTE											
Total Undergradute FTE	758.00	939.00	1,106.00	1,216.00	1,321.00	1,414.00	1,495.00	1,525.00	1,535.00	1,535.00	1,535.00
Total Graduate FTE	130.60	182.60	230.50	312.90	363.35	461.85	539.80	581.60	621.50	659.55	695.85
Total FTE	**888.60**	**1,121.60**	**1,336.50**	**1,528.90**	**1,684.35**	**1,875.85**	**2,034.80**	**2,106.60**	**2,156.50**	**2,194.55**	**2,230.85**
Workload Ratio	***20.00***	***18.69***	***17.47***	***17.18***	***16.43***	***16.90***	***17.17***	***17.16***	***17.25***	***17.42***	***17.71***
Majors - Headcount											
Undergraduate	952.00	1,140.00	1,300.00	1,450.00	1,595.00	1,735.00	1,875.00	1,940.00	1,970.00	1,980.00	1,990.00
Graduate	137.00	201.00	253.00	342.00	398.00	510.00	598.00	645.00	690.00	732.00	773.00
Total Majors	**1,089.00**	**1,341.00**	**1,553.00**	**1,792.00**	**1,993.00**	**2,245.00**	**2,473.00**	**2,585.00**	**2,660.00**	**2,712.00**	**2,763.00**
Research Targets											
Principal Investigators											
Ladder Faculty	39.00	49.00	64.00	77.00	90.00	98.00	107.00	112.00	117.00	121.00	124.00
Research Scientists	2.00	-	2.00	6.00	16.00	18.00	22.00	26.00	32.00	35.00	39.00
Total P.I.s	41.00	49.00	66.00	83.00	106.00	116.00	129.00	138.00	149.00	156.00	163.00
Total Awards	**5,000,000**	**8,060,000**	**11,945,000**	**16,350,000**	**21,335,000**	**24,460,000**	**27,795,000**	**30,525,000**	**32,860,000**	**34,530,000**	**36,075,000**
Total Expenditures	**3,729,247**	**5,252,500**	**8,043,000**	**12,148,000**	**19,081,000**	**24,248,500**	**27,612,000**	**30,445,500**	**33,452,400**	**35,172,500**	**36,766,200**
Indirect Cost Recovery (ICR)	**735,106**	**1,155,550**	**1,769,460**	**2,672,560**	**4,197,820**	**4,364,730**	**6,074,640**	**6,698,010**	**7,359,528**	**7,737,950**	**8,088,564**
ICR Rate	**19.71%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE	**16.83**	**21.67**	**24.80**	**27.39**	**29.89**	**32.14**	**33.98**	**34.66**	**34.89**	**34.89**	**34.89**
Student/TA Ratio	**45.03**	**44.80**	**44.60**	**44.40**	**44.20**	**44.00**	**44.00**	**44.00**	**44.00**	**44.00**	**44.00**
Staffing (FTE)											
Technical	11.75	11.75	15.75	16.75	18.75	19.75	20.75	20.75	21.75	21.75	21.75
Dept Admin	27.49	32.73	38.23	42.23	49.08	55.33	62.32	62.82	62.82	63.82	63.82
Total Staff	**39.24**	**44.48**	**53.98**	**58.98**	**67.83**	**75.08**	**83.07**	**83.57**	**84.57**	**85.57**	**85.57**
Graduate Support											
GSRs (quarters)	130.00	185.00	275.00	401.00	584.00	722.00	809.00	864.00	919.00	950.00	970.00
Teaching Assts (quarters)	101.00	130.00	150.00	165.00	180.00	192.00	204.00	207.00	208.00	208.00	208.00
Campus Fellowships (quarters)	16.00	38.00	41.00	54.00	63.00	80.00	93.00	101.00	108.00	114.00	120.00
Employment/Other (quarters)	15.00	15.00	20.00	25.00	29.00	36.00	42.00	45.00	49.00	51.00	54.00

TABLE 6 PLANNING PROFILE - APPLIED MATHEMATICS AND STATISTICS

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Applied Math	3.00	3.00	3.00	4.00	6.00	6.00	7.00	7.00	7.00	7.00	7.00
Statistics/Envirometrics	3.00	4.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	10.00	10.00
Total Ladder Faculty FTE	**6.00**	**7.00**	**7.00**	**9.00**	**12.00**	**13.00**	**15.00**	**16.00**	**17.00**	**17.00**	**17.00**
Less: Open Positions	(3.00)	(2.00)	(1.00)	(1.00)		(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	
Plus: Lecturers/Adjuncts	0.45	2.00	3.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00	
Total Faculty FTE	**3.45**	**7.00**	**9.00**	**11.00**	**15.00**	**15.00**	**17.00**	**17.00**	**17.00**	**17.00**	**17.00**
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Applied Math	9.00	50.00	70.00	90.00	110.00	120.00	125.00	125.00	125.00	125.00	125.00
Statistics/Envirometrics	43.00	60.00	80.00	100.00	110.00	120.00	125.00	125.00	125.00	125.00	125.00
Total Undergradute FTE	**52.00**	**110.00**	**150.00**	**190.00**	**220.00**	**240.00**	**250.00**	**250.00**	**250.00**	**250.00**	**250.00**
Graduate											
Applied Math	-	-	-	9.90	18.90	27.00	35.10	37.80	38.70	39.60	39.60
Statistics	-	0.90	4.50	10.80	18.90	27.90	36.00	37.80	38.70	39.60	40.50
Total Graduate FTE	**-**	**0.90**	**4.50**	**20.70**	**37.80**	**54.90**	**71.10**	**75.60**	**77.40**	**79.20**	**80.10**
Total FTE	**52.00**	**110.90**	**154.50**	**210.70**	**257.80**	**294.90**	**321.10**	**325.60**	**327.40**	**329.20**	**330.10**
Workload Ratio	***15.07***	***15.84***	***17.17***	***19.15***	***17.19***	***19.66***	***18.89***	***19.15***	***19.26***	***19.36***	***19.42***
Majors - Headcount											
Undergraduate											
Applied Math	-			5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Statistics	-			5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Total UG Majors	**-**	**-**	**-**	**10.00**	**20.00**	**30.00**	**40.00**	**50.00**	**60.00**	**70.00**	**80.00**
Graduate											
Applied Math				11.00	21.00	30.00	39.00	42.00	43.00	44.00	44.00
Statistics		1.00	5.00	12.00	21.00	31.00	40.00	42.00	43.00	44.00	45.00
Total Graduate Majors	**-**	**1.00**	**5.00**	**23.00**	**42.00**	**61.00**	**79.00**	**84.00**	**86.00**	**88.00**	**89.00**
Total Majors	**-**	**1.00**	**5.00**	**33.00**	**62.00**	**91.00**	**119.00**	**134.00**	**146.00**	**158.00**	**169.00**
Research Targets											
Ladder Faculty											
Principal Investigators	3.00	5.00	6.00	8.00	12.00	12.00	14.00	15.00	16.00	16.00	17.00
Annual Awards per PI		42,000	70,000	87,500	105,000	150,000	150,000	150,000	150,000	150,000	150,000
Awards-Ladder Faculty		**210,000**	**420,000**	**700,000**	**1,260,000**	**1,260,000**	**1,470,000**	**1,575,000**	**1,680,000**	**1,680,000**	**1,785,000**

Expenditures per PI	731	14,000	35,000	65,625	105,000	150,000	150,000	150,000	150,000	150,000	150,000
Expenditures - Ladder Fac.	**2,193**	**70,000**	**210,000**	**525,000**	**1,260,000**	**1,800,000**	**2,100,000**	**2,250,000**	**2,400,000**	**2,400,000**	**2,550,000**
Research Scientists											
Principal Investigators			1.00	1.00	2.00	2.00	3.00	3.00	4.00	4.00	5.00
Annual Awards per PI			150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Awards-Research Sci.	**-**	**-**	**150,000**	**150,000**	**300,000**	**300,000**	**450,000**	**450,000**	**600,000**	**600,000**	**750,000**
Expenditures per PI			50,000	100,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Expenditures-Research Sci.	**-**	**-**	**50,000**	**100,000**	**300,000**	**300,000**	**450,000**	**450,000**	**600,000**	**600,000**	**750,000**
Total Awards	**-**	**210,000**	**570,000**	**850,000**	**1,560,000**	**1,560,000**	**1,920,000**	**2,025,000**	**2,280,000**	**2,280,000**	**2,535,000**
Total Expenditures	**2,193**	**70,000**	**260,000**	**625,000**	**1,560,000**	**2,100,000**	**2,550,000**	**2,700,000**	**3,000,000**	**3,000,000**	**3,300,000**
Indirect Cost Recovery (ICR)	**721**	**15,400**	**57,200**	**137,500**	**343,200**	**378,000**	**561,000**	**594,000**	**660,000**	**660,000**	**726,000**
ICR Rate	**32.88%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE	**-**	**2.17**	**3.36**	**4.28**	**4.98**	**5.45**	**5.68**	**5.68**	**5.68**	**5.68**	**5.68**
Staffing (FTE)											
Technical											
Dept Admin	2.25	2.75	2.75	2.75	3.50	3.50	4.00	4.00	4.00	4.00	4.00
Total Staff	**2.25**	**2.75**	**2.75**	**2.75**	**3.50**	**3.50**	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**
Graduate Support											
GSRs (quarters)	-	2.00	7.00	18.00	44.00	63.00	74.00	79.00	84.00	84.00	89.00
Teaching Assts (quarters)	-	13.00	20.00	26.00	30.00	33.00	34.00	34.00	34.00	34.00	34.00
Campus Fellowships (quarters)	-	-	1.00	3.00	6.00	9.00	12.00	13.00	13.00	13.00	13.00
Employment/Other (quarters)	-	-	-	1.00	2.00	3.00	4.00	4.00	4.00	4.00	4.00

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - BIOMOLECULAR ENGINEERING

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Biomolecular Eng.	2.00	2.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00	6.00
Bioinformatics	1.00	2.00	4.00	5.00	6.00	6.00	6.00	7.00	8.00	8.00	8.00
Total Ladder Faculty FTE	**3.00**	**4.00**	**6.00**	**8.00**	**10.00**	**11.00**	**12.00**	**13.00**	**14.00**	**14.00**	**14.00**
Less: Open Positions	(3.00)	(3.00)	(3.00)	(2.00)	(2.00)	(1.00)	(1.00)	(1.00)	(1.00)		
Plus: Lecturers/Adjuncts					-	-	1.00	1.00	1.00		
Total Faculty FTE	**-**	**1.00**	**3.00**	**6.00**	**8.00**	**10.00**	**12.00**	**13.00**	**14.00**	**14.00**	**14.00**
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Biomolecular Eng.					5.00	20.00	40.00	50.00	50.00	50.00	50.00
Bioinformatics		10.00	20.00	40.00	50.00	55.00	55.00	55.00	55.00	55.00	55.00
Total Undergradute FTE	**-**	**10.00**	**20.00**	**40.00**	**55.00**	**75.00**	**95.00**	**105.00**	**105.00**	**105.00**	**105.00**
Graduate											
Biomolecular Eng.	-	-	-	-	-	4.50	13.50	18.00	22.50	27.00	31.50
Bioinformatics	-	-	-	31.50	45.00	67.50	76.50	76.50	76.50	76.50	76.50
Total Graduate FTE	**-**	**-**	**-**	**31.50**	**45.00**	**72.00**	**90.00**	**94.50**	**99.00**	**103.50**	**108.00**
Total FTE	**-**	**10.00**	**20.00**	**71.50**	**100.00**	**147.00**	**185.00**	**199.50**	**204.00**	**208.50**	**213.00**
Workload Ratio	**-**	***10.00***	***6.67***	***11.92***	***12.50***	***14.70***	***15.42***	***15.35***	***14.57***	***14.89***	***15.21***
Majors - Headcount											
Undergraduate											
Biomolecular Eng.					10.00	30.00	60.00	75.00	75.00	75.00	75.00
Bioinformatics		25.00	30.00	60.00	75.00	85.00	85.00	85.00	85.00	85.00	85.00
Total UG Majors	**-**	**25.00**	**30.00**	**60.00**	**85.00**	**115.00**	**145.00**	**160.00**	**160.00**	**160.00**	**160.00**
Graduate											
Biomolecular Eng.						5.00	15.00	20.00	25.00	30.00	35.00
Bioinformatics				35.00	50.00	75.00	85.00	85.00	85.00	85.00	85.00
Total Graduate Majors	**-**	**-**	**-**	**35.00**	**50.00**	**80.00**	**100.00**	**105.00**	**110.00**	**115.00**	**120.00**
Total Majors	**-**	**25.00**	**30.00**	**95.00**	**135.00**	**195.00**	**245.00**	**265.00**	**270.00**	**275.00**	**280.00**
Research Targets											
Ladder Faculty											
Principal Investigators	-	1.00	3.00	6.00	8.00	10.00	11.00	12.00	13.00	14.00	14.00
Annual Awards per PI	-	250,000	300,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Awards-Ladder Faculty	**-**	**250,000**	**900,000**	**2,100,000**	**2,800,000**	**3,500,000**	**3,850,000**	**4,200,000**	**4,550,000**	**4,900,000**	**4,900,000**

Expenditures per PI		82,500	150,000	262,500	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Expenditures - Ladder Fac.	**-**	**82,500**	**450,000**	**1,575,000**	**2,800,000**	**3,500,000**	**3,850,000**	**4,200,000**	**4,550,000**	**4,900,000**	**4,900,000**
Research Scientists											
Principal Investigators				3.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Annual Awards per PI				200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Awards-Research Sci.	**-**	**-**	**-**	**600,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**
Expenditures per PI				66,000	132,000	200,000	200,000	200,000	200,000	200,000	200,000
Expenditures-Research Sci.	**-**	**-**	**-**	**198,000**	**1,188,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**	**1,800,000**
Total Awards	**-**	**250,000**	**900,000**	**2,700,000**	**4,600,000**	**5,300,000**	**5,650,000**	**6,000,000**	**6,350,000**	**6,700,000**	**6,700,000**
Total Expenditures	**-**	**82,500**	**450,000**	**1,773,000**	**3,988,000**	**5,300,000**	**5,650,000**	**6,000,000**	**6,350,000**	**6,700,000**	**6,700,000**
Indirect Cost Recovery (ICR)	**-**	**18,150**	**99,000**	**390,060**	**877,360**	**954,000**	**1,243,000**	**1,320,000**	**1,397,000**	**1,474,000**	**1,474,000**
ICR Rate	**0.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE		**0.22**	**0.45**	**0.90**	**1.24**	**1.70**	**2.16**	**2.39**	**2.39**	**2.39**	**2.39**
Staffing (FTE)											
Technical											
Dept Admin	1.00	1.00	2.00	2.50	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Total Staff	**1.00**	**1.00**	**2.00**	**2.50**	**3.60**	**3.60**	**3.60**	**3.60**	**3.60**	**3.60**	**3.60**
Graduate Support											
GSRs (quarters)	-	3.00	16.00	55.00	98.00	123.00	135.00	147.00	159.00	172.00	172.00
Teaching Assts (quarters)	-	1.00	3.00	5.00	7.00	10.00	13.00	14.00	14.00	14.00	14.00
Campus Fellowships (quarters)	-	-	-	5.00	8.00	12.00	15.00	16.00	17.00	17.00	18.00
Employment/Other (quarters)	-	-	-	2.00	3.00	4.00	5.00	5.00	6.00	6.00	6.00

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - COMPUTER ENGINEERING

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Computer Engineering	16.00	17.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	26.00
Software Engineering	1.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total Ladder Faculty FTE	**17.00**	**18.00**	**21.00**	**21.00**	**22.00**	**23.00**	**24.00**	**25.00**	**26.00**	**27.00**	**27.00**
Less: Open Positions	(4.00)	(1.00)	(2.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Plus: Lecturers/Adjuncts	1.42	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00
Total Faculty FTE	**14.42**	**19.00**	**22.00**	**23.00**	**24.00**	**25.00**	**26.00**	**27.00**	**27.00**	**27.00**	**27.00**
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Computer Engineering	257.00	275.00	290.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Software Engineering											
Total Undergradute FTE	**257.00**	**275.00**	**290.00**	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**	**300.00**
Graduate											
Computer Engineering	57.60	72.00	80.10	87.30	93.60	100.80	107.10	113.40	120.60	129.60	135.00
Total Graduate FTE	**57.60**	**72.00**	**80.10**	**87.30**	**93.60**	**100.80**	**107.10**	**113.40**	**120.60**	**129.60**	**135.00**
Total FTE	**314.60**	**347.00**	**370.10**	**387.30**	**393.60**	**400.80**	**407.10**	**413.40**	**420.60**	**429.60**	**435.00**
Workload Ratio	***21.82***	***18.26***	***16.82***	***16.84***	***16.40***	***16.03***	***15.66***	***15.31***	***15.58***	***15.91***	***16.11***
Majors - Headcount											
Undergraduate											
Computer Engineering	300.00	320.00	360.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00	380.00
Software Engineering*											
Total UG Majors	**300.00**	**320.00**	**360.00**	**380.00**	**380.00**	**380.00**	**380.00**	**380.00**	**380.00**	**380.00**	**380.00**
Graduate											
Computer Engineering	64.00	80.00	89.00	97.00	104.00	112.00	119.00	126.00	134.00	144.00	150.00
Software Engineering*											
Total Graduate Majors	**64.00**	**80.00**	**89.00**	**97.00**	**104.00**	**112.00**	**119.00**	**126.00**	**134.00**	**144.00**	**150.00**
Total Majors	**364.00**	**400.00**	**449.00**	**477.00**	**484.00**	**492.00**	**499.00**	**506.00**	**514.00**	**524.00**	**530.00**
Research Targets											
Ladder Faculty											
Principal Investigators	13.00	17.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	26.00
Annual Awards per PI		100,000	125,000	150,000	175,000	200,000	225,000	250,000	250,000	250,000	250,000
Awards-Ladder Faculty		**1,700,000**	**2,375,000**	**3,000,000**	**3,675,000**	**4,400,000**	**5,175,000**	**6,000,000**	**6,250,000**	**6,500,000**	**6,500,000**

Expenditures per PI	86,561	100,000	100,000	125,000	150,000	175,000	200,000	225,000	250,000	250,000	250,000
Expenditures - Ladder Fac.	**1,125,290**	**1,700,000**	**1,900,000**	**2,500,000**	**3,150,000**	**3,850,000**	**4,600,000**	**5,400,000**	**6,250,000**	**6,500,000**	**6,500,000**
Research Scientists											
Principal Investigators	1.00					1.00	2.00	3.00	4.00	5.00	6.00
Annual Awards per PI						200,000	200,000	200,000	200,000	200,000	200,000
Awards-Research Sci.	-	-	-	-	-	**200,000**	**400,000**	**600,000**	**800,000**	**1,000,000**	**1,200,000**
Expenditures per PI						66,000	132,000	200,000	200,000	200,000	200,000
Expenditures-Research Sci.	-	-	-	-	-	**66,000**	**264,000**	**600,000**	**800,000**	**1,000,000**	**1,200,000**
Total Awards	-	**1,700,000**	**2,375,000**	**3,000,000**	**3,675,000**	**4,600,000**	**5,575,000**	**6,600,000**	**7,050,000**	**7,500,000**	**7,700,000**
Total Expenditures	**1,125,290**	**1,700,000**	**1,900,000**	**2,500,000**	**3,150,000**	**3,916,000**	**4,864,000**	**6,000,000**	**7,050,000**	**7,500,000**	**7,700,000**
Indirect Cost Recovery (ICR)	**209,718**	**374,000**	**418,000**	**550,000**	**693,000**	**704,880**	**1,070,080**	**1,320,000**	**1,551,000**	**1,650,000**	**1,694,000**
ICR Rate	**18.64%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE	**6.33**	**6.33**	**6.50**	**6.76**	**6.79**	**6.82**	**6.82**	**6.82**	**6.82**	**6.82**	**6.82**
Staffing (FTE)											
Technical											
Dept Admin	2.25	2.75	3.25	3.25	3.50	5.00	6.00	6.00	6.00	6.00	6.00
Total Staff	**2.25**	**2.75**	**3.25**	**3.25**	**3.50**	**5.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**
Graduate Support											
GSRs (quarters)	39.00	60.00	67.00	88.00	110.00	135.00	161.00	189.00	219.00	228.00	228.00
Teaching Assts (quarters)	38.00	38.00	39.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00
Campus Fellowships (quarters)	5.00	12.00	14.00	15.00	16.00	17.00	18.00	19.00	21.00	22.00	23.00
Employment/Other (quarters)	6.00	5.00	7.00	7.00	8.00	9.00	9.00	10.00	10.00	11.00	12.00

*Shown in CS

Notes:
[1] Madhyastha to CE 7/1/01

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - COMPUTER SCIENCE

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Computer Science	20.00	19.00	22.00	25.00	27.00	29.00	30.00	31.00	32.00	33.00	33.00
Software Engineering	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Total Ladder Faculty FTE	**23.00**	**23.00**	**26.00**	**29.00**	**31.00**	**33.00**	**34.00**	**35.00**	**36.00**	**37.00**	**37.00**
Less: Open Positions	(7.00)	(7.00)	(3.00)	(3.00)	(2.00)	(2.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Plus: Lecturers/Adjuncts	3.85	7.00	6.00	6.50	6.50	6.00	4.00	3.00	2.00	1.00	1.00
Total Faculty FTE	**19.85**	**23.00**	**29.00**	**32.50**	**35.50**	**37.00**	**37.00**	**37.00**	**37.00**	**37.00**	**37.00**
Enrollment Targets											
Enrollment FTE				**CAP STARTS HERE**							
Undergraduate											
Computer Science	395.00	454.00	510.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
Software Engineering											
Total Undergradute FTE	**395.00**	**454.00**	**510.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**
Graduate											
Computer Science	73.00	92.70	104.40	99.90	106.20	113.40	120.60	129.60	139.50	148.50	157.50
Software Engineering	-	-	13.50	22.50	27.00	36.00	45.00	45.00	45.00	45.00	45.00
Total Graduate FTE	**73.00**	**92.70**	**117.90**	**122.40**	**133.20**	**149.40**	**165.60**	**174.60**	**184.50**	**193.50**	**202.50**
Total FTE	**468.00**	**546.70**	**627.90**	**622.40**	**633.20**	**649.40**	**665.60**	**674.60**	**684.50**	**693.50**	**702.50**
Workload Ratio	***23.58***	***23.77***	***21.65***	***19.15***	***17.84***	***17.55***	***17.99***	***18.23***	***18.50***	***18.74***	***18.99***
Majors - Headcount											
Undergraduate											
Computer Science	600.00	625.00	650.00	650.00	650.00	650.00	650.00	650.00	650.00	650.00	650.00
Software Engineering											
Total UG Majors	**600.00**	**625.00**	**650.00**	**650.00**	**650.00**	**650.00**	**650.00**	**650.00**	**650.00**	**650.00**	**650.00**
Graduate											
Computer Science	73.00	103.00	116.00	111.00	118.00	126.00	134.00	144.00	155.00	165.00	175.00
Software Engineering			15.00	25.00	30.00	40.00	50.00	50.00	50.00	50.00	50.00
Total Graduate Majors	**73.00**	**103.00**	**131.00**	**136.00**	**148.00**	**166.00**	**184.00**	**194.00**	**205.00**	**215.00**	**225.00**
Total Majors	**673.00**	**728.00**	**781.00**	**786.00**	**798.00**	**816.00**	**834.00**	**844.00**	**855.00**	**865.00**	**875.00**
Research Targets											
Ladder Faculty											
Principal Investigators	16.00	16.00	23.00	26.00	29.00	31.00	33.00	34.00	35.00	36.00	36.00
Annual Awards per PI		150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Awards-Ladder Faculty		**2,400,000**	**3,450,000**	**3,900,000**	**4,350,000**	**4,650,000**	**4,950,000**	**5,100,000**	**5,250,000**	**5,400,000**	**5,400,000**

Expenditures per PI	116,394	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Expenditures - Ladder Fac.	**1,862,305**	**2,400,000**	**3,450,000**	**3,900,000**	**4,350,000**	**4,650,000**	**4,950,000**	**5,100,000**	**5,250,000**	**5,400,000**	**5,400,000**
Research Scientists											
Principal Investigators	1.00				1.00	1.00	2.00	3.00	4.00	5.00	6.00
Annual Awards per PI					50,000	100,000	150,000	200,000	220,000	230,000	240,000
Awards-Research Sci.	**-**	**-**	**-**	**-**	**50,000**	**100,000**	**300,000**	**600,000**	**880,000**	**1,150,000**	**1,440,000**
Expenditures per PI					16,500	49,500	99,000	148,500	188,100	214,500	227,700
Expenditures-Research Sci.	**-**	**-**	**-**	**-**	**16,500**	**49,500**	**198,000**	**445,500**	**752,400**	**1,072,500**	**1,366,200**
Total Awards	**-**	**2,400,000**	**3,450,000**	**3,900,000**	**4,400,000**	**4,750,000**	**5,250,000**	**5,700,000**	**6,130,000**	**6,550,000**	**6,840,000**
Total Expenditures	**1,862,305**	**2,400,000**	**3,450,000**	**3,900,000**	**4,366,500**	**4,699,500**	**5,148,000**	**5,545,500**	**6,002,400**	**6,472,500**	**6,766,200**
Indirect Cost Recovery (ICR)	**422,209**	**528,000**	**759,000**	**858,000**	**960,630**	**845,910**	**1,132,560**	**1,220,010**	**1,320,528**	**1,423,950**	**1,488,564**
ICR Rate	**22.67%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE	**10.17**	**11.33**	**11.43**	**11.26**	**11.31**	**11.36**	**11.36**	**11.36**	**11.36**	**11.36**	**11.36**
Staffing (FTE)											
Technical											
Dept Admin	2.25	2.75	3.25	3.75	4.50	5.50	5.50	5.50	5.50	5.50	5.50
Total Staff	**2.25**	**2.75**	**3.25**	**3.75**	**4.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**
Graduate Support											
GSRs (quarters)	65.00	84.00	121.00	137.00	152.00	163.00	173.00	179.00	184.00	189.00	189.00
Teaching Assts (quarters)	61.00	68.00	69.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00	68.00
Campus Fellowships (quarters)	11.00	23.00	22.00	23.00	25.00	28.00	31.00	32.00	34.00	36.00	38.00
Employment/Other (quarters)	9.00	9.00	12.00	12.00	13.00	15.00	17.00	18.00	19.00	20.00	20.00

Notes:
[1] Madhyastha to CE 7/1/01

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - ELECTRICAL ENGINEERING

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Electrical Engineering	10.00	11.00	13.00	15.00	17.00	17.00	19.00	19.00	19.00	20.00	21.00
Total Ladder Faculty FTE	**10.00**	**11.00**	**13.00**	**15.00**	**17.00**	**17.00**	**19.00**	**19.00**	**19.00**	**20.00**	**21.00**
Less: Open Positions	(4.00)	(2.00)	(2.00)	(2.00)	(2.00)					(1.00)	(1.00)
Plus: Lecturers/Adjuncts								0.75	2.00	2.00	1.00
Total Faculty FTE	**6.00**	**9.00**	**11.00**	**13.00**	**15.00**	**17.00**	**19.00**	**19.75**	**21.00**	**21.00**	**21.00**
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Electrical Engineering	26.00	55.00	86.00	116.00	146.00	179.00	210.00	220.00	230.00	230.00	230.00
Total Undergradute FTE	**26.00**	**55.00**	**86.00**	**116.00**	**146.00**	**179.00**	**210.00**	**220.00**	**230.00**	**230.00**	**230.00**
Graduate											
Electrical Engineering	-	15.30	25.20	45.90	47.70	59.40	68.40	77.40	85.50	94.50	102.60
Total Graduate FTE	**-**	**15.30**	**25.20**	**45.90**	**47.70**	**59.40**	**68.40**	**77.40**	**85.50**	**94.50**	**102.60**
Total FTE	**26.00**	**70.30**	**111.20**	**161.90**	**193.70**	**238.40**	**278.40**	**297.40**	**315.50**	**324.50**	**332.60**
Workload Ratio	***4.33***	***7.81***	***10.11***	***12.45***	***12.91***	***14.02***	***14.65***	***15.06***	***15.02***	***15.45***	***15.84***
Majors - Headcount											
Undergraduate											
Electrical Engineering	52.00	110.00	170.00	230.00	290.00	360.00	420.00	440.00	460.00	460.00	460.00
Total UG Majors	**52.00**	**110.00**	**170.00**	**230.00**	**290.00**	**360.00**	**420.00**	**440.00**	**460.00**	**460.00**	**460.00**
Graduate											
Electrical Engineering		17.00	28.00	51.00	53.00	66.00	76.00	86.00	95.00	105.00	114.00
Total Graduate Majors	**-**	**17.00**	**28.00**	**51.00**	**53.00**	**66.00**	**76.00**	**86.00**	**95.00**	**105.00**	**114.00**
Total Majors	**52.00**	**127.00**	**198.00**	**281.00**	**343.00**	**426.00**	**496.00**	**526.00**	**555.00**	**565.00**	**574.00**
Research Targets											
Ladder Faculty											
Principal Investigators	6.00	9.00	11.00	13.00	15.00	17.00	19.00	19.00	19.00	19.00	20.00
Annual Awards per PI		350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Awards-Ladder Faculty		**3,150,000**	**3,850,000**	**4,550,000**	**5,250,000**	**5,950,000**	**6,650,000**	**6,650,000**	**6,650,000**	**6,650,000**	**7,000,000**

Expenditures per PI	115,597	100,000	150,000	200,000	300,000	350,000	350,000	350,000	350,000	350,000	350,000
Expenditures - Ladder Fac.	**693,580**	**900,000**	**1,650,000**	**2,600,000**	**4,500,000**	**5,950,000**	**6,650,000**	**6,650,000**	**6,650,000**	**6,650,000**	**7,000,000**
Research Scientists											
Principal Investigators			1.00	2.00	3.00	4.00	5.00	7.00	9.00	10.00	11.00
Annual Awards per PI			350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Awards-Research Sci.	**-**	**-**	**350,000**	**700,000**	**1,050,000**	**1,400,000**	**1,750,000**	**2,450,000**	**3,150,000**	**3,500,000**	**3,850,000**
Expenditures per PI		-	150,000	200,000	300,000	350,000	350,000	350,000	350,000	350,000	350,000
Expenditures-Research Sci.	**-**	**-**	**150,000**	**400,000**	**900,000**	**1,400,000**	**1,750,000**	**2,450,000**	**3,150,000**	**3,500,000**	**3,850,000**
Total Awards	**-**	**3,150,000**	**4,200,000**	**5,250,000**	**6,300,000**	**7,350,000**	**8,400,000**	**9,100,000**	**9,800,000**	**10,150,000**	**10,850,000**
Total Expenditures	**693,580**	**900,000**	**1,800,000**	**3,000,000**	**5,400,000**	**7,350,000**	**8,400,000**	**9,100,000**	**9,800,000**	**10,150,000**	**10,850,000**
Indirect Cost Recovery (ICR)	**100,709**	**198,000**	**396,000**	**660,000**	**1,188,000**	**1,323,000**	**1,848,000**	**2,002,000**	**2,156,000**	**2,233,000**	**2,387,000**
ICR Rate	**14.52%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE	**0.33**	**0.83**	**1.93**	**2.61**	**3.30**	**4.07**	**4.77**	**5.00**	**5.23**	**5.23**	**5.23**
Staffing (FTE)											
Technical											
Dept Admin	2.25	2.75	3.25	3.25	3.75	5.00	6.00	6.00	6.00	6.00	6.00
Total Staff	**2.25**	**2.75**	**3.25**	**3.25**	**3.75**	**5.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**
Graduate Support											
GSRs (quarters)	24.00	32.00	58.00	91.00	158.00	208.00	233.00	233.00	233.00	233.00	245.00
Teaching Assts (quarters)	2.00	5.00	12.00	16.00	20.00	24.00	29.00	30.00	31.00	31.00	31.00
Campus Fellowships (quarters)	-	3.00	4.00	8.00	8.00	10.00	11.00	13.00	14.00	16.00	17.00
Employment/Other (quarters)	-	1.00	1.00	3.00	3.00	3.00	4.00	4.00	5.00	5.00	6.00

Notes:

[1] Pedrotti effective 7/1/01. P&B shows his position filled last year because he had already accepted.

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - ISM / ISTM

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Info. Systems Mgmt.		1.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	10.00
Total Ladder Faculty FTE	**-**	**1.00**	**3.00**	**4.00**	**5.00**	**6.00**	**7.00**	**8.00**	**9.00**	**10.00**	**10.00**
Less: Open Positions		(1.00)	(2.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	
Plus: Lecturers/Adjuncts	0.70	1.00	1.50	0.50	1.00	2.00	2.50	3.00	2.00	1.00	
Total Faculty FTE	**0.70**	**1.00**	**2.50**	**3.50**	**5.00**	**7.00**	**8.50**	**10.00**	**10.00**	**10.00**	**10.00**
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Info. Systems Mgmt.	28.00	35.00	50.00	70.00	100.00	120.00	140.00	150.00	150.00	150.00	150.00
Total Undergradute FTE	**28.00**	**35.00**	**50.00**	**70.00**	**100.00**	**120.00**	**140.00**	**150.00**	**150.00**	**150.00**	**150.00**
Graduate											
ISTM					0.75	18.75	30.00	37.50	45.00	48.75	56.25
Total Graduate FTE	**-**	**-**	**-**	**-**	**0.75**	**18.75**	**30.00**	**37.50**	**45.00**	**48.75**	**56.25**
Total FTE	**28.00**	**35.00**	**50.00**	**70.00**	**100.75**	**138.75**	**170.00**	**187.50**	**195.00**	**198.75**	**206.25**
Workload Ratio	***40.00***	***35.00***	***20.00***	***20.00***	***20.15***	***19.82***	***20.00***	***18.75***	***19.50***	***19.88***	***20.63***
Majors - Headcount											
Undergraduate											
Info. Systems Mgmt.		60.00	90.00	120.00	170.00	200.00	240.00	260.00	260.00	260.00	260.00
Total UG Majors	**-**	**60.00**	**90.00**	**120.00**	**170.00**	**200.00**	**240.00**	**260.00**	**260.00**	**260.00**	**260.00**
Graduate											
ISTM					1.00	25.00	40.00	50.00	60.00	65.00	75.00
Total Graduate Majors	**-**	**-**	**-**	**-**	**1.00**	**25.00**	**40.00**	**50.00**	**60.00**	**65.00**	**75.00**
Total Majors	**-**	**60.00**	**90.00**	**120.00**	**171.00**	**225.00**	**280.00**	**310.00**	**320.00**	**325.00**	**335.00**
Research Targets											
Ladder Faculty											
Principal Investigators	-	-	1.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
Annual Awards per PI	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Awards-Ladder Faculty	**-**	**-**	**100,000**	**300,000**	**400,000**	**500,000**	**600,000**	**700,000**	**800,000**	**900,000**	**1,000,000**

Expenditures per PI	-	-	33,000	50,000	75,000	100,000	100,000	100,000	100,000	100,000	100,000
Expenditures - Ladder Fac.	**-**	**-**	**33,000**	**150,000**	**300,000**	**500,000**	**600,000**	**700,000**	**800,000**	**900,000**	**1,000,000**
Research Scientists											
Principal Investigators					1.00	1.00	1.00	1.00	2.00	2.00	2.00
Annual Awards per PI					50,000	50,000	50,000	50,000	50,000	50,000	50,000
Awards-Research Sci.	**-**	**-**	**-**	**-**	**50,000**	**50,000**	**50,000**	**50,000**	**100,000**	**100,000**	**100,000**
Expenditures per PI					16,500	33,000	50,000	50,000	50,000	50,000	50,000
Expenditures-Research Sci.	**-**	**-**	**-**	**-**	**16,500**	**33,000**	**50,000**	**50,000**	**100,000**	**100,000**	**100,000**
Total Awards	**-**	**-**	**100,000**	**300,000**	**450,000**	**550,000**	**650,000**	**750,000**	**900,000**	**1,000,000**	**1,100,000**
Total Expenditures	**-**	**-**	**33,000**	**150,000**	**316,500**	**533,000**	**650,000**	**750,000**	**900,000**	**1,000,000**	**1,100,000**
Indirect Cost Recovery (ICR)	**-**	**-**	**7,260**	**33,000**	**69,630**	**95,940**	**143,000**	**165,000**	**198,000**	**220,000**	**242,000**
ICR Rate	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE		**0.78**	**1.12**	**1.58**	**2.26**	**2.73**	**3.18**	**3.41**	**3.41**	**3.41**	**3.41**
Staffing (FTE)											
Technical											
Dept Admin	-	-	-	-	0.50	1.00	2.00	2.50	2.50	2.50	2.50
Total Staff	**-**	**-**	**-**	**-**	**0.50**	**1.00**	**2.00**	**2.50**	**2.50**	**2.50**	**2.50**
Graduate Support											
GSRs (quarters)	-	-	1.00	5.00	11.00	18.00	21.00	25.00	28.00	32.00	35.00
Teaching Assts (quarters)	-	5.00	7.00	9.00	14.00	16.00	19.00	20.00	20.00	20.00	20.00
Campus Fellowships (quarters)	-	-	-	-	-	4.00	6.00	8.00	9.00	10.00	11.00
Employment/Other (quarters)	-	-	-	-	-	2.00	3.00	4.00	5.00	5.00	6.00

TABLE 6 SCHOOL OF ENGINEERING PLANNING PROFILE - SOE GENERAL

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Faculty											
Faculty FTE											
Permanent											
Program #1											
Program #2											
Program #3											
Total Ladder Faculty FTE	-	-	-	-	-	-	-	-	-	-	-
Less: Open Positions											
Plus: Lecturers/Adjuncts											
Total Faculty FTE	-	-	-	-	-	-	-	-	-	-	-
Enrollment Targets											
Enrollment FTE											
Undergraduate											
Program #1											
Program #2											
Program #3											
Total Undergradute FTE	-	-	-	-	-	-	-	-	-	-	-
Graduate											
Program #1											
Program #2											
Program #3											
Total Graduate FTE	-	-	-	-	-	-	-	-	-	-	-
Total FTE	-	-	-	-	-	-	-	-	-	-	-
Workload Ratio											
Majors - Headcount											
Undergraduate											
Program #1											
Program #2											
Program #3											
Total UG Majors	-	-	-	-	-	-	-	-	-	-	-
Graduate											
Program #1											
Program #2											
Program #3											
Total Graduate Majors	-	-	-	-	-	-	-	-	-	-	-
Total Majors	-	-	-	-	-	-	-	-	-	-	-
Research Targets											
Ladder Faculty											
Principal Investigators	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annual Awards per PI		350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Awards-Ladder Faculty		**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**

Expenditures per PI	45,879	100,000	150,000	200,000	300,000	350,000	350,000	350,000	350,000	350,000	350,000
Expenditures - Ladder Fac.	**45,879**	**100,000**	**150,000**	**200,000**	**300,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**
Research Scientists											
Principal Investigators											
Annual Awards per PI											
Awards-Research Sci.	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Expenditures per PI											
Expenditures-Research Sci.	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Awards	**-**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**
Total Expenditures	**45,879**	**100,000**	**150,000**	**200,000**	**300,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**	**350,000**
Indirect Cost Recovery (ICR)	**1,749**	**22,000**	**33,000**	**44,000**	**66,000**	**63,000**	**77,000**	**77,000**	**77,000**	**77,000**	**77,000**
ICR Rate	**3.81%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**18.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**	**22.00%**
Instruction and Research Support											
Teaching Assistant FTE											
Staffing (FTE)											
Technical	11.75	11.75	15.75	16.75	18.75	19.75	20.75	20.75	21.75	21.75	21.75
Administrative	17.49	20.73	23.73	26.73	29.73	31.73	35.22	35.22	35.22	36.22	36.22
Total Staff	**29.24**	**32.48**	**39.48**	**43.48**	**48.48**	**51.48**	**55.97**	**55.97**	**56.97**	**57.97**	**57.97**
Graduate Support											
GSRs (quarters)	2.00	4.00	5.00	7.00	11.00	12.00	12.00	12.00	12.00	12.00	12.00
Teaching Assts (quarters)	-	-	-	-	-	-	-	-	-	-	-
Campus Fellowships (quarters)	-	-	-	-	-	-	-	-	-	-	-
Employment/Other (quarters)	-	-	-	-	-	-	-	-	-	-	-

TABLE 7 BUDGET PROJECTIONS 2002-11 ALL SCHOOL

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																					
Faculty FTE			17.00		10.00		11.00		6.00		8.00		5.00		5.00		4.00		1.00		**67.00**
Rank(s):																					
Professor																					
Associate Professor																					
Assistant Professor																					
Subtotal-Faculty Salaries			1,498,400		942,200		920,600		520,700		672,400		405,900		425,600		330,100		77,400		**5,793,300**
Faculty Start-up																					
Personal																					
Removal																					
Recruitment																					
Library																					
Subtotal-Faculty Start-up		3,159,000		2,542,000		2,796,000		1,595,000		1,963,000		1,157,000		1,344,000		1,039,000		313,000		**15,908,000**	
Staffing																					
Staff FTE	44.48		9.50		5.00		8.85		7.25		7.99		0.50		1.00		1.00		-		**41.09**
Salaries:																					
Asst. III																					
Admin. Spec.																					
MSO I																					
AA II																					
Subtotal - Salaries		-	449,175	-	248,607	-	355,114	-	294,261		302,234		17,516		41,754		35,031		-	**-**	**1,743,691**
Benefits		-	88,870	-	48,975	-	76,023	-	61,744		64,681		3,941		8,912		8,213		-	**-**	**361,360**
Instruction & Research Support																					
General I&R Support			130,000	0	101,000	0	113,500	0	63,000		85,960		42,500		46,500		38,000		8,500	**-**	**628,960**
Admin. Equipment & Furniture		214,408		230,567		205,592		234,508		218,391		120,067		126,425		105,550		86,267		**1,541,774**	**-**
Instructional Lab Equipment		-	322,619	-	-	-	100,000	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**422,619**
Computer Hardware		-	316,576	-	38,600	-	63,400	-	49,800	-	29,850	-	51,750	-	59,800	-	66,700	-	74,750	**-**	**751,226**
Computer Software		-	71,248	-	9,750	-	15,450	-	12,720	-	14,780	-	11,500	-	18,400	-	21,850	-	24,725	**-**	**200,423**
Network Expenses		-	165,000	-	20,625	-	18,563	-	20,418	-	22,461	-	24,707	-	27,177	-	29,895	-	49,327	**-**	**378,173**
Back-up, Machine Room Expenses		-	39,666	-	2,000	-	4,000	-	8,667	-	2,000	-	3,000	-	2,000	-	3,000	-	6,033	**-**	**70,366**
Subtotal-I&R Support		214,408	1,045,109	230,567	171,975	205,592	314,913	234,508	154,605	218,391	155,051	120,067	133,457	126,425	153,877	105,550	159,445	86,267	163,335	**1,541,774**	**2,451,767**
		3,373,408	3,081,554	2,772,567	1,411,757	3,001,592	1,666,650	1,829,508	1,031,309	2,181,391	1,194,366	1,277,067	560,813	1,470,425	630,143	1,144,550	532,789	399,267	240,735	**17,449,774**	**10,350,118**

TABLE 7 BUDGET PROJECTIONS 2002-11 APPLIED MATHEMATICS AND STATISTICS DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03		2003-04		2004-05		2005-06	
			One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent
Faculty										
Faculty FTE	6.00	1.00		1.00		2.00		3.00		1.00
Rank(s):										
Professor				111,900						
Associate Professor						87,000				
Assistant Professor						72,400		217,200		72,400
Subtotal-Faculty Salaries			-	111,900	-	159,400	-	217,200	-	72,400
Faculty Start-up										
Personal					225,000		300,000		100,000	
Removal					10,000		12,000		4,000	
Recruitment					8,000		12,000		4,000	
Library					10,000		15,000		5,000	
Subtotal-Faculty Start-up			-	-	253,000	-	339,000	-	113,000	-
Staffing										
Staff FTE	2.75					-		0.75		
Salaries:										
Admin. Manager						-				
AA II										
AA III								26,273		
Subtotal - Salaries				-	-	-	-	26,273	-	-
Benefits				-	-	-	-	5,911	-	-
Instruction & Research Support										
General I&R Support				-		17,000		25,500		8,500
Admin. Equipment & Furniture			6,000		12,000		18,000		6,000	
Subtotal-I&R Support			6,000	-	12,000	17,000	18,000	25,500	6,000	8,500
			6,000	111,900	265,000	176,400	357,000	274,885	119,000	80,900

	2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty												
Faculty FTE		2.00		1.00		1.00					**-**	**10.00**
Rank(s):											**-**	**-**
Professor		111,900									**-**	**223,800**
Associate Professor				87,000							**-**	**174,000**
Assistant Professor		72,400				72,400					**-**	**506,800**
Subtotal-Faculty Salaries	-	184,300	-	87,000	-	72,400	-	-	-	-	**-**	**904,600**
Faculty Start-up												
Personal	275,000		125,000		100,000						**1,125,000**	**-**
Removal	10,000		6,000		4,000						**46,000**	**-**
Recruitment	8,000		4,000		4,000						**40,000**	**-**
Library	10,000		5,000		5,000						**50,000**	**-**
Subtotal-Faculty Start-up	303,000	-	140,000	-	113,000	-	-	-	-	-	**1,261,000**	**-**
Staffing												
Staff FTE		0.50										**1.25**
Salaries:											**-**	**-**
Admin. Manager											**-**	**-**
AA II		15,102									**-**	**15,102**
AA III												**26,273**
Subtotal - Salaries	-	15,102	-	-	-	-	-	-	-	-	**-**	**41,375**
Benefits	-	3,398	-	-	-	-	-	-	-	-	**-**	**9,309**
Instruction & Research Support												
General I&R Support		17,000		8,500		8,500		-		-	**-**	**85,000**
Admin. Equipment & Furniture	12,000		6,000		6,000						**66,000**	**-**
Subtotal-I&R Support	12,000	17,000	6,000	8,500	6,000	8,500	-	-	-	-	**66,000**	**85,000**
	315,000	219,800	146,000	95,500	119,000	80,900	-	-	-	-	**1,327,000**	**1,040,285**

FOOTNOTES:
1. Assumed centrally held faculty FTE will be released to SOE in 2002-03.

TABLE 7 BUDGET PROJECTIONS 2002-11 BIOMOLECULAR ENGINEERING DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03		2003-04		2004-05		2005-06	
			One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent
Faculty										
Faculty FTE	3.00	1.00		3.00		2.00		2.00		1.00
Rank(s):										
Professor								100,500		
Associate Professor				177,400		92,400				
Assistant Professor				86,100		86,100		86,100		86,100
Subtotal-Faculty Salaries			-	263,500	-	178,500	-	186,600	-	86,100
Faculty Start-up										
Personal			800,000		800,000		900,000		400,000	
Removal			10,000		10,000		10,000		4,000	
Recruitment			8,000		8,000		8,000		4,000	
Library			10,000		10,000		10,000		5,000	
Subtotal-Faculty Start-up			828,000	-	828,000	-	928,000	-	413,000	-
Staffing										
Staff FTE	1.00			1.00		0.50		1.10		-
Salaries:										
Admininstrative Staff				37,500		17,976		39,100		-
Tech Support										
Subtotal - Salaries				37,500	-	17,976	-	39,100	-	-
Benefits				8,438	-	4,045	-	8,798	-	-
Instruction & Research Support										
General I&R Support				17,000		17,000		17,000		8,500
Admin. Equipment & Furniture			18,000		12,000		12,000		6,000	
Subtotal-I&R Support			18,000	17,000	12,000	17,000	12,000	17,000	6,000	8,500
			846,000	326,438	840,000	217,521	940,000	251,498	419,000	94,600

	2006-07		2007-08		2008-09		2009-2010		2010-11		Total	
	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty												
Faculty FTE		1.00		1.00		1.00					**-**	**10.00**
Rank(s):											**-**	**-**
Professor		100,500				100,500					**-**	**301,500**
Associate Professor											**-**	**269,800**
Assistant Professor				86,100							**-**	**430,500**
Subtotal-Faculty Salaries	-	100,500	-	86,100	-	100,500	-	-	-	-	**-**	**1,001,800**
Faculty Start-up												
Personal	500,000		300,000		500,000						**4,200,000**	**-**
Removal	6,000		4,000		6,000						**50,000**	**-**
Recruitment	4,000		4,000		4,000						**40,000**	**-**
Library	5,000		5,000		5,000						**50,000**	**-**
Subtotal-Faculty Start-up	515,000	-	313,000	-	515,000	-	-	-		-	**4,340,000**	**-**
Staffing												
Staff FTE												**2.60**
Salaries:											**-**	**-**
Admininstrative Staff											**-**	**94,576**
Tech Support											**-**	**-**
Subtotal - Salaries	-	-	-	-	-	-	-	-	-	-	**-**	**94,576**
Benefits	-	-	-	-	-	-	-	-	-	-	**-**	**21,280**
Instruction & Research Support												
General I&R Support		8,500		8,500		8,500		-		-	**-**	**85,000**
Admin. Equipment & Furniture	6,000		6,000		6,000						**66,000**	**-**
Subtotal-I&R Support	6,000	8,500	6,000	8,500	6,000	8,500	-	-	-	-	**66,000**	**85,000**
	521,000	109,000	319,000	94,600	521,000	109,000	-	-	-	-	**4,406,000**	**1,202,656**

FOOTNOTES:
1. 1.0 FTE AA II added in 2002-03
2. 0.3 FTE AA II and 0.5 FTE AA III in 2003-04.
3. 1.1 FTE AA III in 2004-05.
4. 0.6 FTE AA III in 2005-06.
5. Assumed centrally held faculty FTE will be released to SOE in 2002-03.

TABLE 7 BUDGET PROJECTIONS 2002-11 COMPUTER ENGINEERING DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
			One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																						
Faculty FTE	18.00	0.00		3.00				1.00		1.00		1.00		1.00		1.00		1.00			**-**	**9.00**
Rank(s):																					**-**	**-**
Professor								104,800													**-**	**104,800**
Associate Professor				90,000																	**-**	**90,000**
Assistant Professor				160,000						80,000		80,000		80,000		80,000		80,000			**-**	**560,000**
Subtotal-Faculty Salaries			-	250,000	-	-	-	104,800	-	80,000	-	80,000	-	80,000	-	80,000	-	80,000	-	-	**-**	**754,800**
Faculty Start-up																						
Personal			650,000				300,000		175,000		175,000		175,000		175,000		175,000				**1,825,000**	**-**
Removal			14,000				6,000		4,000		4,000		4,000		4,000		4,000				**40,000**	**-**
Recruitment			12,000				4,000		4,000		4,000		4,000		4,000		4,000				**36,000**	**-**
Library			15,000				5,000		5,000		5,000		5,000		5,000		5,000				**45,000**	**-**
Subtotal-Faculty Start-up			691,000	-	-	-	315,000	-	188,000	-	188,000	-	188,000	-	188,000	-	188,000	-	-	-	**1,946,000**	**-**
Staffing																						
Staff FTE	2.75			0.50				0.25		1.50		1.00										**3.25**
Salaries:																					**-**	**-**
Develpoment Engr.								-													**-**	**-**
Admin.III-Spec.								8,758		35,031		35,031										**78,820**
AA II				15,102						15,102											**-**	**30,204**
Subtotal - Salaries				15,102	-	-	-	8,758	-	50,133	-	35,031	-	-	-	-	-	-	-	-	**-**	**109,024**
Benefits				3,398	-	-	-	1,970	-	11,280	-	7,882	-	-	-	-	-	-	-	-	**-**	**24,530**
Instruction & Research Support																						
General I&R Support				25,500		-		8,500		8,500		8,500		8,500		8,500		8,500		-	**-**	**76,500**
Admin. Equipment & Furniture			18,000				6,000		6,000		6,000		6,000		6,000		6,000				**54,000**	**-**
Subtotal-I&R Support			18,000	25,500	-	-	6,000	8,500	6,000	8,500	6,000	8,500	6,000	8,500	6,000	8,500	6,000	8,500	-	-	**54,000**	**76,500**
			709,000	294,000	-	-	321,000	124,028	194,000	149,913	194,000	131,413	194,000	88,500	194,000	88,500	194,000	88,500	-	-	**2,000,000**	**964,854**

TABLE 7 BUDGET PROJECTIONS 2002-11 COMPUTER SCIENCE DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03 One-Time	2002-03 Permanent	2003-04 One-Time	2003-04 Permanent	2004-05 One-Time	2004-05 Permanent	2005-06 One-Time	2005-06 Permanent
Faculty										
Faculty FTE	22.00	1.00		4.00		3.00		2.00		2.00
Rank(s):										
Professor				129,400		129,400				
Associate Professor								96,300		
Assistant Professor				229,200		152,800		76,400		152,800
Subtotal-Faculty Salaries			-	358,600	-	282,200	-	172,700	-	152,800
Faculty Start-up										
Personal			720,000		750,000		520,000		540,000	
Removal			14,000		14,000		10,000		8,000	
Recruitment			12,000		12,000		8,000		8,000	
Library			15,000		15,000		10,000		10,000	
Subtotal-Faculty Start-up			761,000	-	791,000	-	548,000	-	566,000	-
Staffing										
Staff FTE	2.75			0.50		0.50		0.75		1.00
Salaries:										
Asst. III				8,758				17,516		35,031
Admin. Spec.										
MSO I						22,025				
AA II				7,551				7,551		
Subtotal - Salaries				16,309	-	22,025	-	25,067	-	35,031
Benefits				3,669	-	4,956	-	5,640	-	7,882
Instruction & Research Support										
General I&R Support				25,500		25,500		17,000		17,000
Admin. Equipment & Furniture			24,000		18,000		12,000		12,000	
Subtotal-I&R Support			24,000	25,500	18,000	25,500	12,000	17,000	12,000	17,000
			785,000	404,078	809,000	334,681	560,000	220,406	578,000	212,713

	2006-07 One-Time	2006-07 Permanent	2007-08 One-Time	2007-08 Permanent	2008-09 One-Time	2008-09 Permanent	2009-2010 One-Time	2009-2010 Permanent	2010-11 One-Time	2010-11 Permanent	Total One-Time	Total Permanent	
Faculty													
Faculty FTE		1.00		1.00		1.00		1.00			**-**	**14.00**	
Rank(s):											**-**		
Professor											**-**	**258,800**	
Associate Professor						96,300		96,300			**-**	**288,900**	
Assistant Professor		76,400		76,400							**-**	**764,000**	
Subtotal-Faculty Salaries	-	76,400	-	76,400	-	96,300	-	96,300	-	-	**-**	**1,311,700**	
Faculty Start-up													
Personal	280,000		290,000		300,000		310,000				**3,710,000**	**-**	
Removal	4,000		4,000		6,000		6,000				**66,000**	**-**	
Recruitment	4,000		4,000		4,000		4,000				**56,000**	**-**	
Library	5,000		5,000		5,000		5,000				**70,000**	**-**	
Subtotal-Faculty Start-up	293,000	-	303,000	-	315,000	-	325,000	-	-	-	**3,902,000**	**-**	
Staffing													
Staff FTE												**2.75**	
Salaries:													
Asst. III												**61,304**	###
Admin. Spec.												**-**	
MSO I												**22,025**	
AA II												**15,102**	###
Subtotal - Salaries	-	-			-	-	-	-	-	-	-	**98,431**	
Benefits	-	-	-	-	-	-	-	-	-	-	**-**	**22,147**	
Instruction & Research Support													
General I&R Support		8,500		8,500		8,500		8,500		-	**-**	**119,000**	
Admin. Equipment & Furniture	6,000		6,000		6,000		6,000				**90,000**	**-**	
Subtotal-I&R Support	6,000	8,500	6,000	8,500	6,000	8,500	6,000	8,500	-	-	**90,000**	**119,000**	
	299,000	84,900	309,000	84,900	321,000	104,800	331,000	104,800	-	-	**3,992,000**	**1,551,278**	

FOOTNOTES:
1. Assumed centrally held faculty FTE will be released to SOE in 2002-03.

TABLE 7 BUDGET PROJECTIONS 2002-11 ELECTRICAL ENGINEERING DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		Total	
			One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																						
Faculty FTE	10.00	1.00		3.00		2.00		2.00				2.00						1.00		1.00	**-**	**10.00**
Rank(s):																					**-**	**-**
Professor						225,800															**-**	**225,800**
Associate Professor								85,500													**-**	**85,500**
Assistant Professor				232,200				77,400				154,800						77,400		77,400	**-**	**619,200**
Subtotal-Faculty Salaries			-	232,200	-	225,800	-	162,900	-	-	-	154,800	-	-	-	-	-	77,400	-	77,400	**-**	**930,500**
Faculty Start-up																						
Personal			425,000		425,000		425,000				425,000						300,000		300,000		**2,300,000**	**-**
Removal			8,000		12,000		10,000				8,000						4,000		4,000		**46,000**	**-**
Recruitment			8,000		8,000		8,000				8,000						4,000		4,000		**40,000**	**-**
Library			10,000		10,000		10,000				10,000						5,000		5,000		**50,000**	**-**
Subtotal-Faculty Start-up			451,000	-	455,000	-	453,000	-	-	-	451,000	-	-	-	-	-	313,000	-	313,000	-	**2,436,000**	**-**
Staffing																						
Staff FTE	2.75			0.50		-		0.50		1.25		1.00										**3.25**
Salaries:																						
Devlopment Engr.				-				-													**-**	**-**
Research Tech Support						-		-		-		-									**-**	**-**
Admin. III-Spec.								17,516		26,273		35,031									**-**	**78,820**
AA II				15,102						15,102											**-**	**30,204**
Subtotal - Salaries				15,102	-	-	-	17,516	-	41,375	-	35,031	-	-	-	-	-	-	-	-	**-**	**109,024**
Benefits				3,398	-	-	-	3,941	-	9,309	-	7,882	-	-	-	-	-	-	-	-	**-**	**24,530**
Instruction & Research Support																						
General I&R Support				17,000		17,000		17,000		-		17,000		-		-		8,500		8,500	**-**	**85,000**
Admin. Equipment & Furniture			18,000		12,000		12,000		-		12,000		-		-		6,000		6,000		**66,000**	**-**
Subtotal-I&R Support			18,000	17,000	12,000	17,000	12,000	17,000	-	-	12,000	17,000	-	-	-	-	6,000	8,500	6,000	8,500	**66,000**	**85,000**
			469,000	267,700	467,000	242,800	465,000	201,356	-	50,685	463,000	214,713	-	-	-	-	319,000	85,900	319,000	85,900	**2,502,000**	**1,149,054**

INFORMATION SYSTEMS MANAGEMENT (ISM & ISTM) DEPT BUDGET PLAN

	Faculty FTE released to SOE	Faculty FTE held centrally	2002-03 One-Time	2002-03 Permanent	2003-04 One-Time	2003-04 Permanent	2004-05 One-Time	2004-05 Permanent	2005-06 One-Time	2005-06 Permanent
Faculty										
Faculty FTE	0.00	1.00		3.00		1.00		1.00		1.00
Rank(s):										
Professor				129,400						129,400
Associate Professor						96,300				
Assistant Professor				152,800				76,400		
Subtotal-Faculty Salaries			-	282,200	-	96,300	-	76,400	-	129,400
Faculty Start-up										
Personal			400,000		200,000		200,000		300,000	
Removal			10,000		6,000		4,000		6,000	
Recruitment			8,000		4,000		4,000		4,000	
Library			10,000		5,000		5,000		5,000	
Subtotal-Faculty Start-up			428,000	-	215,000	-	213,000	-	315,000	-
Staffing										
Staff FTE	-							0.50		0.50
Salaries:										
Asst. III								17,516		17,516
Admin. Spec.										
MSO I										
AA II										
Subtotal - Salaries				-	-	-	-	17,516	-	17,516
Benefits				-	-	-	-	3,941	-	3,941
Instruction & Research Support										
General I&R Support				17,000		8,500		8,500		8,500
Admin. Equipment & Furniture			18,000		6,000		6,000		6,000	
Subtotal-I&R Support			18,000	17,000	6,000	8,500	6,000	8,500	6,000	8,500
			446,000	299,200	221,000	104,800	219,000	106,356	321,000	159,356

	2006-07 One-Time	2006-07 Permanent	2007-08 One-Time	2007-08 Permanent	2008-09 One-Time	2008-09 Permanent	2009-2010 One-Time	2009-2010 Permanent	2010-11 One-Time	2010-11 Permanent	**Total One-Time**	**Total Permanent**	
Faculty													
Faculty FTE		1.00		1.00		1.00		1.00			**-**	**9.00**	
Rank(s):											**-**		
Professor											**-**	**258,800**	
Associate Professor											**-**	**96,300**	
Assistant Professor		76,400		76,400		76,400		76,400			**-**	**534,800**	
Subtotal-Faculty Salaries	-	76,400	-	76,400	-	76,400		76,400	-	-	**-**	**889,900**	
Faculty Start-up													
Personal	200,000		200,000		200,000		200,000				**1,900,000**	**-**	
Removal	4,000		4,000		4,000		4,000				**42,000**	**-**	
Recruitment	4,000		4,000		4,000		4,000				**36,000**	**-**	
Library	5,000		5,000		5,000		5,000				**45,000**	**-**	
Subtotal-Faculty Start-up	213,000	-	213,000	-	213,000	-	213,000	-	-	-	**2,023,000**	**-**	
Staffing													
Staff FTE		1.00		0.50								**2.50**	
Salaries:													
Asst. III				17,516								**52,547**	###
Admin. Spec.		20,038										**20,038**	
MSO I		-										**-**	
AA II												**-**	-
Subtotal - Salaries	-	20,038		17,516	-	-	-	-	-	-	**-**	**72,585**	
Benefits	-	4,509	-	3,941	-	-	-	-	-	-	**-**	**16,332**	
Instruction & Research Support													
General I&R Support		8,500		8,500		8,500		8,500		-	**-**	**76,500**	
Admin. Equipment & Furniture	6,000		6,000		6,000		6,000		-		**60,000**	**-**	
Subtotal-I&R Support	6,000	8,500	6,000	8,500	6,000	8,500	6,000	8,500	-	-	**60,000**	**76,500**	
	219,000	109,447	219,000	106,356	219,000	84,900	219,000	84,900	-	-	**2,083,000**	**1,055,316**	

FOOTNOTES:
1. Assumed centrally held faculty FTE will be released to SOE in 2002-03.

TABLE 7 BUDGET PROJECTIONS 2002-11 GRADUATE ADVISING STAFF BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Faculty Start-up																					
Personal																				**-**	**-**
Removal																				**-**	**-**
Recruitment																				**-**	**-**
Library																				**-**	**-**
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Staffing																					
Staff FTE	2.00				1.00						1.00						-			**-**	**2.00**
Salaries:																				**-**	**-**
SAO II					42,300															**-**	**42,300**
SAO I											38,425						-			**-**	**38,425**
																				-	**-**
																				-	**-**
Subtotal - Salaries		-	-	-	42,300	-	-	-	-	-	38,425	-	-	-	-	-	-	-	-	**-**	**80,725**
Benefits		-	-	-	8,969	-	-	-	-	-	8,566	-	-	-	-	-	-	-	-	**-**	**17,535**
Instruction & Research Support																					
General I&R Support					4,000						4,000						-			**-**	**8,000**
Admin. Equipment & Furniture																				**-**	**-**
Subtotal-I&R Support		-	-	-	4,000	-	-	-	-	-	4,000	-	-	-	-	-	-	-	-	**-**	**8,000**
		-	-	-	55,269	-	-	-	-	-	50,991	-	-	-	-	-	-	-	-	**-**	**106,260**

FOOTNOTES:
1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. Does not include staffing or other expenses for decentralization of graduate admissions to academic divisions.
4. I&R Support at $5,000 per staff hire.

TABLE 7 BUDGET PROJECTIONS 2002-11 UNDERGRADUATE ADVISING & MEP STAFF BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Faculty Start-up																					
Personal																				**-**	**-**
Removal																				**-**	**-**
Recruitment																				**-**	**-**
Library																				**-**	**-**
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Staffing																					
Staff FTE	6.25		1.50				1.00		1.00		1.00				-				-	**-**	**4.50**
Salaries:																					
SAO II							42,300								-					**-**	**42,300**
SAO I			19,213								38,425								-	**-**	**57,638**
MEP Counsellor			44,150						44,150											**-**	**88,300**
																				-	**-**
Subtotal - Salaries		-	63,363	-	-	-	42,300	-	44,150	-	38,425	-	-	-	-	-	-	-	-	**-**	**188,238**
Benefits		-	13,445	-	-	-	8,969	-	9,162	-	8,566	-	-	-	-	-	-	-	-	**-**	**40,142**
Instruction & Research Support																					
General I&R Support			6,000				4,000		4,000		4,000				-				-	**-**	**18,000**
Admin. Equipment & Furniture																				**-**	**-**
Subtotal-I&R Support		-	6,000	-	-	-	4,000	-	4,000	-	4,000	-	-	-	-	-	-	-	-	**-**	**18,000**
		-	82,807	-	-	-	55,269	-	57,312	-	50,991	-	-	-	-	-	-	-	-	**-**	**246,379**

FOOTNOTES:
1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. MEP counsellors to be funded by UCOP MEP resources.
4. MEP counsellors assumed to be SAO I.

TABLE 7 BUDGET PROJECTIONS 2002-11 BELS INSTRUCTIONAL LAB STAFF & EQUIPMENT BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																					
																				-	-
																				-	-
																				-	-
																				-	-
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faculty Start-up																					
																				-	-
																				-	-
																				-	-
																				-	-
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staffing																					
Staff FTE	2.00		2.00		-		1.00				1.00				-					-	**4.00**
Salaries:																					
Sr. Develop. Engineer							62,050								-					-	**62,050**
Assoc. Develop. Engineer			56,400								56,400									-	**112,800**
Assist. Develop. Engineer					-															-	-
Jr. Develop. Engineer			46,525																	-	**46,525**
Subtotal - Salaries		-	102,925	-	-	-	62,050	-	-	-	56,400	-	-	-	-	-	-	-	-	-	**221,375**
Benefits		-	19,844	-	-	-	11,023	-	-	-	10,436	-	-	-	-	-	-	-	-	-	**41,303**
Instruction & Research Support																					
General I&R Support			8,000		-		4,000				4,000									-	**16,000**
Instructional Lab Equipment			322,619				100,000													-	**422,619**
Computer Hardware			60,776				20,000													-	**80,776**
Computer Software			6,248				5,000													-	**11,248**
Network Expenses																				-	-
Back-up, Machine Room Expenses			2,000				2,000													-	**4,000**
Admin. Equipment & Furniture																				-	-
Subtotal-I&R Support		-	399,643	-	-	-	131,000	-	-	-	4,000	-	-	-	-	-	-	-	-	-	**534,643**
		-	522,412	-	-	-	204,073	-	-	-	70,836	-	-	-	-	-	-	-	-	-	**797,321**

FOOTNOTES:
1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. One-time equipment expenses include on-going replacement and equipment for new labs.
4. 50% of BELS equipment, computer and software projected to be non-state ("19900") funded by 2010-11.
5. Instructon and Research Support expense increases starting in 2004-05 to accomadate the new Biomolecular Engineering Department Requirements.

TABLE 7 BUDGET PROJECTIONS 2002-11 TECHNICAL STAFF & IT BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																				**-**	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Faculty Start-up																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Staffing																					
Staff FTE	9.75		2.00		1.00		1.00		1.00		-		-		1.00		-		-	**-**	**6.00**
Salaries:																				**-**	**-**
Progrmer Analyst IV (MSP II)			71,025				-		71,025		-		-							**-**	**142,050**
Progrmer Analyst III (PSS L)			58,675		-		-				-		-				-			**-**	**58,675**
Progrmer Analyst II (PSS J)					48,475										-					**-**	**48,475**
Cmptr Resource Specialist II			-				41,754		-						41,754		-		-	**-**	**83,508**
Subtotal - Salaries		-	129,700	-	48,475	-	41,754	-	71,025	-	-	-	-	-	41,754	-	-	-	-	**-**	**332,708**
Benefits		-	22,629	-	9,611	-	8,912	-	11,957	- -	-	-	-	-	8,912	-	-	-	-	**-**	**62,022**
Instruction & Research Support																				**-**	
General I&R Support			8,000		4,000		4,000		4,000		-		-		4,000		-		-	**-**	**24,000**
Computer Hardware			255,800		38,600		43,400		49,800		29,850		51,750		59,800		66,700		74,750	**-**	**670,450**
Computer Software			65,000		9,750		10,450		12,720		14,780		11,500		18,400		21,850		24,725	**-**	**189,175**
Network Expenses			165,000		20,625		18,563		20,418		22,461		24,707		27,177		29,895		49,327	**-**	**378,173**
Back-up, Machine Room Expenses			37,666		2,000		2,000		8,667		2,000		3,000		2,000		3,000		6,033	**-**	**66,366**
Admin. Equipment & Furniture																					
Subtotal-I&R Support		-	531,466	-	74,975	-	78,413	-	95,605	-	69,091	-	90,957	-	111,377	-	121,445	-	154,835	**-**	**1,328,164**
		-	683,795	-	133,061	-	129,079	-	178,587	-	69,091	-	90,957	-	162,043	-	121,445	-	154,835	**-**	**1,722,894**

FOOTNOTES:
1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. One-time equipment expenses include on-going replacement and equipment for new labs.
4. 50% of tech staff salary and benefit expenses projected to be non-state ("19900") funded by 2010-11.
5. 25% of equipment expenses projected to be funded by non-state ("19900") resources by 2010-11.

TABLE 7 BUDGET PROJECTIONS 2002-11 FACILITIES STAFF BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																					
Faculty FTE																				-	-
Rank(s):																					
Professor																				-	-
Associate Professor																				-	-
Assistant Professor																				-	-
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faculty Start-up																					
Personal																				-	-
Removal																				-	-
Recruitment																				-	-
Library																				-	-
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staffing																					
Staff FTE	2.00		1.00				-													-	**1.00**
Salaries:																				-	-
Facilities Director																				-	-
Assist Facilities Director																				-	-
Assist Facilities Director																				-	-
Facilities Assistant III			39,750				-													-	**39,750**
Subtotal - Salaries		-	39,750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**39,750**
Benefits			8,704		-		-		-	-	-	-	-	-	-	-	-	- -	-	-	**8,704**
Instruction & Research Support																					
General I&R Support			4,000																	-	**4,000**
Admin. Equipment & Furniture																				-	-
Subtotal-I&R Support		-	4,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4,000**
		-	52,454	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**52,454**

FOOTNOTES:

1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. Assistant Facilities Director = Sr. Admin. Analyst (PSS K). Facilities Assistant III = "__" Assistant III.
4. June 2002 temp move to about 20,000 asf surge space and release space, plus E2 and Cal-ISI projects. Add temporary facilities asssst director.
5. Jan 2004 PSB opens, July 2005 E2 opens, Jan 2005 Alts 2 & 3 completed. Add temporary facilities director.
6. Projected SOE construction events:

Jan 02	Science Communication space released to SOE
June 02	SOE surge space available until E2 and PSB available
Jan 04	PSB available
July 05	E2 available (July 04 if lease revenue bond financed)
Jan 05	Alts 2 available
Jan 06	Alts 3 available

TABLE 7 BUDGET PROJECTIONS 2002-11 DEVELOPMENT AND INDUSTRIAL RELATIONS STAFF BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																				**-**	**-**
																				-	**-**
																				-	**-**
																				-	**-**
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Faculty Start-up																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Staffing																					
Staff FTE	0.98				1.00		1.00				0.49				-					**-**	**2.49**
Salaries:																					
Assist Develp Director (PSS L)											28,751									**-**	**28,751**
Development Asst III															-					**-**	**-**
Industrial Relations Director (MSP II)					82,800															**-**	**82,800**
Industrial Relations Asst III					-		39,750													**-**	**39,750**
Subtotal - Salaries		-	-	-	82,800	-	39,750	-	-	-	28,751	-	-	-	-	-	-	-	-	**-**	**151,301**
Benefits		-	-	- -	13,181	- - -	8,704	- - -	-	- -	5,229	- -	-	- -	-	- -	-	- -	-	**-**	**27,115**
Instruction & Research Support																					
General I&R Support					4,000		4,000				1,960				-					**-**	**9,960**
Admin. Equipment & Furniture																				**-**	**-**
Subtotal-I&R Support		-	-	-	4,000	-	4,000	-	-	-	1,960	-	-	-	-	-	-	-	-	**-**	**9,960**
		-	-	-	99,981	-	52,454	-	-	-	35,940	-	-	-	-	-	-	-	-	**-**	**188,375**

FOOTNOTES:
1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. 51% of salary and benefit expense for Assist Development Director and 2 Development Assistant III from University Relations.
4. 49% of salary and benefit expense for Assist Development Director and 2 Development Assistant III from SOE STIP income.
5. Industrial Releations Director and Industrial Relations Assistant III salary and benefit expense funded by non-state ("19900") resources.

TABLE 7 BUDGET PROJECTIONS 2002-11 DEAN'S OFFICE AND BUSINESS STAFF BUDGET PLAN

	Current Staff FTE	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
		One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty FTE																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Salaries		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Faculty Start-up																					
																				-	**-**
																				-	**-**
																				-	**-**
																				-	**-**
Subtotal-Faculty Start-up		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
Staffing																					
Staff FTE	9.50		0.50		1.00		1.00		1.00		1.00						1.00			**-**	**5.50**
Salaries:																				**-**	**-**
SHR			29,425		35,031						35,031									**-**	**99,487**
AHR							-													**-**	**-**
Business Services					-		35,031													**-**	**35,031**
General Admin.									35,031								35,031			**-**	**70,062**
Subtotal - Salaries		-	29,425	-	35,031	-	35,031	-	35,031	-	35,031	-	-	-	-	-	35,031	-	-	**-**	**204,580**
Benefits		-	5,345	-	8,213	-	8,213 -	- -	8,213	- -	8,213	- -	-	- -	-	- -	8,213	- -	-	**-**	**46,411**
Instruction & Research Support																					
General I&R Support			2,000		4,000		4,000		4,000		4,000						4,000			**-**	**22,000**
Admin. Equipment & Furniture																				**-**	**-**
Subtotal-I&R Support		-	2,000	-	4,000	-	4,000	-	4,000	-	4,000	-	-	-	-	-	4,000	-	-	**-**	**22,000**
		-	36,770	-	47,244	-	47,244	-	47,244	-	47,244	-	-	-	-	-	47,244	-	-	**-**	**272,991**

FOOTNOTES:

1. Staff benefit expense per Troy Lawson. For FTE > 0.44, benefit expense $4,570 plus 10.4% of salary expense.
2. Salary expense is mid-point of position's payroll job title.
3. Increase SHR coordinator to 1.0 FTE (PSS K) in 2002-03.
4. Add AA III in SHR and AA III in Budget/Accounting in 2003-04.
5. Add Admin Specialist (PSS H) in AHR and AA III in Purchasing in 2004-05.
6. Add AA III supporting Associate Deans for Student Affairs and Research and Graduate Studies in2005-06.
7. Add AA III supporting SHR in 2006-07.
8. Add AA III supporting Dean's Office Administration on 2009-10.

TABLE 7 BUDGET PROJECTIONS 2002-11 FURNITURE EXPENSE *

	2002-03		2003-04		2004-05		2005-06		2006-07		2007-08		2008-09		2009-2010		2010-11		**Total**	
	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	One-Time	Permanent	**One-Time**	**Permanent**
Faculty																				
See Footnote *																				
Graduate Students																				
headcount increase		52		89		56		112		88		47		45		42		41		
furniture expense	84,933		145,367		91,467		182,933		143,733		76,767		73,500		68,600		66,967		**934,267**	
Staff																				
See Footnote *																				
Does not include dept staff.																				
headcount increase		7		4		5		3		4		-		1		1		-		
furniture expense	20,825		11,900		14,875		8,925		13,358		-		2,975		2,975		-		**75,833**	
Other																				
Researchers																				
headcount increase		2		4		10		2		4		4		6		3		4		
furniture expense	6,650		13,300		33,250		6,650		13,300		13,300		19,950		9,975		13,300		**129,675**	
	112,408		170,567		FALSE		198,508		170,391		90,067		96,425		81,550		80,267		**1,000,183**	

Footnotes:

*** Faculty and dept staff furniture expense projections captured in individual department spreadsheets**

1. Assume 75% of grads housed in research labs and each workstation provides for 1.5 graduate students
2. Assume 25% of grads housed in SOE common grad labs and each workstaion provides for 3 graduate students
3. Assume 75% of staff housed in bullpen workspace.
4. Assume 25% of staff housed in single or multiple occupancy office.
5. Assume bullpen workspace costs $2,800 per workstation.
6. Assume office workstation costs $3,500 per workstation.
7. Grad headcount projections from "All School" Planning Profiles spreadsheet.
8. Assume 75% of researchers in single or multiple occupany office.
9. Assume 25% of researchers in bullpen workspace.
10. Assume researcher furniture expense funded by University Opportunity Funds.

TABLE 7 BUDGET PROJECTIONS 2002-11 SOE Budget Planning Assumptions & Guidelines

Faculty	ALL AMOUNTS GO IN THE PERMANENT COLUMN
Faculty FTE	Number of faculty to be appointed (as of 7/1/XX) in a given year.
Rank(s):	
Professor	Sum the salaries for professor hires.
Associate Professor	Sum of the salaries for associate hires.
Assistant Professor	Sum of the salaries for assistant hires.
Subtotal-Faculty Salaries	Total of all faculty salaries for that year.
Faculty Start-up	ALL AMOUNTS GO IN THE ONE-TIME COLUMN.
Personal	Sum of the start-up amounts for the faculty appointed. Get total from Recruitment Proposal spreadsheet.
[Include renovation costs to research lab if person will reside in Baskin Engineering. Consult with Jim/Dave Cosby for amount.]	
Removal	Use $4k for each non-tenured appt. and $6k for each tenured appt.
Recruitment	Use $4k for each recruitment, regardless of level.
Library	Use $5k for each recruitment, regardless of level.
Subtotal-Faculty Start-up	Total of above.
Staffing	ALL AMOUNTS GO IN THE PERMANENT COLUMN.
Staff FTE	Number of staff to be appointed (as of 7/1/XX) in a given year.
Salaries:	List the classification and salary for each position included in the FTE count.
Benefits	Should calculate automatically. Line should total 22.5% of total staff salaries.
Instruction & Research Support	AMOUNTS CAN BE EITHER ONE-TIME OR PERMANENT.
General I&R Support	PERMANENT Amount per faculty appointed. Use the following schedule:
[Covers new staff positions,	2002-03: $10,000
course support, general supplies	2003-04: $10,000
and telephone, computing, biz,	2004-05: $10,000
BELS, and advising budgets.]	2005-06: $11,000
	2006-07: $11,000
	2007-08: $11,000
	2008-09: $11,000
	2009-10: $11,000
	2010-11: $12,000
Admin. Equipment & Furniture	ONE-TIME amount per faculty appointed. Use the following schedule:
[Covers standard complement of	2002-03 through 2005-06: $6,000 per faculty appointed.
furniture for faculty office and	2006-07 through 2010-11: $7,500 per faculty appointed.
for furniture for associated	These amounts cover standard furniture complement for faculty and associated
staff (~3 faculty = 1 staff).]	staff. You may include special items if you know of any. Please list them as a
	footnote on the budget sheet.
Subtotal-I&R Support	Totals (one-time and permanent separate) of above.

SECTION 5 - ADMINISTRATION

DEVELOPMENT AND INDUSTRIAL RELATIONS

Development

The development of resources for any engineering program—beyond state funding—is critically important to the School's success. The Baskin School of Engineering has benefited from strong private supporters including Mr. Jack Baskin, Dr. Narinder Kapany, Mr. David Lee, and businesses including Agilent, Cisco, HHMI, HP, Intel, Lucent Technologies, Microsoft, National Instruments, National Semiconductor Company, Nokia, Nortel, Packard Foundation, Plantronics Company, Samsung Electronics, Seagate, Silicon Graphics, Sun Microsystems, Xilinx, as well as from our alumni.

The past year has been challenging for the School without a Development Director. However, the incoming Development Director, Mr. John Idstrom, starts in January 2002. The School is well poised to move ahead for active development in collaboration with University Relations. The School will actively participate in the campus-wide comprehensive campaign over the next several years to develop funds for the Engineering II building, endowed chairs, graduate fellowships, undergraduate scholarships, unrestricted funds for faculty housing assistance, and special programs such as entrepreneurship development.

The following list highlights these significant needs:

- Matching funds for the CITRIS-sponsored portion of Engineering II building—$3M plus $2M equipment
- Endowed chairs—$350K+/professor
- Fellowship endowments—$150K +/student
- Student scholarships—$5-10K/student
- Endowments for faculty housing assistance—$100K/professor

The School, in partnership with University Relations, anticipates filling its Development Assistant vacancy shortly after John Idstrom arrives. As the School develops its development resources, it anticipates hiring an Assistant Development Director in 2006-07.

Engineering will mark its fifth anniversary in 2002 and the School plans to celebrate this significant milestone. The School's goal will be to involve the campus, plus current and past students, by offering distinguished lectures, recognition of outstanding alumni, and poster displays, among other celebratory events throughout the year.

Industrial Relations

To forge our relationships with key industry in the region, especially those companies in Santa Cruz County and Silicon Valley and the local chambers of commerce, the School plans to do more proactive outreach by developing internships and Co-op program opportunities for our engineering students. The development of two California Institutes—CITRIS and QB3—and the new program offerings at UCSC Silicon Valley Center, will create new opportunities for collaboration. The Information Systems and Technology Management (ISTM) degree program and the Pacific Rim Roundtable Forum are also very promising and will help accelerate our School's visibility which will lead to future development opportunities.

The School's departments will actively support and coordinate fund-raising activities through the Office of Development and Industrial Relations. Many potential donors have an interest in engineering projects such as the Human Genome Project and development of new technologies to advance medical research and human health. As spearheaded by the CBSE, activities are presently in place to reach out to donors, including maintaining a web page and press packet, giving tours of the facilities and being available to give talks at key events. Computer Engineering faculty have been successful in obtaining approximately $100,000 per year in external research gift funds, and an estimated $50,000 in other forms of external income, such as copyright and patent licensing. The Computer Science Department maintains close relationships with major companies including National Semiconductor Corporation, Ricoh, and DuPont Pharmaceutical Laboratories. Other targeted companies include Microsoft, Oracle, and Agilent. Electrical Engineering will continue existing relationships with a number of firms such as Lucent Technologies, Agilent, and Intel to support research and teaching laboratories. A number of faculty with interests in optoelectronics have developed a research collaboration with K-2 Optronics, sharing equipment and research projects.

AMSL (formerly Silicon Valley Group), manufacturers of innovative equipment for semiconductor fabrication lines, have contacted the School and indicated interest is both research collaborations and internship programs. Future plans include the continuation and expansion of existing joint research projects with high tech companies through the UC SMART and Micro programs, e.g. with Agility Communications. National Semiconductor has a special interest in analog integrated circuits that fits well with faculty interests in the photonics and electronic group. The School, through the electrical engineering department, has contacted National Semiconductor; Mr. Dennis Monticelli of National Semiconductor was the keynote speaker at this year's faculty retreat.

With the growth in this area and corporate membership fee, an Industrial Relations Director will be hired in 2003-04 and an assistant in 2004-05. The director will be responsible for planning and executing collaborative efforts and liaison functions in matters of research, corporate alliances, and technology licensing on behalf of the Baskin School of Engineering. The position will require interface and coordination with the School's Director of Development and technology licensing units within the University.

The Director will also be responsible for an external relations program—Industrial Affiliates Program—that enhances visibility, and establishes strong strategic alliances with corporations, individuals, organizations, universities, and foundations.

Industrial Affiliates Program

The School of Engineering will be ramping up its Industrial Affiliates Program with the hiring of the Industrial Relations Director. The Industrial Affiliates program will target general and specific research areas.

This program will enhance the flow of research, talent, and personal contact between member companies and the School of Engineering faculty and students. Enhanced technology transfer will be one of the primary objectives of the School of Engineering's Industrial Affiliates Program. The transfer of knowledge from the university to industry is accomplished by positive interaction between industry's research and development groups and the School's research groups. Programs will be flexible and designed to meet specific needs of the member companies. Benefits and costs will vary among the affiliate programs, but may include workshops, faculty visits, visiting scholar programs, enhanced recruiting opportunities, and more.

Alumni
The School of Engineering alumni are a critical component to the School's goal of fundraising and support-building. In addition to financial support, engineering alumni will be encouraged to help open doors to industry where they are employed or have connections; help identify companies that will work with the School in offering internship opportunities. The School will work with our engineering alumni to create more opportunities for interaction and ways in which we can solicit their input and support. Anticipated outreach efforts to our alumni will include a yearly School of Engineering annual report, e-newsletters from the Dean, a distinguished alumni award as well as invitations to visit the School during graduation and other School-wide events.

GRADUATE STUDENT ADMISSION DELEGATED TO THE DIVISIONS

The School of Engineering currently has graduate programs in Computer Engineering and Computer Science. With the expected approval of its third graduate program (Electrical Engineering) in 2001-2002, the School of Engineering will be accepting applications for three graduate programs in 2002-2003 and likely four in 2003-2004; the proposal for the Bioinformatics program was just submitted for campus approval.

The decentralization of graduate admissions is vital to the School of Engineering's ability to attract and recruit excellent graduate students. Expedited reviews of applications, early access to completed applications, and direct contact between applicants and knowledgeable advisors and/or faculty is a major factor affecting recruitment.

Using the estimates provided by the Graduate Division, the School will need 2.0 FTE to take on decentralized admissions immediately, and this number will grow to roughly 5.0 FTE by 2010 with the projected growth. These numbers assume that we continue with our mostly paper-based application process. However, with improved electronic support of the graduate office and the introduction of the School of Engineering on-line admissions, the number of FTE should be less, which would allow Graduate Programs staff to spend more time on advising, student recruitment, and outreach. An initial investment of technical support will be required to streamline the admissions process and improve staff productivity.

A conservative estimate for immediate staff needs is:

- 1 FTE for admissions (position described in memo of April 2001)
- 1.0 technical staff FTE to support on-line admissions and graduate databases

After a successful trial period with on-line admissions the School could require applicants to apply on-line. Based on the projected growth in both graduate headcounts and number of Graduate programs, by 2010, a total of 2.5 FTE (beyond the normal Graduate Advising staff that would accompany the growth) would be required to support admissions. This number includes 0.5 FTE in technical staff.

Library Resources
Successful graduate programs across the divisions will require improved and strengthened library resources in the form of significantly increased access to electronic and print collections. This is especially true in engineering where journals are exceptionally expensive and many journals have more than doubled in price over the past ten years. The scientific disciplines, including engineering, depend heavily upon the journal literature and the databases that index those journals to support their current research, teaching, and grant proposals. It is imperative that a predictable and long-term commitment of funds be provided to the library by the campus to maintain the excellence in teaching and research we have come to expect. Additionally, as new programs are proposed, the library should be consulted about the level of funding needed for monographs, serials and non-print materials to support these programs.

Funding for Faculty and Staff
Established less than five years ago, the Baskin School of Engineering is UCSC's youngest academic division, as well as the campus's first professional school. Consequently, Engineering and the campus community can expect challenges related to the School's newness and the integration of an academic engineering culture into Santa Cruz's existing campus culture. Some of these challenges are apparent and easy to appreciate—like Engineering's space needs—while others are subtler and require informed consideration.

One set of issues requiring consideration arises from Engineering being in its start-up phase and actively hiring a significant number of new employees, both faculty and staff. As Engineering endeavors to fill vacancies, it has become apparent UC and UCSC lag the marketplace significantly in offering competitive compensation packages. In order to fill openings, Engineering routinely is forced to start faculty and staff at salaries above the position's minimum starting salary. This, in turn, creates equity issues for existing personnel. Campus expects new employees will be brought in at the entry level of the position's salary range—however, UCSC's lag behind marketplace compensation makes this impossible.

To compound the situation, Campus expects above-minimum salary hires and equity adjustments will be funded from turnover salary savings resulting from the separation of mature personnel earning higher salaries. However, as a new division, Engineering's faculty and staff are young and many are just starting their careers. As such they will be with Engineering for the foreseeable future, therefore, projected turnover savings to address new employee compensation will be limited. Unfortunately, the state's current economic slump cannot be expected to correct this situation. While the slump should improve Engineering's faculty and staff applicant pools, the School is concurrently facing a reduction in its budget, thereby neutralizing its ability to capitalize on improved applicant pools even if the applicants can be hired at lower salaries.

Student-Faculty Workload Ratios
Delivery of engineering curricula requires lower student-faculty workload ratios than many other academic disciplines. This is especially true for instrumentation and equipment-intensive engineering disciplines such as electrical engineering, biomolecular engineering, and computer engineering. The School will conduct a more detailed assessment of student-faculty workload ratios at comparable engineering schools. However, the School's current working assumptions of about 15:1 for electrical engineering and biomolecular engineering; 16:1 for computer engineering; and 19 to 20:1 for computer science, AMS and ISTM appear to be reasonable starting points. Additionally, the 44:1 student-TA ratio will also be addressed. It has been suggested engineering disciplines require lower ratios consequently, the School plans to explore this topic in greater detail.

Instructional Equipment Replacement Allocation
Engineering is an equipment, instrumentation, and computer intensive field. For example, the School received a $1.2 million initial complement equipment budget from UCOP to equip its electrical engineering undergraduate instructional laboratories. The School's instructional laboratory manager, Mr. Robert Vitale, projects Engineering has a $300-500,000 annual equipment replacement budget to keep the laboratories current and equip the new laboratories created by the faculty. Engineering plans to generate half of this expense using a variety of extramural resources including its industrial affiliates program, industry sponsorship and development. Nonetheless, campus also needs to recognize its obligation in equipping these laboratories. Currently, the Engineering instructional laboratories receive forty percent of the School's $126,000 Instructional Equipment Replacement allocation or about $50,000 annually. This translates to less than 15% of the School's total instructional laboratory equipment replacement expense and we request the campus provide at least 50% of this expense. This request is reflected in the School using $42,500 as the campus I&R support allocation per Engineering faculty FTE.

Space Requirements
One of the School's biggest challenges is its on-going space shortage. As a start-up enterprise, Engineering is growing rapidly and generating a pressing need for space. However, space for Engineering must be carved from existing campus space inventories, or alternatively off-campus, until new Engineering space starts coming on-line around January 2004.

Using conservative measures for space need, Capital Planning estimates the School is currently short more than 5,000 asf, increasing to about 12,500 asf in 2002-03, and reaching 20,000 asf before PSB comes on-line in January 2004 (Table 9). Capital Planning is working with Associate Vice Chancellor Michaels and the School of Engineering to create an interim strategy to address Engineering's short term space needs until the new Physical Sciences Building is available. Campus anticipates providing 12,500 asf in temporary space to Engineering by late spring 2002. The School acknowledges and appreciates campus efforts to secure this temporary space.

Additionally, the School may need to consider additional short-term space beyond Capital Planning's projections. Capital Planning's projections are based on ladder rank faculty need only. However, as part of the matching obligations for both the Cal-ISI CITRIS and QB3 proposals, Engineering must generate over $10 million in research awards over the next four years—before the Cal-ISI funded space in the Engineering II building comes on -line in July 2005. Consequently, there is also a need to provide temporary space for the Cal-ISI researchers during this three to four year interim period until the Cal-ISI space comes on-line in the Engineering II building. Engineering's iNIST director, Professor Patrick Mantey, is working with Dean Kang, Associate Vice Chancellor Michaels and Capital Planning to devise potential solutions to meet this additional space need.

Programmatic planning conducted for the September 2000 Engineering II building Project Planning Guide (PPG) assumed the School would have 104 faculty FTE, 425 graduate students and 1,267 undergraduate majors in 2007-08. Currently, Engineering projects it will have 116 faculty FTE, 645 graduate and 1,940 undergraduate majors in 2007-08. By 2010-11, the School anticipates 126 faculty FTE, 773 graduates and 1,990 undergraduate majors. Given these projections, Table 8 was created to estimate Engineering's programmatic space needs in 2010-11. This data was combined with the School's current space expectations to create a space sources and uses table for 2010-11 (Table 11). This analysis anticipates Engineering requiring an additional 27,000 asf to fulfill its programmatic needs by 2010-11, which is anticipated, to come as release space in Baskin Engineering and/or Engineering II.

Finally, the importance of the Baskin Engineering Alterations 2 and 3 projects to fulfill Engineering's space needs must be underscored. These are long-standing alterations projects on the Campus Major Capital Improvement Program and the Engineering II Program Planning Committee incorporated them into the program. Specifically, in order to minimize Engineering II building costs, the Programming Committee anticipated the Alternations 2 and 3 projects would create Engineering's instrumentation/equipment intensive research space, wet laboratory space, additional student instructional laboratory space, and some of the School's administrative space. As noted throughout the September 2000 Engineering II Building PPG, the planned renovations to Baskin Engineering were incorporated into the Engineering II building program. Thus, it is imperative the campus move ahead with the Baskin Engineering Alterations 2 and 3 projects.

Table 8 Engineering Programmatic Space Projections in 2011

	E2 PPG Projections for 104 Faculty FTE (1)			Projections for 126 Faculty FTE		
	Faculty FTE	Total asf		Faculty FTE	Total asf	
Department						
Space by category						
Applied Math & Statistics	10			17		
Research/scholarly activities		4,950			8,415	
Offices		3,205			5,449	
Applied Math & Statistics total asf		8,155			13,864	
Biomolecular Engineering	9			14		
Class laboratories		1,600			2,489	
Research/scholarly activities		6,180			9,613	
Offices		3,200			4,978	
Biomolecular Engineering total asf		10,980			17,080	
Computer Engineering	21			27		
Class and special class laboratories		2,600			3,343	
Research/scholarly activities		10,395			13,365	
Offices		5,890			7,573	
Computer Engineering total asf		18,885			24,281	
Computer Science	26			37		
Research/scholarly activities		12,870			18,315	
Offices		7,415			10,552	
Standard I&R total		20,285			28,867	
Open laboratories		500			712	
Computer Science total asf		20,785				
Software Engineering	8			- (2)		
Research/scholarly activities		3,960				
Offices		1,340				
Software Engineerig total asf		5,300				
Software Eng & Computer Science total asf		26,085			29,579	
Electrical Engineering	15			21		
Class and special class laboratories		3,700			5,180	
Research/scholarly activities		9,145			12,803	
Offices		4,530			6,342	
Electrical Engineering total asf		17,375			24,325	
Mechanical Engineering	7			- (3)		
Class laboratories		800			-	
Research/scholarly activities		3,465			-	
Offices		1,225			-	
Mechanical Engineering total asf		5,490			-	
Information Systems Management	4			10		
Research/scholarly activities		1,980			4,950	
Offices		800			2,000	
Information Systems Mgmt total asf		2,780			6,950	
Engineering Management	4			- (4)		
Research/scholarly activities		1,980			-	
Offices		670			-	
Engineering Mgmt total asf		2,650			-	
General Engineering						
Teaching laboratory support		4,040			4,895	
Research/scholarly activities		6,210			7,524	
Offices		1,340			1,623	
Standard I&R total		11,590			14,042	
Open laboratories		6,060			7,342	
General Engineering total asf		17,650			21,384	
School of Engineering Administration						
Non-I&R offices		5,195			6,294	
School of Engineering Admin total asf		5,195			6,294	
School of Engineering	104			126		
Class and special class laboratories		12,740			15,906	
Research/scholarly activities		61,135			74,985	
Offices (I&R)		29,615			38,517	
Standard I&R total		103,490			129,408	
Open laboratories		6,560			8,053	
I&R total		110,050			137,462	
Non-I&R offices		5,195			6,294	
Sub-Total asf			**115,245**			**143,755**
HHMI						
Research/scholarly activities					2,734	
Offices					156	
						2,890
Cal-ISI QB3						
Research/scholarly activity and support					4,525	
Academic and admin offices and support					1,560	
						6,085
Cal-ISI CITRIS						
Research/scholarly activity and support					12,800	
Admin offices and support					2,335	
						15,135
					School of Engineering total asf	**167,865**

Footnotes:

1. Data from Table 9 in Engineering Building PPG, Sept. 27, 2000.
2. Software Engineering faculty FTE combined with Computer Science facutly FTE.
3. Mechanical Engineering faculty moved into Biomolecular Engineering (4 FTE) and Electrical Engineering (3 FTE).
4. Engineering Management becomes Information Systems & Technology Management and moves to ISM.

Table 9 Engineering Space Needs for Period 2001-08

	01-02	02-03	03-04	04-05 PSB	05-06 E2 (4)	06-07 Baskin Alts 3	07-08
Estimated Faculty Growth - FTE (2)	49	58	68	80	92	102	104
Projected Faculty FTE by P&B	66	79	89	96	97	103	104
Available Office/Research Space - asf (3)	34,000	34,000	34,000	41,734	81,000	90,000	90,000
Required Office/Research Space - asf	39,200	46,400	54,400	64,000	79,580	88,230	89,960
Yearly Incremental Space - asf	5,200	7,200	8,000	1,866	Space needs met by E2 & Baskin		
Total Additional Space - asf	5,200	12,400	20,400	22,266	Space needs met by E2 & Baskin		

FOOTNOTES:

1. Data prepared by Dennis Artman in Capital Planning, October 31, 2001.
2. Estimated faculty growth is slower than P&B projections and is used to determine future space required.
   Greater or lesser faculty growth may change estimated space needs projection.
3. 7,734 ASF available in PSB (12,600 - 4,300 QB3 - 566 classroom) in early 2004, all QB3/CITRIS space in addition to above space
4. Includes renovated Baskin Engineering space - Alts 2

Incremental space per faculty pre E2	800	asf
Incremental space per faculty at E2	865	asf

Space available in Kerr Hall	>12000	>8,000	>2000	indefinite
Space available in Baskin Engineering	12000	7412	minimal	indefinite

Table 10 Space Availability Projections

	Engineering ASF (1)		Available Date	
CURRENT SPACE				
Baskin Engineering	48,000		current	
HHMI (2)	2,900		current	
TEMPORARY SURGE SPACE (3)				
Surge Space	22,000	(4)	July 2002	
NEW SPACE				
Physical Sciences Building	12,500		Jan 2004	
Engineering II Building	48,000		July 2005	(5)
Cal-ISI CITRIS (6)	15,000		July 2005	(5)
Cal-ISI QB3 (6)	6,000		July 2005	(5)
RENOVATED ENGINEERING SPACE (7)				
BE Alterations 2 Project	14,000		July 2005	
BE Alterations 3 Project	11,000		July 2006	

Table 11 Space Sources and Uses in 2011

	ASF
SOURCES	
Current Baskin Engineering	48,000
E. Tox. Release Space	11,500
PSB Space	12,500
E2 Space	48,000
Cal-ISI CITRIS	15,000
Cal-ISI QB3	6,000
Total Sources	141,000
USES	
from Table 8	168,000
Additional Space Need	27,000

FOOTNOTES:

1. Space ASF are rounded to the nearest hundred.
   Currently planned Engineering space is about 144,000 asf.
   At 126 faculty, Engineering projects need for additional 24,000 asf.
2. HHMI = BE Engineering space assigned to Howard Hughes Medical Institute.
3. Campus providing Engineering with temporary surge space until capital projects completed.
4. Projected Engineering Need: 5,000 asf in 01-02; 12,500 asf in 02-03; 20,500 asf in 0304; and 22,000 asf in 04-05.
   See"Projection of School of Engineering Space Needs-2001-2008" for detail.
5. State lease revenue bond funding expected to move up E2 availability date by one year to July 2004.
6. Cal-ISI space is an addition to E2 space and capital project.
7. Renovation of 1970-era space in Baskin Engineering to meet Engineering's programmatic needs. Tied to E2 Project.
   Includes approx 11,500 asf in Science Communication and E. Tox. Space released to Engineering.

TECHNOLOGY REQUIREMENTS

Expanded and Upgraded Videoconferencing and Distance Learning Capabilities
Present videoconferencing and distance learning facilities are not only outdated, but too few for future requirements. Since the School will be actively participating in numerous off-campus activities and due to space and local housing constraints, growth in some areas will need to occur off campus, such as the Silicon Valley Center, Monterey Bay Science and Technology (MBEST) and at the expanding number of UCSC Extension sites. Presently there is one videoconference room and two distance learning classrooms in the Jack Baskin Engineering Building. This is insufficient. Although additional video conferencing facilities will be installed in the planned Engineering II building, more facilities and upgrades to existing facilities will be required to accommodate not only off campus initiatives but to enable principal investigators to collaborate in a far more efficient and effective manner.

Computer Network Infrastructure
Computer networking requirements have always outstripped our most expansive predictions. Our present 100Mb switched system to the desktop is doing reasonably well however at peek times, network delays and latency are experienced. These delays presently tend to be due to roadblocks our networking trunk lines. Future data requirements will acerbate these delays making them intolerable. Upgrade, expansion and redundancy for the network backbone especially the School's mainline connections to the Communications Building (CATS), to the new Physical Sciences Building (PSB) and to the New Engineering (E2) Building will be required. In addition, due the liklihood of expanded desktop videoconferencing and collaboration, new desktop installations should take the form of the highest data rate possible within reasonable cost considerations. This may include fiber but could also include gigabit Ethernet (1Gb/sec) which can run over existing CAT5E cabling. It is important to note that much of the Applied Sciences Alternations Phase I project made use of wall mounted wire moldings for many instructional and research labs. These wire moldings will allow upgrading and expansion of wiring; both networking and power, at much reduce construction costs. Phase II and III of the new Jack Baskin Building should incorporate not only this flexible system but also initiatives to improve the School's connections to the campus backbone.

Wireless Communications
As the School grows into occupying three buildings and increasing the numbers of students, the challenge will be to find productivity enhancements that do not require additional overhead staffing. One means for enhanced productivity for faculty and staff could come from providing a uniform wireless communications for voice and data throughout the engineering complex perhaps even the UCSC core area. School personnel could work throughout the complex all the while maintaining contact via long range cordless phones or corporate cell phone typology and maintain data contact via hand held wireless computers. A small start has already begun in the School where a test bed wireless data system was rolled out in 2000. This existing system in 2001-02 covers over 1/3 of the Jack Baskin Engineering Building with IEEE 802.11 (11Mb/sec) shared data coverage. This existing coverage is only available to faculty and staff of the School of Engineering. Future enhancements should be explored to allow 100Mb/sec shared data access throughout the building with the capability for allowing student level access. Wireless data systems have the advantage of low cost and flexible installations that increase productivity of

personnel that need to collaborate or attend meetings at various locations throughout the School of Engineering Complex.

Security and Environmental Technology Infrastructure
The campus should invest in remote camera systems, card-key access to rooms and hard-wired doors for sensitive areas such as laboratories containing expensive equipment. Projects to place environmental sensors throughout the building may also prove useful not only for research but also to ensure workplace quality. A similar project has been done at UC Berkeley Cory Hall to monitor building environmental and energy qualities. That project has led to significant energy savings and a potentially safer work environment.

Development of Dedicated Computer Science Instructional Labs
Presently the Computer Science department conducts undergraduate laboratories using the UCSC Central Campus instructional computing laboratories, otherwise known as CATS ICL. These laboratories are general-purpose computing environments arranged to serve a wide variety of courses from many different departments and divisions. Computer Science undergraduate studies require far more access to hardware and software than is physically obtainable from these campus open labs. In addition, several CS courses would like their undergraduate students to install, administer, experiment with and maintain software as part of the curriculum. This is especially true for Operating Systems, E-Commerce, internet and database software. Many of our Junior Colleges transfer students had this ability at their JC Campus only to find it lacking at UCSC. This ability to offer CS students full access to computers cannot be offered in an open lab that many other departments and students depend upon for their studies as well. The School plans to investigate providing a few dedicated Computer Science computing labs principally for upper division courses. These labs would not be open to the general campus population and could be configurable depending upon the sole needs of the CS Department. Many CS courses would likely continue to utilize the general computing labs of CATS ICL when possible, especially for lower division courses where requirements for unimpeded access is not required.

Table 12 Timeline for Engineering Degree Programs

	Existing	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09
Applied Math & Statistics									
Applied Mathematics				MS/PhD	BS				
Statistics/Envirometrics				MS/PhD	BS				
Biomolecular Engineering									
Bioinformatics		BS	MS/PhD						
Biomolecular Engineering					BS	MS/PhD			
Computer Engineering									
Computer Engineering	BS/MS/PhD								
Network Engineering	MS								
Computer Science									
Computer Science	BA/BS/MS/PhD								
Software Engineering					MS				
Web & Internet Engineering					MAS				
Electrical Engineering									
Electrical Engineering		BS/MS/PhD							
Environmental Engineering						BS/MS/PhD			
Multidisciplinary Engineering Programs									
Information Systems Management	BS								
Info. Systems & Technology Mgnt				MS/PhD					

Table 13 Engineering Enrollment FTE Projections

	2000-01		2005-06		2010-11	
	Undergrad	Graduate	Undergrad	Graduate	Undergrad	Graduate
F, W, S	758	131	1,414	461	1,535	696
Summer	7	0	250	0	360	0
Off-Campus	0	0	20	50	33	65

Table 14 Engineering Historic Student FTE

	Enrollment FTE					
	Computer Science & ISM	Computer Engineering	Electrical Engineering	Applied Math & Statistics	Total	Annual Growth
1993-94	259	159	0	0	418	
1994-95	244	186	0	0	430	3%
1995-96	254	170	0	0	424	-1%
1996-97	312	174	0	0	486	15%
1997-98	339	201	1	0	541	11%
1998-99	359	246	7	0	612	13%
1999-00	423	288	24	0	735	20%
2000-01	496	315	26	52	889	21%
2001-02	592	347	70	111	1122	26%

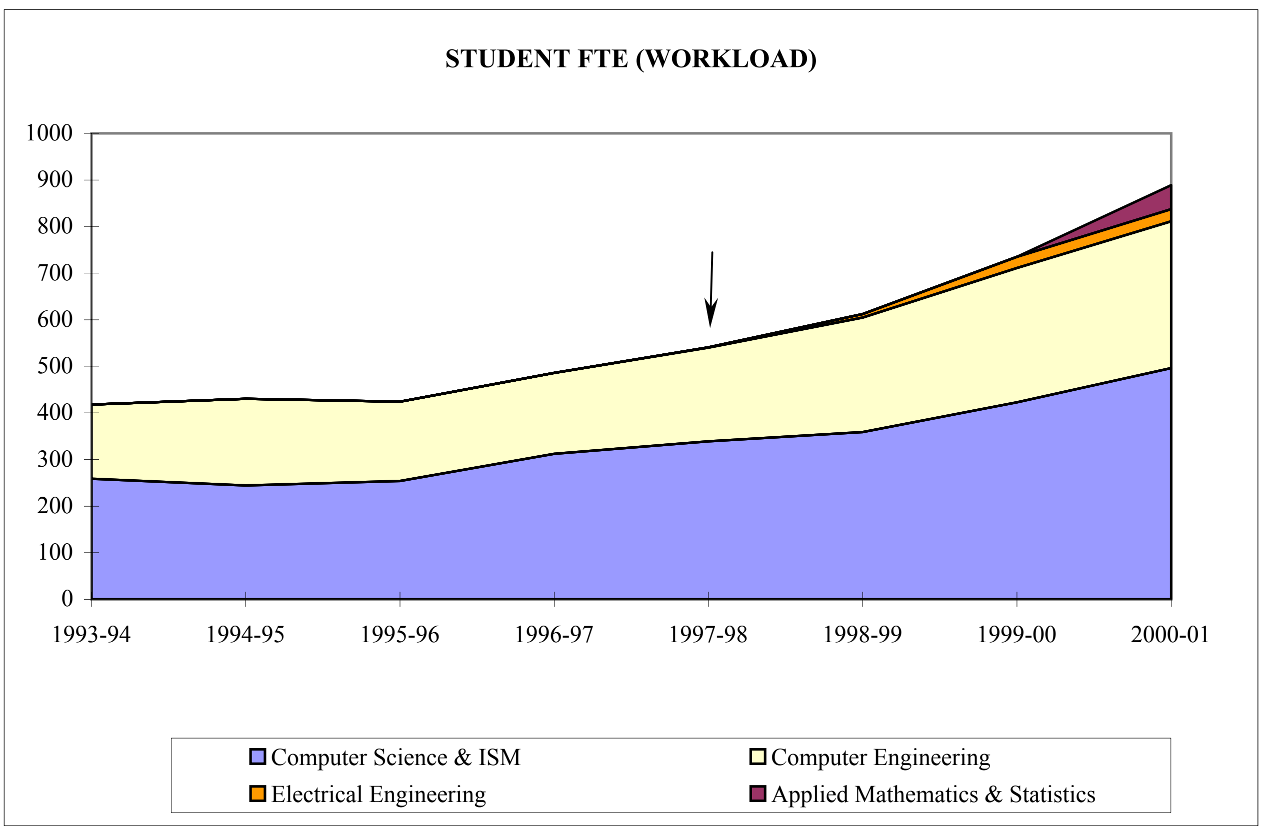
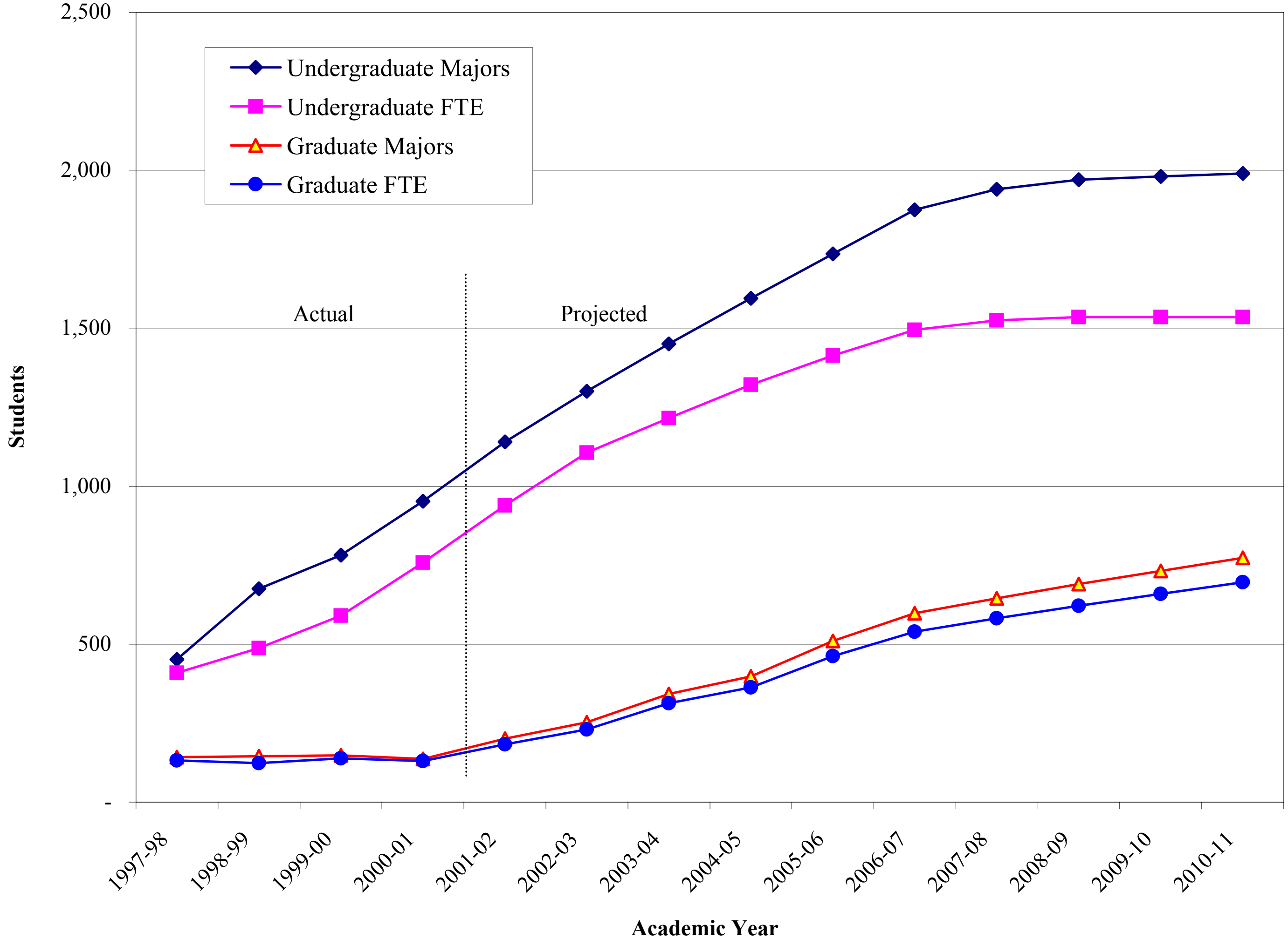


TABLE 15 SOE STUDENT GROWTH SINCE OPENING AND GROWTH PROJECTION



SECTION 7 – ESTIMATED BENEFITS AND/OR IMPACT ON OTHER CAMPUS UNITS

STUDENT ADMISSIONS

With the rise in the School of Engineering's national reputation, more students will seek to pursue university studies at UC Santa Cruz. The School anticipates about 1,414 undergraduate FTE and 462 graduate FTE in 2005-06, growing to 1,535 and 696, respectively by 2010-11. Additionally, the future establishment of the Silicon Valley Center will only increase the attraction by students to the UC campus. Moreover, 50-60% of the lower division undergraduate courses taken by Engineering majors are electives and general education courses offered by the other divisions.

INDIRECT COST RECOVERY RESULTING FROM RESEARCH AWARDS

Engineering expects to increase its extramural awards from the current level of $5 million annually to almost $25 million in 2005-06 and reaching $36 million by 2010-11. This, in turn, is projected to generate a total of about $49 million in indirect cost recovery for UC during the coming ten years. In increase in ICR will be critical for new campus initiatives, matching in grant applications, and support in interdivisional research collaboratives.

DIVERSITY PROMOTION

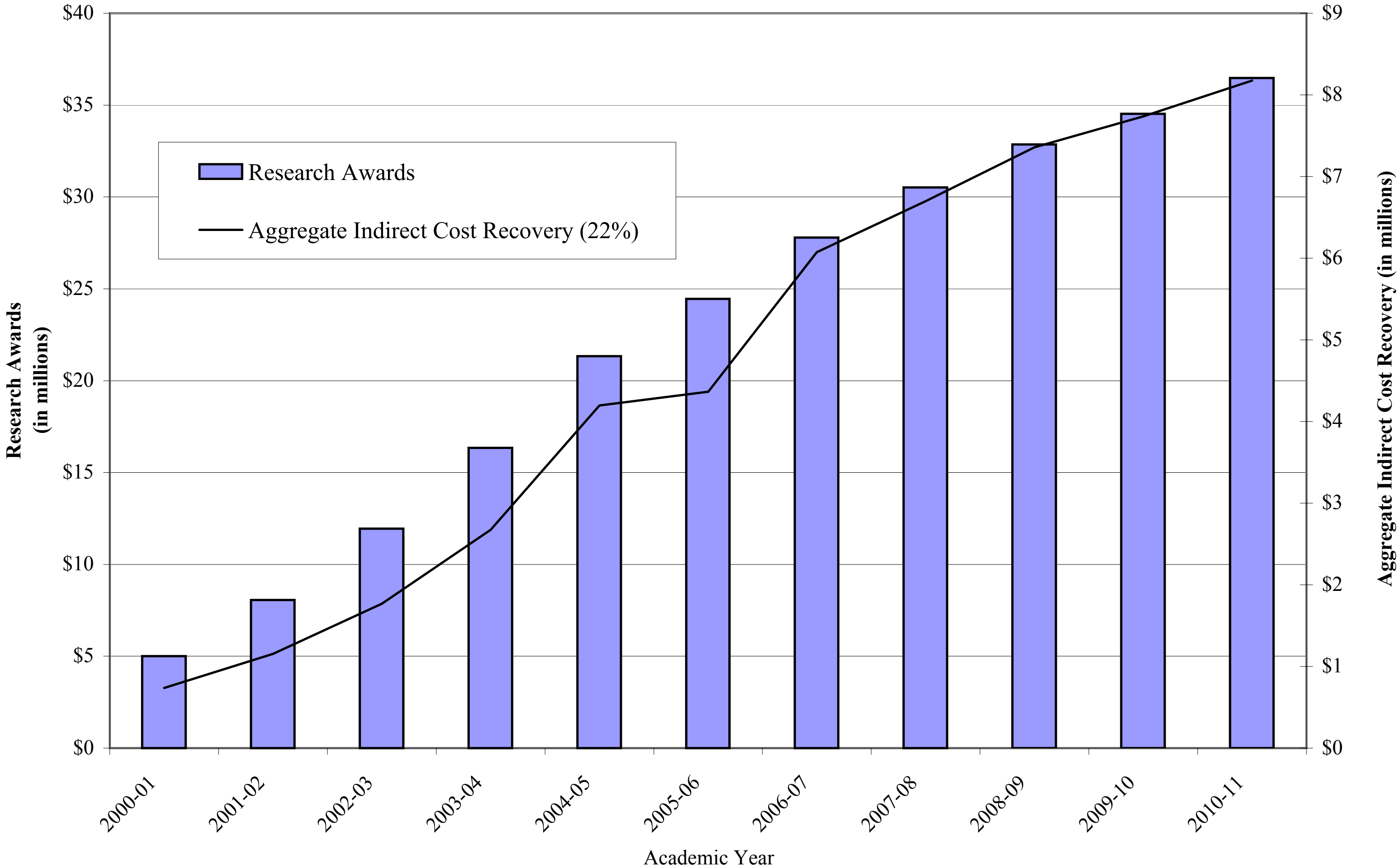
The School of Engineering is committed to continuing to make strong efforts to recruit, develop, promote, and retain the highest quality faculty, students and staff. We will continue to foster an environment that highlights diversity of thought, expression, culture and educational experiences.

Students
The School of Engineering is committed to promoting diversity in education and will take part in several targeted, co-curricular support programs and services that further diversity and sustains an academic climate for the advancement and success of all engineering students.

While the School of Engineering currently boasts the highest percentage of Asian students on campus at both the graduate (48%) and undergraduate (31%) level, it still remains on the lower end in the overall percentage of other ethnic minorities and women. Among the other campus divisions, the percentage of female students ranges between 54% and 67% at the undergraduate level and 42% to 66% at the graduate level.

To support women in engineering disciplines (currently 21% undergraduate, 25% graduate), we created a Society of Women Engineers (SWE) student chapter. Additionally, we are also taking part in MentorNet an electronic mentoring network designed to encourage more women to pursue their interests in engineering and related sciences through the provision of mentoring by professionals working in industry. As a contributing campus sponsor to MentorNet, we enabled

TABLE 16 SOE CONTRACT AND GRANT PROJECTION



all interested UCSC female students (undergraduates and graduates) thinking about studying engineering or science to apply to MentorNet for the first time; 62 UCSC students have successfully applied. However, our continued participation in the future may be dependent on securing sponsorship funding. Special emphasis still needs to be placed on attracting and retaining more women into these programs. Thus far, no female students have been selected to participate in the Computer Engineering BS/MS degree program. Therefore, we will put significant effort into encouraging women to consider entering graduate studies through this option. Using our SWE resources, we expect to explore other recruitment and retention strategies that encourage and promote the successful mentoring of female students.

The Multicultural Engineering Participation (MEP) program, also known as the MESA Engineering Program, plays a central role in supporting the undergraduate educational experience of a diverse engineering student population. MEP provides academic support services to assure greater opportunities for the preparation and retention of women, minority and other non-traditional student populations. We expect MEP to provide academically based services and professional development activities that will challenge students to excel and increase their potential for graduate studies.

We recognize the importance of affiliations with professional and ethnic engineering societies and will strongly encourage students' membership and involvement with UCSC student chapters of national and regional engineering organizations. These presently include the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), the Society of Women Engineers (SWE), along with the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronic Engineers (IEEE). We also propose to create a Tau Beta Pi engineering honor society chapter at UCSC. Activities through these affiliations respond to under-served interests and concerns among a multicultural student population, and have a direct impact on students' personal success and growth. Participation in these organizations also relates to how talented women and minority students are encouraged to pursue graduate study.

We propose to sponsor and encourage underrepresented students likely to succeed in graduate school to participate in campus programs that feed into the pipeline for graduate studies. Examples of those programs include the Academic Excellence Honors Program (ACE), the California Alliance for Minority Participation Program (CAMP), and the University of California Leadership Excellence through Advanced Degrees Program (UC LEADS). Another local organization which also supports underrepresented students' research and graduate studies interests is SACNAS (Society for the Advancement of Chicanos and Native Americans in Science). These programs help mentor and prepare highly motivated minority students' competitiveness for admission into UC doctoral programs.

With available sponsorship funds we hope to offer continuing opportunities for the CAMP-MESA Summer Science Program that introduces research methodology to college students enrolled in MESA California Community College Programs (CCCP). The MEP and CAMP programs at UCSC have forged a creative collaboration with the neighboring Cabrillo College MESA program to bring students from several statewide MESA CCCP's to the Santa Cruz campus for this annual program. More than 200 students from twenty-four California community colleges have participated in this recruitment program which was designed for underrepresented students who intend to transfer to UCSC or other four-year institutions to pursue baccalaureate or advanced degrees in engineering and computer science.

With the expected growth in undergraduate and graduate students over the next 10 years, the SOE Division will give greater attention to increasing the diversity of its students. That is a goal shared by all in the university community. Some universities pay full travel expenses for outstanding prospective students to visit their graduate programs. We will explore funding sources for attracting talented students to UCSC.

We also expect to place our best foot forward in the promotional information that's distributed or posted on our web site in order to attract and retain quality students. To complement our outreach and recruitment efforts, we plan to develop a SOE brochure as a marketing tool to be mailed to high schools for the recruitment of exceptional students. We also propose to advertise our presence and reputation in national ethnic magazines and newsletters. Examples of such include the following: *Hispanic Engineer; MAES (Minority Americans in Engineering & Science); the SACNAS News (Society for the Advancement of Chicano and Native Americans in Science); the TECHNICA (Hispanics at the Forefront of Engineering and Science) Magazine; the SHPE (Society of Hispanic Professional Engineers) Magazine; and the Hispanic Network Magazine.* Our recruitment efforts will also target those schools with successful programs at the pre-college and college level such as MESA and PUENTE that better prepare students from underrepresented groups and/or university level studies.

Faculty

Faculty recruitment provides challenges and opportunities. The challenge is to attract exceptional faculties who are well established within their fields. However, at the same time, we must make the most of the recruitment opportunity to attract faculty with great potential who will establish themselves and serve as role models at our School of Engineering. To achieve this goal we will use "focused" outreach efforts as a part of the recruitment strategy. These efforts include more publications that include women and minorities and increased web-based announcements. The school is also seeking special funds to attend association conferences, whereby creating more of a presence for the entire Santa Cruz campus. Our recruitment in 2000-01 has successfully brought further gender and ethnic diversity to the School of Engineering. We will continue to use our current faculty for personal outreach efforts as they attend conferences and network with their colleagues. We have more than the national average of female faculty members because at present, 7 of 49 faculty members--or 14%--are women.

Staff

The current staff of the School represents diversity in ethnicity and gender. We have successfully recruited professional and technical staff from the available workforce and from the campus community. Staff recruited to the School has brought a combination of skills which include university institutional knowledge and broad-based business experience. The School intends to continue and strengthen its outreach efforts to ensure that we maintain a diverse workforce composition.

INTERDIVISIONAL COLLABORATION

Over the next 10 years, the School of Engineering plans to expand interdivisional collaborations in the Arts, Humanities, Natural Sciences and Social Sciences. We are committed to building bridges to the academic community and promoting the excellence of all UCSC students. We will engage in active participation of interdivisional collaborations to ensure continued quality of academic study at UCSC.

Applied Mathematics and Statistics
AMS envisions at least the following three opportunities for interdivisional collaborations over the next 10 years:

- The Envirometrics program within the School will have strong support from the Statistics Group and involve significant participation by researchers in other Departments across campus, including Earth Sciences, Environmental Studies, and Ocean Sciences.

- AMS is interested in reviving the Center for Nonlinear Analysis, which will involve significant participation by researchers in Earth Sciences, Mathematics, and Physics.

- The Statistics Group intends to launch a Statistical Consulting Service (SCS) for Engineering and UCSC, anticipation launch of 2002. By its nature all of the contacts in this Service outside Engineering will involve interdivisional collaboration. Short consultations in the SCS would be free; medium-length consultations would involve a transfer of funds from a grant held by the person initiating the consultation. Long-term consultations may be better viewed as research collaborations.

AMS looks forward to a rich and interesting decade of teaching challenges and research collaborations with our colleagues in Engineering and beyond, and we anticipate playing a significant role in the rising success of the Baskin School of Engineering and UCSC.

Biomolecular Engineering and CBSE
Interdivisional as well as extramural collaborations will be an area of great strength for the BME Department, as biomolecular engineering itself is based on interdivisional disciplines. All of the academic programs offered by the BME Department will be interdivisional/interdisciplinary to some extent. For the Bioinformatics programs, the curricula are comprised of approximately half Engineering courses and half Natural Sciences courses. The Biomolecular Engineering graduate program will most likely be a similar blend of courses from the two divisions. Many of the BME faculty will be affiliated with QB3 contributing research that cuts across traditional boundaries. The BME Department (currently through the auspices of the CBSE) is also part of an MRU proposal for a UC-wide Bioengineering Institute of California. The CBSE itself is a proposed ORU that is administratively housed in the School of Engineering and will be closely tied to the BME department, but has members and fosters research across three divisions: Engineering, Natural Sciences, and Social Sciences. BME Department faculty and students will be involved in large interdivisional projects (such as those currently underway), and BME faculty will also

undoubtedly form individual collaborations with faculty from other divisions and other campuses.

Computer Engineering
The bioinformatics programs and the Center for Biomolecular Science and Engineering are the most obvious current interdivisional collaborations. We expect this collaboration to continuing and grow over the next several years. Although this collaboration is primarily with the Natural Sciences division, we have also begun working with members of the philosophy department on the ethics curriculum for the bioinformatics programs with Prof. Dom Massaro of the Psychology Department on human-computer interface related image processing.

Computer Science
Computer Science will continue to encourage collaborations with faculty from other divisions in offering innovative courses such as the development of new general education courses—Introduction to Virtual Reality, Computer Ethics & Social Responsibility. A few faculty members are actively engaged in new media and digital arts programs in the Arts Division.

Electrical Engineering
Collaborations with other divisions are a natural activity of engineering departments. In Electrical Engineering we have established relationships with departments and Organized Research Unit's (ORU) in Natural Sciences, e.g. Physics, Earth and Marine Science, Center for Adaptive Optics and IGPP. We plan to continue such collaborations and are making a special effort to work with the new NSF Center of Excellence in Adaptive Optics. Two of our faculty members and one emeritus faculty in EE are working with this center. Faculty from Astronomy and Astrophysics are collaborating with Prof. Vesecky in teaching his Design Course (EE127/128), which includes conceptual design of an interferometric imaging system for extrasolar planets. This system would operate in solar orbit between Mars and Jupiter.

EE chair, John Vesecky, is actively involved in remote & environmental sensing research that contributes to these programs and could be a good basis for future growth in environmental engineering program elements within the School of Engineering.

In addition to collaborations with other UC campuses, San Jose State University, and other research community, the EE Department plans to continue existing collaborations within the UCSC campus.

Table 17 Accountability Milestones

	2000-01	2005-06	2010-11
Ladder Faculty FTE	59	103	126
Total Undergradute FTE	758	1,414	1,535
Total Graduate FTE	131	462	696
Total FTE	889	1,876	2,231
Undergraduate Majors	952	1,735	1,990
Graduate Majors	137	510	773
Total Majors	1,089	2,245	2,763
Total Awards	$5,000,000	$24,460,000	$36,075,000
Indirect Cost Recovery	$735,106	$4,364,730	$8,088,564

2001-02	Bioinformatics Undergraduate Program Approval Electrical Engineering Graduate Program Approval
2002-03	Bioinformatics Graduate Program Approval iNIST gains official ORU status CBSE gains official ORU status AMS Departmental Status Received
2003-04	AMS Graduate Program Approval BME Departmental Status Received CE Undergraduate Program ABET Reaccredited CS Undergraduate Program ABET Accredited EE Undergraduate Program ABET Accredited ISTM Graduate Program Approval
2004-05	Applied Math Undergraduate Program Approval Statistics Undergraduate Program Approval BME Undergraduate Program Approval Software Engineering Graduate Program Approval Web & Internet Engineering MAS Program Approval
2005-06	Biomolecular Eng Graduate Program Approval Environmental Engineering Graduate Program Approval
2006-07	Bioinformatics ABET Accredited * Biomolecular Eng Undergraduate Program ABET Accredited

* assumes ABET intiates accreditation program in Bioinformatics

Department of Applied Mathematics and Statistics (AMS), Baskin School of Engineering Long-Range Plan, 2001-2011

3 December 2001

1. Introduction

After a number of years of preliminary planning, including the important work that went into the creation of the Seiden Report, the Applied Mathematics and Statistics (AMS) initiative at the University of California, Santa Cruz, began a new phase of effort toward the goal of formal Departmental status in January 2001, under the leadership of founding Chair David Draper. At present AMS consists of the following people (in what follows **AM** and **S** stand for Applied Mathematics and Statistics, respectively).

•Four ladder faculty:

- Associate Professor Neil Balmforth (AM); *Associate Chair and Head of Applied Mathematics Group*; non-Newtonian fluid dynamics and applications in geology, large dynamical systems, pattern formation in systems with continuous spectra, fluid shear flows;

- Professor David Draper (S); *Chair and Head of Statistics Group*; Bayesian statistics, hierarchical modeling, stochastic optimization, Markov chain Monte Carlo (MCMC) methods, statistical model uncertainty, quality assessment in health and education, stochastic modeling in the medical and social sciences;

- Assistant Professor Raquel Prado (S; Bayesian analysis of nonstationary time series, with medical and other applications, bioinformatics; and

- Assistant Professor Hongyun Wang (AM); biophysics and molecular biology, energy transduction in biological systems, force generation mechanism and thermodynamics of molecular motors, fluid mechanics, differential equations, numerical analysis, fast algorithms, parallel computing.

• Three open ladder searches (one in AM at Assistant Professor step II; two in S -- 1 up to Professor step I, 1 at Assistant Professor step II);

• One long-term Visiting Associate Professor of Statistics: Bruno Sansó (S); Bayesian robustness, spatio-temporal stochastic modeling in hydrology and other environmental areas) (it is expected that Sansó will play a long-term role in AMS under one or another of several possible scenarios;

• Two Lecturers: Marshall Sylvan (S), Hong Zhou (AM).

• Four short-term visitors/postdocs this year: Peter Grünwald (S) [joint with CS]; Eurandom, Holland; 4 months); Richard Kerswell (AM) Bristol, UK; 2 weeks); Bruno Mendes (S), Stockholm; 9 months); Roberto Sassi (AM), Milan; 9 months);

• One Ph.D. student, Shufeng Liu (S); and

•Two administrators: Kim Tyler (AMS *Department Manager*), and Dana Kopald (AMS *Assistant Department Manager*).

We have established the first AMS Research Lab in 137 BE, with work areas for four people (each including a 500MHz SunBlade 100 workstation) and two Sun Enterprise 220R CPU servers (each with two 450MHz UltraSPARC-II processors, 4MB E-cache, 2GB memory, and two 36GB SCSI disks).

In summary of the current faculty situation, with successful searches this year AMS will have eight long-term faculty (seven ladder) in autumn 2002.

2. Mission

The mission of the Department of Applied Mathematics and Statistics is

• to promote the sound use of theories, methods, and applications in applied mathematics and statistics on the campus of the University of California, Santa Cruz, and

• to provide service to the campus, the surrounding community, the state of California, and the professions of applied mathematics and statistics, through excellence in research and teaching.

We will attain these goals over the period from 2001 to 2011 (a) by recruiting two groups of outstanding researchers in AMS, one each in applied mathematics and statistics, who will achieve national and international prominence in their fields of research specialization, and (b) by developing high-quality teaching programs which will offer students the opportunity to pursue B.S., M.S., and Ph.D. degrees in applied mathematics and statistics.

3. AMS required faculty size

We have made a study of how the top Departments in the world in AM and S have achieved their research and teaching excellence. The main conclusions from this study are as follows.

•Top departments achieve their top status in research in their first 10 years by identifying 3-4 areas upon which to concentrate and hiring 3-4 top people in each area. This argues for a critical mass on the research side of 9-16 people in each subject.

• High-quality B.S. and B.A. degrees typically require any given department to offer 20-25 different undergraduate courses per year in the subject area of each degree, and high-quality Ph.D. degrees typically require such a department to offer an additional 12-15 graduate courses per year in the subject area of each degree (at both the undergraduate and graduate levels students will then fill up the rest of their degree programs with courses from other departments). High-quality teaching departments employ ladder faculty to satisfy most of this demand (a sure way to receive criticism and low teaching ratings by external review committees is to rely too much on temporary teaching staff). At the Baskin School of Engineering target rate of three courses taught per year by each ladder faculty member, this argues for a critical mass on the teaching side of 11-14 people in each subject. (See Sections 6 and 7 below for more details on teaching plans.)

It should therefore come as no surprise to find, as we did, that the top departments had 10-15 faculty in each subject area within 10 years of their creation. By making creative use of existing faculty from allied subjects in other Departments on campus we will be able to lower the top-end requirement in this range a bit, but we are led to the inescapable conclusion that **to meet the goals set out in our mission statement AMS will need to reach the following size by 2010-11: 10-12 ladder faculty in applied mathematics, and 10-12 ladder faculty in statistics.**

These numbers are consistent with the low- and middle-range figures for AMS (22 and 24, respectively) in the draft plan submitted to Campus Provost and Executive Vice Chancellor Simpson in March 2001; the overall middle-range figure for Engineering in that document was 140 faculty by 2010.

If Engineering is capped at 125, Dean Kang has informed us that (a) AMS will be allowed to grow to 17 FTE by 2010 and (b) statistics is somewhat more mission-critical for Engineering than applied mathematics (the latter topic may well receive some growth in the Natural Sciences Department of Mathematics over the next 10 years, which will not be true of statistics). We have been guided by consultation with Dean Kang and others to a plan involving 10 **Engineering FTE devoted to statistics and 7 Engineering FTE dedicated to applied mathematics**. In all hiring plans we strive for a balance between junior and senior faculty which will ensure research leadership while also promoting the hiring of new Ph.D.s.

Under the 17-FTE plan AMS intends over the next 10 years to increase the number of faculty on campus who are strongly involved in applied mathematics by approaching a number of Departments outside Engineering (including Astronomy and Astrophysics, Biology, Earth Sciences, Ocean Sciences, and Physics) to propose searches for one senior faculty member from each Department whose FTE would be jointly funded by Engineering and the non-Engineering Department and whose research interests would be truly collaborative between AM and the non-Engineering Department. If we are successful at four such hires, for example, this would increase the number of faculty in AM from 7 to 9. We also intend to attempt the same strategy with statistics (the list of non-Engineering Departments which we will approach for joint hiring in statistics will include Biology, Earth Sciences, Economics, Environmental Studies, and Sociology). If present and possible future applied mathematicians in the Department of Mathematics are counted as part of a kind of virtual Applied Mathematics group on campus, the goal of 10-12 applied mathematicians and 10-12 statisticians active in collaborative interdisciplinary research at UCSC by 2010-11 is achievable.

From September through November 2001 an alternative plan for developing the Applied Mathematics Group at UCSC was considered: the Chair of the Mathematics Department in Natural Sciences proposed that AM should grow in Mathematics, not in AMS. After considerable discussion at the faculty and Dean levels this plan--at least in the short run--was eventually rejected both by Engineering and by Mathematics, with an agreement (a) to revisit the issue again in the future (perhaps in 2005) and (b) to cooperate closely on curriculum development and other matters of mutual interest.

4. Target areas of research excellence

AMS strives to achieve research excellence in two general areas:

- *Dynamic mathematical modeling* of complex natural phenomena, and

- *Bayesian statistical methods* of inference, prediction, and decision-making,

in both cases with applications in engineering and the sciences. Our focus is on *modeling of the world around us (*we are methodologists who like to develop new methods in the process of solving real-world problems), and our approach is *computationally intensive* (through the numerical solution of systems of partial differential equations in AM and the use of Markov chain Monte Carlo (MCMC) methods and other techniques for approximating high-dimensional integrals in S).

We are committed to full interdisciplinary collaborations in which we serve as co-PIs on grants with investigators from other fields, so that our publications are a mix of methodology articles in leading AM and S journals and substantive articles in leading journals in the fields in which we collaborate.

5. Academic program goals and strategies

5.1 Specific areas of research focus

After reflection and consultation with colleagues in other Departments around campus we have arrived at the following plans for subgroup areas of research concentration.

- **Applied mathematics**:

  - **Mathematical physics and geosciences**: The expertise in this subgroup will be in theoretical fluid mechanics and the application of applied mathematics techniques in geophysics problems. As the National Science Foundation has recently recognized (and will substantially fund in the coming years), research in this area is poised for significant advances, and it is an opportune moment for development. Initially this subgroup will establish strong links with the Institute of Geophysics and Planetary Physics (of which Balmforth is already a member), and several departments in Natural Sciences (including Astronomy, Earth Sciences, and Ocean Sciences). If, as is currently under discussion, the campus creates a center for the environmental sciences, this subgroup will play a significant role in developing some of the theoretical aspects of the research. Members: Balmforth and 2-3 new hires.

- **Mathematical biology**: This subgroup will provide a theoretical counterpart of the existing and developing Engineering groups in bioinformatics, computational biology, and envirometrics. Key mathematical developments in biomolecular engineering are both deterministic (involving PDEs) and stochastic, leading to collaborations both with researchers in the Center for Biomolecular Science and Engineering and in the Statistics Group. Members: Wang and 2-3 new hires.

- **Solution of partial differential equations**. This subgroup will be the methodological backbone of Applied Mathematics on campus, and its goal will be the development of practical methods for solving the classes of partial differential equations (PDEs) which arise frequently in Engineering and the natural sciences. The aim is to create a subgroup of researchers with expertise in deriving the solutions of PDEs (using numerical, analytical, or perturbation techniques, for example); this contrasts with, but complements, researchers in the Mathematics Department who deal with the purer side of PDEs (focusing, for example, on questions of existence of solutions rather than how to find them). The methodologists in this subgroup will work closely, not only with the other two Applied Mathematic subgroups and researchers in Engineering disciplines such as electronics and photonics and signal and image processing where PDEs are crucial, but also with statisticians on problems of common interest (as occur, for example in stochastic analysis) and researchers from other Departments. Members: 3-4 new hires.

• Statistics:

- **Bayesian nonparametric methods**: The wave of the future in Bayesian methods is nonparametrics, which involves placing probability distributions on functions (the statistics of the 21st century) rather than on scalars or vectors (the statistics of the 18th through 20th centuries). This has significant applications in many Engineering disciplines, including bioinformatics, machine learning, nanotechnology, and uncertainty visualization, and is also relevant to the research in a number of departments outside Engineering, including Astronomy, Earth Sciences, and Ocean Sciences. Members: Draper and 2-3 new hires.

- **Computationally intensive Bayesian inference, prediction, and decision-making**: Modern methods of Bayesian statistics employ Markov chain Monte Carlo techniques to draw inferences and make predictions and decisions. These methods are highly computationally intensive, and are crucial to the continued success of the Bayesian approach in applied problem-solving in a number of Engineering disciplines including computational biology, modeling of remote sensing data, and signal and image processing, and non-Engineering departments including Biochemistry, Molecular Biology, Physics, and Sociology. Members: Prado and 2-3 new hires.

- **Envirometrics**: Bayesian statistics will play a leading role in this important interdisciplinary effort. Examples include spatio-temporal modeling of pollution data, decision analysis for environmental policy based on maximization of expected utility, and stochastic optimization as a tool for finding new solutions that increase energy efficiency in applications as diverse as power plant design and home heating and cooling. Members: 3-4 new hires.

5.2 Program planning

• We intend to submit application materials for Departmental status by the end of March 2002, and we hope to achieve this status by late in 2002 or early in 2003.

• Similarly, we intend to submit application materials for status as a Graduate program able to admit Ph.D. students by the end of June 2002, and we hope to achieve this status by the late winter of 2003. We will advertise broadly for M.S.and Ph.D.students in fall 2002, noting in the advertisements that our program is expected to be formally approved in time for students to arrive in fall 2003. Prior to that date an arrangement has been made with the Department of Computer Science for Ph.D.students in Statistics (S) to be admitted through the existing Ph.D. program in Computer Science, with the intention that they be transferred to the AMS Ph.D. once it is established, and a similar arrangement has been made with the Department of Physics for Ph.D.students in Applied Mathematics (AM).

Table 1: ***Years 1 and 2 of the AMS Ph.D. degree (draft; S option)***

Year	Fall	Winter	Spring
1	PSP I	PSP II	PSP III
	S I (freq)	S II (Bayes 1)	S III (Bayes 2)
	CS 200	AMS 297	AMS 297
2	Bayes 3	NumAnal	Appl Stat
	Econ 216	CS 243	CS 244
	MCMC	Econ 211A	Econ 211B

Notes: PSP = Probability and Stochastic Processes, S = Statistics,
Econ 211AB, 216 = econometrics, CS 243, 244 = bioinformatics, computational genomics.

Table 2: ***Years 1 and 2 of the AMS Ph.D. degree (draft; AM option)***

Year	Fall	Winter	Spring
1	PSP I	PSP II	PSP III
	AM I	AM II	AM III
	(PDEs)	(complex)	(transforms)
	CS 200	AMS 297	AMS 297
2	NumAnal	DynSys 1	DynSys 2
	Math 203	Math 204	Math 235
	Math 200	Math 249A	Math 249B

Notes: Math 200 = algebra (group theory), Math 203-4 = analysis,
Math 235 = dynamical systems theory, Math 249AB = mechanics.

6. Graduate programs

In the spring of 2003 we expect to begin formally accepting M.S.and Ph.D.students into graduate study in AMS, to begin in fall 2003.

6.1 The Ph.D. in Applied Mathematics and Statistics

Our initial offering at the Ph.D. level will be a joint Ph.D. in Applied Mathematics and Statistics with AM and S options. This will involve two years of coursework, followed by a qualifying exam. After admission to candidacy for the Ph.D., students will typically complete the research summarized in their dissertations within two additional years; during this second two-year period students will continue to take a variety of special-topics graduate courses at their discretion. Tables 1 and 2 present drafts of the first two years of courses under the S and AM options.

In the Planning Profile spreadsheet that accompanies this document we anticipate growth in the Ph.D. program from 1 student in 2001-02 to a target of 51 students in 2010-11; this is consistent with the observation that top research Departments in AM and S typically have 3-5 Ph.D. students per ladder faculty member.

6.2. The M.S. in Applied Mathematics and Statistics

Starting in fall 2003 we intend to offer a one-year M.S. in Applied Mathematics and Statistics, with AM and S options, which will involve nine courses and either a thesis or a project. In the Planning Profile spreadsheet that accompanies this document we have targeted M.S. students (after a ramping-up period) at the rate of 0.75 M.S. students per Ph.D. student, which appears typical given the data we have gathered on other M.S. programs. The total number of AM and S M.S. students is projected to reach 38 by 2010-11.

7. Undergraduate programs

7.1. The B.S. in Applied Mathematics and Statistics

In fall 2003 we intend to begin admitting undergraduates to study for a B.S. degree in Applied Mathematics and Statistics with AM and S options. UCSC undergraduates are required to fulfill 14 General Education requirements, which typically take 10-14 courses to complete; in a 4-year B.S. program in which 3 courses are taken per quarter, that leaves 22-26 courses for any given B.S. major. Tables 3 and 5 present draft versions of the core courses in the AM and S options, respectively, and Table 4 gives the elective courses for both options. In the Planning Profile spreadsheet that accompanies this document we have set targets for 40 AM and 40 S majors by 2010-11.

Table 3: ***18 core courses in years 1-4 of the AMS B.S. degree (draft; AM option)***

Year	Fall	Winter	Spring
1	AMS 15A	AMS 15B CMPS 12A	AMS 15C
2	MATH 21	MATH 23B CMPE 16	MATH 24
3	CMPE 107 AMS 105	MATH 103 AMS 106	MATH 106B
4	MATH 141	AMS 146 OR MATH145	AMS 147
	AMS 150		ST/IS

Notes: AMS 15ABC = calculus for engineering, CMPS 12A = programming, MATH 21 = linear algebra, MATH 23B = multivariable calculus, MATH 24 = ordinary differential equations,
CMPE 16 = discrete mathematics, CMPE 107 = stochastic systems analysis, MATH 103 = complex analysis, MATH 106B = partial differential equations, AMS 105 = fluid mechanics,
AMS 106 = geophysical fluid dynamics, MATH 141 = nonlinear mathematics, AMS 146 = chaotic dynamical systems, MATH 145 = chaos theory, AMS 147 = computational methods,
AMS 150 = mathematical biology, ST/IS = senior thesis/independent study.

Table 4. ***Elective courses in the AMS B.S. degree (draft; in the AM option, students choose 4-8; in the S option, students choose 2-6)***

Lower division

ASTR 12, 13
CMPS 12B, 12C
EART 10
EE 70
AMS 5
MATH 30
PHYS 5A, 5B, 5C, 5D

Upper division

ASTR 112, 113
CHEM 163A, 163B
CMPE 177
CMPS 101, 106, 130, 132
EART 140, 142, 162, 166, 172
EE 103, 135, 136
MATH 100, 105A, 105C, 106A, 107, 113, 115, 117, 143, 148
PHYS 105, 107, 112, 114A, 114B, 115, 139A, 139B, 155, 171

Table 5: 20 *core courses in years 1-4 of the AMS B.S. degree (S) option)*

Year	Fall	Winter	Spring
1	AMS 15A	AMS 15B	AMS 15C
		CMPS 12A	
2	MATH 21	MATH 23B	MATH 24
	AMS 5	CMPE 16	
3	CMPE 107	MATH 103	MATH 106B
		AMS 156	AMS 158
4	AMS 171	AMS 172	AMS 173
	AMS 181	AMS 182	ST/IS

Notes: AMS 15ABC = calculus for engineering, CMPS 12A = programming, MATH 21 = linear algebra, MATH 23B = multivariable calculus, MATH 24 = ordinary differential equations,
AMS 5 = statistics, CMPE 16 = discrete mathematics, CMPE 107 = stochastic systems analysis, MATH 103 = complex analysis, MATH 106B = partial differential equations, AMS 156 = linear statistical models, AMS 158 = probability II, AMS 171 = experimental design, AMS 172 = time series analysis, AMS 173 = categorical data analysis, AMS 181 = applied statistics, AMS 182 = sampling, ST/IS = senior thesis/independent study.

7.2 Other undergraduate teaching

AMS expects to do a large amount of service teaching for the rest of the Engineering School and other departments on campus, mainly at the lower-division undergraduate level. The principal service courses we expect to offer are as follows:

• Applied Mathematics:

- *AMS 3*: This is a one-quarter course on Precalculus **for engineering**, to be taken by those Engineering students who need extra mathematical preparation before beginning the calculus sequence (beginning in 2001). Estimated annual student enrollment by 2010-11: 22 FTE.

- *AMS 15ABC*: This will be a three-quarter sequence on **Calculus for engineering**, to be taken as a requirement for all Engineering students (beginning in 2003). Estimated annual student enrollment by 2010-11: 87 FTE.

- *AMS 27:* This is a one-quarter course on **Mathematical methods for engineering,** to be taken as a requirement for all Engineering students (beginning in 2001). Estimated annual student enrollment by 2010-11: 29 FTE.

• Statistics:

- *AMS 5*: This is a one-quarter course on **Statistics** (offered twice a year), which is taken as a required course by students from a variety of (principally) non-social-sciences departments around campus (beginning in 2001). Estimated annual student enrollment by 2010-11: 35 FTE.

- *AMS 7*: This is a one-quarter course on **Biostatistics**, taken as a required course mainly by biology students (beginning in 2001). Estimated annual student enrollment by 2010-11: 18 FTE.

- *AMS 18*: This will be a one-quarter course on **Statistics for the social sciences**, which will be team-taught with faculty from social sciences departments; it will be a required course for one or more social-science majors (beginning in 2003). Estimated annual student enrollment by 2010-11: 30 FTE.

- *AMS 110:* This will be a one-quarter upper-division course on **Managerial statistics,** to be taken (as a required course) by students in the Information Systems Management (ISM) program in Engineering (beginning in 2002). Estimated annual student enrollment by 2010-11: 12 FTE.

- *CE 16:* This is a one-quarter course on **Applied discrete mathematics** (offered three times a year), which is required for all Engineering students. We expect to share the teaching of this course with Computer Engineering (beginning in 2002). Estimated annual AMS student enrollment by 2010-11: 21 FTE.

- *CE 107:* This is a one-quarter course on **Stochastic systems analysis** (offered three times a year), which is required for all Engineering students. We expect to share the teaching of this course with Computer Engineering (beginning in 2002). Estimated annual AMS student enrollment by 2010-11: 21 FTE.

These and other AM and S courses lead to a combined AMS target enrollment, as given in the Planning Profile spreadsheet that accompanies this document, of at least **250** student FTE by 2010-11.

8. 3-2 programs

AMS has no plans at present to develop 3-2 programs, but we are open to the possibility as circumstance change and new information becomes available.

9. Summer programs

AMS is not yet fully clear on how we can best help with summer teaching. We are opposed to any plan for year-round operations, which threatens research productivity and/or the quality of faculty we can hire. At present we plan to use Lecturers (with input from ladder faculty on course content) to teach sections of large classes such as AMS 15ABC and AMS 5 or 7 in the summer; this would increase student numbers for Engineering without compromising research excellence.

We remain concerned, however, that many unanswered questions about year-round operations persist, e.g.:

- If there is pressure on Departments for ladder faculty to teach summer courses, but faculty are told that they have a choice as to which three out of four quarters they teach in an given calendar year, what will the mechanism be to force faculty to teach in the summer if no one chooses to do so voluntarily, and would such a mechanism not violate an important traditional form of academic freedom?

- If new courses, or new repetitions of existing courses, are to be given in the summer, how will this extra teaching burden be paid for?

10. Silicon Valley Center programs

Our thinking on how we can help with the Silicon Valley Center (SVC) initiative is also not yet clear. We are open to doing some teaching of both AM and S in the SVC as long as this does not adversely affect our research, teaching, and recruiting on the main UCSC campus (this suggests an emphasis on distance learning), and we look forward to the possibility of using the SVC as a spring-board for collaborative consulting projects with industry in both AM and S.

11. SoE's Participation in Cal ISIs, QB3, and CITRIS

AMS looks forward to significant research collaborations with individual investigators in these programs on a case-by-case basis.

12. Pacific Rim Roundtable for Technology and Society

AMS has no special plans for this initiative but intends to play a full part in the overall Engineering School effort in the Pacific Rim Roundtable for Technology and Society.

13. Internships and COOP programs

AMS has no plans at present to create internships and COOP programs, but we are open to the possibility as circumstances change and new information becomes available.

14. Research program goals and strategies; extramural research funding from industry and government laboratories

Since AMS is only a few months old we do not yet have strong external relationships, but we are committed to developing lasting ties with industry and the national laboratories in both AM and S which will lead to collaborative grants and other sources of opportunity funds.

The goal of AMS is for ladder faculty members to generate an average of $150k per year in research funds by 2004-05 and to maintain that level through 2010-11.

We also envision significant hiring of people on the Research track who will fund themselves as co-PIs on interdisciplinary grants with investigators from other Departments in Engineering and elsewhere on campus.

15. Private funds development

As with other Departments and Divisions on campus, AMS intends to attempt to generate opportunity funds through private donations from individuals who especially wish to support research and teaching in applied mathematics and statistics.

16. Instructional and research space

The planning document for the Engineering II (E2) building budgets 1 data-intensive research laboratory per faculty member on average across the whole School of Engineering, at 495 asf per lab.

This appears adequate for each AMS faculty member to house her/his research group (e.g., 1 postdoc at 100 asf, 3 Ph.D. students at 75 asf each, 1 visitor at 100 asf, and 70 asf for everything else), although no account is taken in this figure of the space needs of M.S. students (e.g., 50 asf per student). (See table next page.)

Table 6: ***AMS projected space needs , 2001-11***

		Faculty (asf)		M.S. Students		Admin	Total
Year	#	Office	Lab	#	asf	asf	asf
00-01	4	600	1980				2580
01-02	6	900	2970			65	3935
02-03	7	1050	3465			100	4615
03-04	9	1350	4455	8	400	230	6435
04-05	12	1800	5940	17	850	300	8890
05-06	13	1950	6435	26	1300	1535	11220
06-07	15	2250	7425	34	1700	1600	12975
07-08	16	2400	7920	36	1800	1600	13720
08-09	17	2550	8415	37	1850	1600	14415
09-10	17	2550	8415	38	1900	1600	14465
10-11	17	2550	8415	38	1900	1600	**14465**

Note: In 2005-6, when E2 comes online, the E2 planning document estimates are used here for administrative space, including the AMS Department office.

Table 6 presents estimates of AMS space needs through 2010-11. **NB**: These projections are far in excess of any previous figures on required AMS space, because earlier planning figures were based on an AMS Department size that was far too small to meet SoE and campus needs. The E2 planning document quotes 8,155 asf for AMS, which is too small even in 2005 when the building will come online and makes no allowance for growth from 2005 through 2011.

17. Residential college relationships

AMS has no special plans in this area but intends to be a full partner in the Engineering effort to develop ties with Crown College.

18. Promotion of diversity

AMS is committed to creating a diverse faculty and student environment. Our faculty recruiting effort each year involves running advertisements in a total of eight journals specifically targeted for outreach to women and minority applied mathematicians and statisticians. Postdoctoral and graduate student recruiting efforts, when undertaken, will feature a similar emphasis on diversity.

19. Interdivisional collaborations

AMS envisions at least the following three opportunities for interdivisional collaborations over the next 10 years:

- The envirometrics program within Engineering, which will have strong support from within the Statistics Group, will also involve significant participation by researchers in other Departments across campus, including Earth Sciences, Environmental Studies, and Ocean Sciences.

- We are interested in reviving the **Center for Nonlinear Analysis**, which will involve significant participation by researchers in Earth Sciences, Mathematics, and Physics.

- The Statistics Group intends to launch a **Statistical Consulting Service (**SCS) for Engineering and the rest of campus, perhaps as soon as 2002. By its very nature all of the contacts in this Service outside Engineering will involve interdivisional collaboration. Short consultations in the SCS would be free; medium-length consultations would involve a transfer of funds from a grant held by the person initiating the consultation. (Long-term consultations are better viewed as research collaborations; see Section 14 above.)

20. Summary

AMS looks forward to a rich and interesting decade of teaching challenges and research collaborations with our colleagues in Engineering and beyond, and we anticipate playing a significant role in the rising success of the Baskin School of Engineering and UCSC.

Biomolecular Engineering Department Long Range Plan

UCSC Jack Baskin School of Engineering

December 10, 2001

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Appendix: Table 1: Bioengineering/CBSE Faculty Recruitment Plan

Introduction

This document is being prepared for the purposes of long term planning for the Baskin School of Engineering, to provide an outlook through 2011. It will be superceded by future, more detailed planning as the involved faculty and the dean further develop their vision for the Biomolecular Engineering (BME) Department. It is expected that a formal proposal to form the new department will be submitted in 2002, for approval in late 2003.

1. Academic Program Goals and Strategies

1.1 Graduate Programs

The Biomolecular Engineering (BME) Department will offer MS and PhD degree programs in Bioinformatics and Biomolecular Engineering. A proposal to establish the Bioinformatics Graduate programs has been completed and is being submitted for campus consideration in Fall quarter, 2001. We expect final approval between 2002 and 2003, and for the program to begin no later than Fall 2003. At that time, students who are specializing in bioinformatics while enrolled in other programs, primarily Computer Science, may choose to transfer into the new program. A Bioinformatics BS/MS honors program is also planned, modeled after the Computer Engineering program. Students admitted to this program will be able to use up to two graduate courses taken for the BS degree in satisfying the course requirements of the MS degree. The Biomolecular Engineering Graduate program will be the last of the graduate programs to be developed, potentially as soon as 2004.

1.2 Undergraduate Programs

A new BS degree program in Bioinformatics has commenced as of Fall 2001, currently offered through the Computer Engineering Department. The program will see its first graduate in Winter, 2002. This program will be administered by the BME Department upon its inception. There currently is also consideration of a second BS degree program, in Biomolecular Engineering. The future of such a program will depend on the measured need for such a program in several years, and on the group of faculty that have joined the department.

1.3 3-2 Programs

There is currently no plan for the Biomolecular Engineering academic programs to participate in a 3-2 paradigm, but it will be considered once our standard programs are established.

1.4 Summer Programs

Summer programs for the Biomolecular Engineering Department will initially be research-oriented, such as undergraduate senior thesis projects (BME 195), and graduate independent research (BME 297), dissertation research (BME 299), and industry internships (BME 297 or 299). Internships are also being considered for the undergraduate Bioinformatics program. Within a few years, the BME faculty plan to add a service course: "Bioinformatics for biologists and chemists" that will require less programming proficiency than the current introductory bioinformatics course (BME100). Depending on demand, this course may also be offered in the summer.

1.5 Silicon Valley Center

As a growing department, Biomolecular Engineering's primary academic efforts will be aimed at developing the curricula of required and elective courses for our new undergraduate and graduate programs. Some of these courses will be of great interest and value to students located in Silicon Valley, such as part-time students who work in the computer or biotech industry, and students working towards a transition from a community college, a prior career, or a different academic background. We see our participation in the Silicon Valley Center (SVC) to initially take the form of distance learning classes, once the required infrastructure has been put in place in which courses taught live on the Santa Cruz campus are broadcast at SVC. We will also take advantage of opportunities in which adjunct faculty and lecturers choose to offer relevant courses from SVC, particularly for courses that would not otherwise be offered on campus.

1.6 Internships and Co-op Programs

An optional industry internship program is planned for the MS and PhD programs in Bioinformatics, and under consideration for the BS program. Biotechnology industry leaders were provided a draft of the graduate program proposal, and asked to comment on their interest in an associated internship program. The majority expressed a strong interest in participating in such a program. This program will contribute substantially to the recruitment of high quality students, provide a practical dimension to their academic experience, enhance their preparation for professional careers, and assist them significantly in securing a first position following graduation.

Students will be allowed to perform a summer or academic quarter industry internship. Internships may earn credit through the 297 Independent Study course, or 299 Thesis Research. With faculty approval, research performed during an industry internship may count towards the thesis requirement for the M.S. degree in place of research conducted on campus.

1.7 Promotion of Diversity

The Biomolecular Engineering Department will value the excellence achieved through diversity in the academic environment, and will strive to create such an environment through targeted outreach to women and minorities during faculty and student recruitment campaigns.

1.8 Interdivisional and Intercampus Collaborations

This will be an area of great strength for the BME Department, as biomolecular engineering itself is based on interdivisional disciplines. Existing collaborations occur at several levels: the academic program level (both graduate and undergraduate programs), the Multi-Campus Research Unit (MRU) and Organized Research Unit (ORU) levels, the program project level, and the individual investigator level. Detail on each level of involvement is provided below.

All of the academic programs offered by the BME Department will be interdivisional to some extent. For the Bioinformatics programs, the curricula are comprised of approximately half Engineering courses and half Natural Sciences courses. The Biomolecular Engineering graduate program will most likely be a similar blend of courses (roughly 50:50) from the two divisions.

The BME Department (currently through the auspices of the CBSE) is part of a MRU proposal for a UC-wide Bioengineering Institute of California. This initiative is being lead by Dr. Shu Chien of UCSD and involves all 10 UC campuses. The proposal is currently undergoing review on the UCSD campus.

The Center for Biomolecular Science and Engineering (CBSE) is a proposed ORU that is administratively housed in the School of Engineering, but has members and fosters research across three divisions: Engineering, Natural Sciences and Social Sciences. The current breakdown of members is 31 from Natural Sciences, 10 from Engineering, and 2 from Social Sciences. The Center is currently a Focused Research Activity (FRA) and is directed by Computer Science Professor David Haussler. The mission of the CBSE is to foster interdivisional interactions through joint research projects, coordinated faculty hiring, and helping to develop joint academic programs and courses aimed at a better understanding of biology and human health. These efforts are unified by the common theme across the divisions of approaching problems in biology and medicine through the study of human and model organism genomes. The DNA blueprints encoding life are amenable to intense study by both computational and experimental approaches, and will be best understood when these complementary approaches are coordinated to tackle specific problems. Such coordination is a primary goal of the CBSE.

BME Department faculty and students will be involved in several large program projects similar to two that are currently underway. The “Bioinformatics and Microarray Expression Analysis of Nervous System Function” project, funded by the Packard Foundation, involves 5 faculty from Natural Sciences, 4 from Engineering, and students, post docs and staff from both divisions. The “UCSC Center for Genomic Sciences” was established by funding from the National Human Genome Research Institute and involves 2 investigators from Engineering and 2 from Natural Sciences, 5 engineering staff positions, and 9 students from both divisions. Because a substantial amount of research funding dollars are committed to large projects that are coordinated between disciplines, the BME department faculty will be encouraged to participate in such projects, and this will be an important consideration during faculty recruitment.

Individual BME Department faculty will also undoubtedly form collaborations with faculty from other divisions and other campuses, as relationships such as this exist already. David

Haussler, for instance, collaborates on a project with Chemistry faculty member David Deamer, and with MCD Biology faculty Manny Ares and Alan Zahler on other projects that have resulted in joint publications. CE faculty Kevin Karplus and Richard Hughey have also worked collaboratively on individual projects with members of the Chemistry faculty. Karplus has also collaborated on projects with faculty from UCSF, resulting in two joint publications. Our most recent hire, Todd Lowe, is housed in Sinsheimer laboratories in part because of the high level of collaboration he plans to establish with MCD Biology faculty. From his graduate and postdoctoral work, Todd has close ties to faculty at several other institutions and is continuing these collaborations.

1.9 Residential College Relationships

There are currently no plans for the BME Department to affiliate with one of the residential colleges, although this may be appropriate once the department is well established.

1.10 Student Admissions

The interdisciplinary nature of the academic programs offered by the future BME Department makes these programs challenging and most accessible to students who have shown the potential to excel in earlier relevant coursework. Screening of graduate students for admittance into the Bioinformatics Programs will include consideration of prior coursework in computer science, mathematics, biology and chemistry, and will also put great weight on relevant work experience. However, because many students with outstanding potential to excel may not have fulfilled all of the background requirements, our academic programs will have the flexibility to allow some “catching up” early on. We will also look closely at the general GRE scores, with particular attention to the quantitative and analytical tests. GRE subject tests will not be required, but we will strongly recommend that they be taken.

A targeted recruiting strategy will be an important mechanism for getting high quality applicants. As academic programs are approved, we will create and distribute informational posters and brochures to a database of appropriate academic and corporate institutions. Such a database and a preliminary promotional brochure are currently being developed.

1.11 Faculty and Staff Resources

Faculty Resources

The Biomolecular Engineering Department will consist of a total of 14 ladder rank faculty by 2010, including 13 regular faculty members and Howard Hughes Medical Institute (HHMI) investigator Prof. Haussler, as well as several affiliated members from other departments (in particular, Computer Engineering, Molecular, Cell and Developmental Biology and Chemistry and Biochemistry) and lecturers. In addition to Prof. Haussler (CS), two other faculty members plan to transfer to the new department upon its inception: Kevin Karplus and Todd Lowe (both of CE). Prof. Lowe was hired in 2001 with the intention that he would move to the new department, and therefore is not currently counted as a regular member of the CE Department. When Prof. Karplus transfers to the new department, a replacement

FTE will be required for the CE department. The table below outlines the areas of expertise that will define the BME Department faculty, the number of faculty in each area, and the approximate hiring order for these 11 positions. The order of hiring is less critical than getting the best faculty possible, thus we will seek to conduct broad searches each year in a manner similar to the 2001-02 SOE recruitment strategy. While there is only a single hire planned in the area of biomolecular image analysis, SOE already has a strong complement of faculty in visualization/graphics who our faculty member can interact with. In addition, the areas listed are highly related to each other—for instance, statistics/bioinformatics, proteomics/protein engineering, and systems biology/molecular modeling, are all sub-areas of bioinformatics, and lab automation, microarrays, and biomolecular image analysis are all sub-areas of biomolecular technology development. (See attached Table 1: Biomolecular Engineering/CBSE Faculty Recruitment Plan for more details on projected resource needs. Note that in certain tables, the word "bioinformatics" may replace "computational biology"—these words are interchangeable.

AREA	**2001 -02**	**2002 -3**	**2003 -04**	**2004 -05**	**2005 -06**	**2006 -07**	**2007 -08**	**2008 -09**	**2009 -10**
Laboratory automation	0	1	1	2	2	3	3	3	3
Statistics; bioinformatics	1*	2	3	3	3	3	3	3	3
Proteomics; protein eng.	1**	1	1	1	1	1	2	2	2
Systems biology; molecular modeling	0	1	1	2	2	2	2	3	3
Microarrays; bioelectronic chips	1***	1	2	2	2	2	2	2	2
Biomolecular image analysis	0	0	0	0	1	1	1	1	1
TOTAL FACULTY	**3**	**6**	**8**	**10**	**11**	**12**	**13**	**14**	**14**

* Prof. Haussler.
** Prof. Karplus.
*** Prof. Lowe.

Workload Projections

Based on the campus target ratio of 18.7 student FTE per one justified faculty FTE, the 14 ladder rank BME faculty members will need to teach 262 student FTE. In actuality, faculty will be expected to have teaching loads similar to those of faculty in other SOE departments: after a lighter load of two courses in the first year, faculty will be expected to teach one graduate course of choice, one lower division undergraduate course, and one upper division undergraduate course per year. There will be individual exceptions to these guidelines depending on each faculty member's strengths, but effort will be made to assure that overall, similar numbers of students are taught by each faculty member. Since Biomolecular Engineering is unlikely to have 14 sections of lower-division courses, the faculty workload will probably be met in part by teaching lower-division courses listed by other departments, such as biology, chemistry, computer engineering, or computer science.

We project that our student FTE:faculty workload ratio should fall in the 16:1 to 18:1 range within 5 years of the department's inception. The following table demonstrates the workload projection of the 14 regular BME faculty based on the standard workload of three courses per year as described above. It assumes that the average enrollment of graduate level courses, and lower- and upper-division undergraduate courses is 25,125 and 40, respectively.

Course/Student Level	**Workload FTE Calculation**	**x # faculty**	**FTE**
Graduate courses (1st stage, pre-candidacy)	$\frac{\text{enrollments x credits}}{36} = \frac{25 \text{ x } 5}{36} = 3.5$	14	49
Upper Division	$\frac{\text{enrollments x credits}}{45} = \frac{40 \text{ x } 5}{45} = 4.4$	14	61.6
Lower Division	$\frac{\text{enrollments x credits}}{45} = \frac{125 \text{ x } 5}{45} = 13.9$	14	194.6
Graduate Students (2nd stage, advanced to candidacy)	27 (excludes students exceeding 9 quarters after advancement)		27
TOTAL PROJECTED WORKLOAD FTE			**332.2**

It is hoped that temporary academic staffing (visiting researchers, lecturers and/or adjunct faculty) will be available to cover some of the teaching load, allowing teaching relief for regular faculty to pursue course development, sabbaticals, and other relevant activities.

Staff Resources

The following table outlines the projected staffing needs for the Biomolecular Engineering Department, and is based on the experience of current SOE departments and their projected needs.

Because faculty are already being recruited for the new department (one was hired last year, and searches for three additional faculty are in progress this year), and because academic programs and courses are already being developed that will reside in the new department, a full time department manager is needed within the next academic year to coordinate the efforts of existing staff and to help in the creation of the new department. The other positions will be needed according to the schedule below. Except for the manager and technical staff, all of the positions are either half time or one-third time. These fractions are based on scaling down from the projected needs of the larger departments in SOE, such as the EE Department, which plans to have 21 faculty FTE by 2010. For technical support, we propose having two full-time positions funded 50% internally, and 50% from extramural sources. For the BME department staff, these positions will provide computer support not available from the SOE technical staff, such as training on new software, the development of databases, and the development and maintenance of administrative web sites. The BME faculty will utilize these positions for instructional lab support. These positions are not included in the total count since it is likely they will be counted as SoE technical staff rather than departmental staff.

Position	Year of Hire	FTE
Department Manager	02/03	1.0
Faculty Recruitment/ Faculty Services	03/04	0.3
Purchasing/Travel Assistant	03/04	0.5
HR Coordinator	04/05	0.3
Internship/Grad Placement Coordinator	04/05	0.3
Contracts and Grants Specialist	04/05	0.5
Budget Coordinator	05/06	0.3
Communications and Outreach Assistant	05/06	0.3
(Technical Support	*05/06*	*0.5)*
(Technical Support	*06/07*	*0.5)*
Total FTE through 2010-2011		**3.5**

2. Research Program Goals and Strategies

2.1 Target Areas of Research Excellence

The goal of the new Biomolecular Engineering Department is to achieve a level of excellence that will place us among the top five similar departments in the country. Biomolecular Engineering is a rather different field from existing Bioengineering departments (hence the different name). Traditionally, bioengineering equates with biomedical devices, tissue engineering, medical imaging, and other areas often associated with a medical school. We are in the process of developing a new blend of engineering, biology and chemistry that draws on current strengths at UCSC and reflects our vision of an important direction that biological and medical discovery should take. The target areas of excellence, highlighted below, intersect with all three areas of excellence identified by Dean Kang for the Baskin School of Engineering: Information Technology, Biotechnology and Nanotechnology. In addition, strengths in these areas will allow the department to play key roles in new campus initiatives, such as the biomedical research focus of MCD Biology, and the STEPS Institute for Innovation in Environmental Research being developed by Ecology and Evolutionary Biology (EEB).

Bioinformatics/Computational Biology

With the transfer of Profs. Haussler, Karplus and Lowe into the BME Department, as well as the new faculty hired in the next couple of years, we will immediately have achieved international prominence in bioinformatics. Our current strengths include genomic sequence alignment and assembly, gene-finding, RNA and protein sequence alignment and structural prediction, and microarray data analysis. These are areas of critical importance as world-wide sequencing projects are completed and become available for analysis. New areas in bioinformatics that the department may focus on include comparative genomics, human variation, pharmacogenetics (the influence of genetic factors on drug activity and metabolism), and pharmacogenomics (the variability of patient responses to drugs due to genetic differences). Two of the three positions of our current faculty search are in bioinformatics.

Computational/Experimental Systems Biology

Another consequence of the availability of complete genome sequences is the advent of a new paradigm in biology in which entire systems are investigated as a whole. The systems to be studied exist at many levels—for example, genetic regulatory pathways that turn genes on and off as a particular organ, tissue or physiological system develops; *intra*cellular signaling pathways in which proteins and second messengers interact physically and biochemically to perform a cellular function; and *inter*cellular pathways in which cells communicate with each other through chemical, physical, and electrophysiological means in order to sense and respond to their environment. It is these networks of genes, gene products, and other cellular components that orchestrate the development of an organism and all of its separate systems (immune system, cardiovascular system, nervous system, etc), and allow those systems to function, for instance, to mount an immune response against a pathogen, or to reinforce the neuronal connections that are the basis of learning and memory. This was a predominant topic at the 2001 UCSC Human Genome Workshop attended by many of the world's top scientists in the fields of genomics, bioinformatics, and molecular biology.

This area is a very good fit for the BME Department, because it builds off of the bioinformatics target areas and strengths described above, and is a natural progression from the more basic studies of genome structure and function. Specific areas that the new department will focus on include gene regulation, large-scale studies of gene function (functional genomics), and computational models of cellular pathways and networks. Microarray technology, currently the primary method for studying thousands of molecules in parallel, will play a key role in understanding systems biology. Proteomics techniques are also expected to become increasingly important. With the first hire for the BME Department, Todd Lowe, and through our collaborations with MCD Biology (particularly in support of the microarray facility and research) we have already begun building expertise in microarray technology. Prof. Lowe provides an excellent example of how computational methods can be combined with experimental approaches such as microarrays to understand more about a system. With two new hires planned in the systems biology area, as well as the three laboratory automation hires and the additional microarray and proteomics hires, the BME Department will have a strong presence in this area.

Technology Development

Another focus of the BME Department will be on the development of technology and informatics methods for basic biological and biochemical discovery, medical applications, biodetection and environmental monitoring. We will build strength in developing both laboratory devices and analytical tools for areas such as:

- measuring gene expression, testing predictions of genes and splicing patterns, detecting genetic polymorphisms, classifying and staging disease, diagnosis of infecting agents, patient genotyping for individualized therapy

- studying the proteome—the complement of proteins in a cell and their interactions

- biohazard detection and identification, including DNA- and protein-based chips and other methods for identifying biohazard strains, projecting virulence, determining whether the strain is natural or genetically engineered

- detection and analysis of more benign environmental threats, such as environmental toxins and common infectious agents

- evolutionary and molecular epidemiological analyses to better understand rapidly mutating viruses and bacteria, such as HIV and the bacterium that causes tuberculosis

- environmental surveys (for example, identification of all microscopic life found in the ocean, or soil, of a particular area) to detect changes in populations and provide an early indication of environmental threat

This focus on technology development will foster collaboration between the BME Department and other SOE departments, such as Applied Mathematics and Statistics, and Electrical Engineering, which also have efforts directed at environmental engineering, and with the Natural Sciences departments of MCD Biology, EEB, Chemistry and Biochemistry, Environmental Toxicology, and Ocean Sciences. Through the CBSE, collaboration between future BME department faculty and some of these other departments is ongoing, for example the microarray projects between MCD Biology and Profs. Haussler and Lowe of CS and CE, and the molecular nanopore DNA analysis project between Prof. Deamer of Chemistry and Prof. Haussler. In addition, our first BME faculty search for someone in the area of technology development is taking place this year. In total, the BME Department will have six faculty focused on technology development—three in laboratory automation, 3 in microarrays and one in imaging and image analysis.

A fourth possible area of research excellence is **Proteomics** (the application of computational methods to study the full complement of proteins in a cell, their modifications, and their interactions) or **Protein Engineering** (the computational design of proteins to enhance or modify their functions). BME Department hires in any of the areas listed could potentially focus on proteins, and our searches will be broad enough to include protein researchers in our pools. This area would fit well with and compliment the other research targets of the department—in fact, a proteomics focus will develop to some extent from the other target areas. Whether this area is further developed or not depends in part on the caliber of applications received and the direction and interests of the early hires.

2.2 Participation in QB^3, a California Institute for Science and Innovation

The Biomolecular Engineering Department will host many of the key participants for the Santa Cruz campus in the tri-campus Institute for Biotechnology, Bioengineering and Quantitative Biomedicine (QB^3). A cooperative effort between UC San Francisco, UC Berkeley, UCSC, and industry, QB3 endeavors to harness the quantitative sciences to create fundamental new discoveries, new products, and new technologies for the benefit of human health. All 14 BME faculty (in addition to faculty from other departments) will take part in this institute.

2.3 Silicon Valley Center

Joint ventures with industry such as QB^3 may serve as the primary vehicle for a Biomolecular Engineering research presence at SVC. If appropriate laboratory space is available, certain research projects involving industry partners and QB3 students and faculty may be housed there, as a central location between the three UC campuses and the biotech industry. A SVC location may also be convenient for partnerships with companies outside of the Bay Area, thus allowing collaborations that may not otherwise have been possible. The SVC may be particularly appropriate for projects involving new product development and testing activities (as opposed to basic research), which may not be allowed on certain tax-exempt financed QB3 spaces on campus (which are constrained by IRS rules on private business use).

2.4 Pacific Rim Roundtable for Technology and Society

The BME Department has not yet established how, if at all, it will interact with institutions in Asia. Participation in the Pacific Rim Roundtable may arise once the department has reached a critical mass of faculty.

2.5 Industry, Government Laboratory Relationships and Support

In addition to research collaborations and student internships facilitated by QB^3 and the CBSE, individual BME faculty will be encouraged to have contact with industry and government labs where related research is taking place. One example is Lawrence Berkeley National Labs, where Berkeley Professor Adam Arkin is trying to create a computer model of how a cell works. The department will also foster relationships by inviting industry and government lab researchers to participate in our seminar series and as guest lecturers in classes.

3. Capital and Resource Development

3.1 Instructional and Research Space

The following table outlines the projected space needs for the BME Department. Note that many of the staff positions requiring space are not full-time and may be shared with other departments, thus some of the projected space needs of the individual departments may be redundant.

Biomolecular Engineering Department Projected Space Needs by 2010

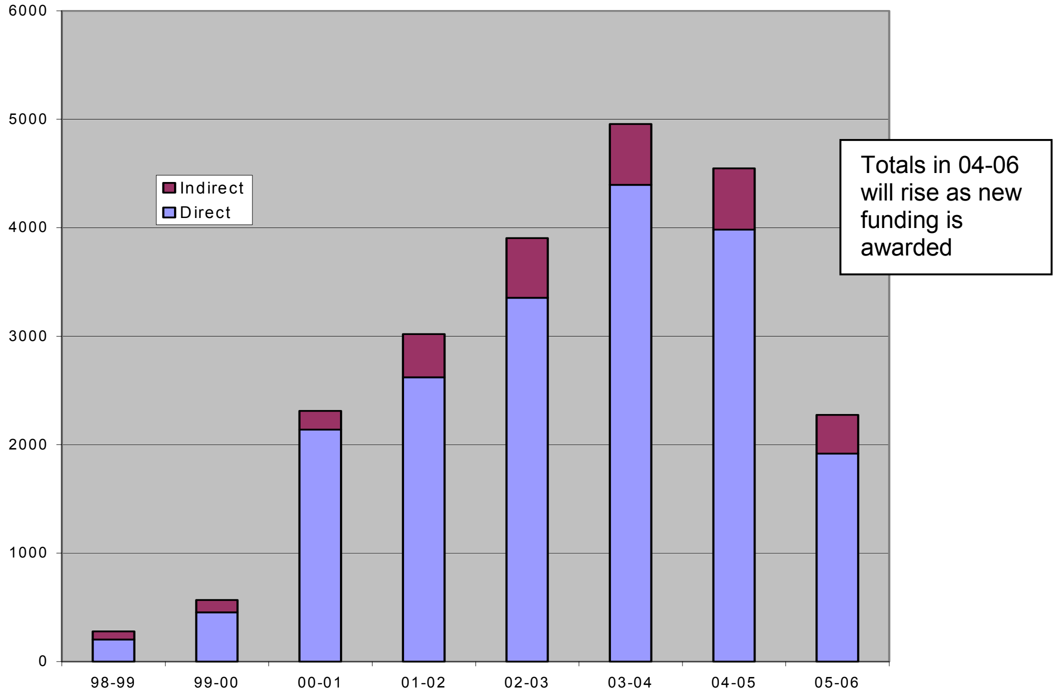
Type of Space	ASF per Person	# Needed	Total
Department Chairman	160	1	160
Faculty Offices	140	13	1,820
HHMI Investigator Office	150	1	150
Department Manager	160	1	160
Admin Cubicles	120	7	840
Technical Support	120	2	240
Admin Service/Common Space	30	10	300
Faculty Service Office/Mailroom	300	1	300
Seminar/Conference Room	25	40	1,000
Teaching Classrooms	600/classroom	2	1,200
Teaching Labs	1000/lab	2	2,000
Faculty Research Labs/Grad Space			
Dry/Computational	600/lab	8	4,800
Biomolecular/Wet Lab	1000/lab	6	6,000
HHMI Dry Lab/Machine Room	2,650 combined	1	2,650
Communal Grad Space	50	40	2,000
Post Doc Space	100	20	2,000
Visiting Researcher Space	120	5	600
TOTAL			**25,320**

3.2 Extramural Research Funding

Most of the major funding agencies (including the NIH and its constituent branches, the NSF, and the DOE) and private foundations (such as HHMI and the Packard, Sloan, Whitaker, and Keck Foundations) allocate substantial portions of their budget to research awards in bioinformatics, proteomics and technology development. BME Department faculty will be strong candidates for such awards, and will be expected to apply for both individual awards and project grants that foster collaborations between departments and divisions.

Our current faculty, individually and through collaborative projects organized by the CBSE, have had extraordinary success in obtaining extramural funds. The following chart shows the annual funding awarded through grants to Prof. Haussler and his research team, and through project grants awarded to Haussler and Co-PIs Karplus, Hughey (CE) and members of Natural Sciences faculty. This chart does not include individual awards to faculty other than Haussler, and only shows awarded funding, not projected.

Awarded Annual Funding for Prof. Haussler and CBSE Multi-PI Projects (in $1000s)



It is expected that the 13 non-HHMI BME faculty will individually receive awards averaging $350K per year, and will also participate in multi-investigator awards totaling $1M to $2M per year. This amounts to annual extramural funds for the 13 regular faculty of approximately $5.5-6.5M.

3.3 Private Funds Development

The BME Department will work closely with SOE and campus Development personnel to take part in appropriate fund-raising opportunities. Many potential donors have an interest in the Human Genome Project and the development of new technologies to advance medical research and human health. By preparing up to date informational materials (such as brochures, news packets, and web sites), giving tours of our facilities and talks, and by having a presence at key opportunity events, the BME Department will maximize its chances of receiving private funds. A Communications and Outreach Assistant, and a technical staffperson responsible for the web sites, will be key for this effort, and are included in the projected departmental staffing needs.

4. Summary

A proposal to establish a new Biomolecular Engineering Department within the Baskin School of Engineering will be put forth by Summer 2002, and may receive approval before the end of 2003. There is great momentum to begin this department, due to the world-class research of an elite group of faculty ready to move to the new department, the timeliness of biomolecular engineering as a new discipline growing out of advances in the computational, biological and engineering sciences, and the strong support for the academic programs which belong in such a department. The department will grow to a total of 14 faculty by 2010, 13 state-supported, regular members, and one HHMI investigator. Graduate programs (MS and PhD) will be offered in Bioinformatics and Biomolecular Engineering, and an undergraduate program in Bioinformatics has already been established. The department will develop a BS/MS program in Bioinformatics after approval of the graduate programs, and will consider a BS program in Biomolecular Engineering within a few years.

The BME department will focus on the following areas of research excellence:

- Bioinformatics/Computational Biology;
- Computational/Experimental Systems Biology;
- Technology Development;

and potentially Proteomics/Protein Engineering.

The department will be composed of faculty with expertise in various sub-areas of bioinformatics and computational biology, including systems biology, and in technology development areas including microarray and other emerging approaches. The first faculty hire for the department took place last year with the addition of Prof. Todd Lowe, currently a member of CE. Prof. Lowe's expertise spans the areas of bioinformatics, microarray, and other laboratory experimentation. We currently are searching for two more faculty in bioinformatics, and one in technology development, and hope to obtain approval for two searches per year for the next two years, and one per year thereafter, to reaching a total of 14 by 2008-9. There will be considerable interaction between the department and other departments on this campus and elsewhere, through MRU, ORU and other interdisciplinary endeavors, some of which are already well established (such as the CBSE, and QB^3).

The predicted annual external funding for the department, excluding Prof. Haussler, is $5.5M to $6.5M, and includes an average of $350K/yr for the 13 regular faculty members, plus an additional $1M-$2M per year in multi-PI project grants. Prof. Haussler, through individual and multi-PI project grants, has been awarded over $3M in the current year, $3.9M in 2002-03, and almost $5M in 2003-04.

A full time Department Manager will be recruited in 2002 as the first departmental staffperson, and additional part-time personnel will be added through 2006/07 to reach a total of 10 positions, or 3.5 FTE.

Table 1: Biomolecular Engineering/CBSE Faculty Recruitment Plan
2001-02 through 2010-11

RECRUIT YEAR	AREA[1]	LEVEL[1]	FTE#	UPGRADE[2]	START-UP	REMOVAL	RECRUIT	LIBRARY
01-02	1. Laboratory automation (BME)	Assoc. II	454	15,000	500,000	6,000	4,000	5,000
01-02	2. Statistics, bioinformatics (BNF)	Assist. IV	551	15,000	300,000	4,000	4,000	5,000
01-02	3. Systems biology; molecular modeling (BNF)	Full III	581	15,000	500,000	6,000	4,000	5,000
02-03	4. Statistics, bioinformatics (BNF)	Assist. IV	new	15,000	300,000	4,000	4,000	5,000
02-03	5. Microarrays, electrohydrodynamic circuitry, bioelectronic chips, microfluidics (BME)	Assoc. II	new	15,000	500,000	6,000	4,000	5,000
03-04	6. Laboratory automation (BME)	Assoc. II	new	15,000	500,000	6,000	4,000	5,000
03-04	7. Systems biology; molecular modeling (BNF)	Assist. IV	new	15,000	300,000	4,000	4,000	5,000
04-05	8. Biomolec. image analysis, optical systems (BME)	Assist. IV	new	15,000	400,000	4,000	4,000	5,000
05-06	9. Laboratory automation (BME)	Assist. IV	new	15,000	400,000	4,000	4,000	5,000
06-07	10. Proteomics, protein engineering (BNF)	Full II	new	15,000	500,000	6,000	4,000	5,000
07-08	11. Systems biology; molecular modeling (BNF)	Assist. IV	new	15,000	300,000	4,000	4,000	5,000

[1]These 11 positions represent the focus areas for the new Biomolecular Engineering Department and the CBSE ORU. At build out, the department will have a total of 14 ladder rank faculty, including HHMI investigator David Haussler. Profs. Karplus and Lowe, of the CE department, will also transfer to the new department. The order of hires and the levels listed are an approximation. The hiring plan is intended to be flexible in order to take advantage of the best opportunities in each pool each year. At the Assistant Professor level, we expect to hire at levels II to IV, depending on the qualifications of the candidates. BME = biomolecular engineering area; BNF = bioinformatics area

[2]Upgrades are additional salary above the 9 month salary scales (effective 10/1/01):

Assist. IV:	$71,100
Assoc. II:	$77,400
Full II:	$85,500
Full III:	$90,900

Department of Computer Engineering

Long Range Plan

2001-2010

Mission

The Department of Computer Engineering provides undergraduate education, graduate education, and research creativity as part of the School, Campus, University, and State of California. In undergraduate education, our goal is to prepare students for careers in industry and to pursue graduate study by offering a balanced foundation in mathematics, science, and engineering design along with advanced study in computer hardware and software technology. In graduate education, we seek to prepare students to succeed in academic and industrial research as well as to teach and lead future Computer Engineers. In research, we strive to offer programs of the highest quality that have positive impacts on society and technology, both state-wide and globally. In all areas, we emphasize continuing innovation to support programs of the highest quality.

PART I ACADEMIC GOALS AND STRATEGIES

The undergraduate program in Computer Engineering (CE) was founded in 1984 and accredited by Accreditation Board for Engineering and Technology (ABET) in 1988. The CE graduate program was established in 1989 and saw its first graduates in 1992. Ten years ago, there were 10 faculty members who had overseen a handful of BS degrees, and would shortly see their first PhD students graduate. Now, our annual enrollments have grown to 300 student FTE, BS degrees granted to 47, MS and PhD degrees granted to 25, and faculty from 12 during most of the decade to 13 in 2000. We now have 17 Computer Engineering faculty and host 1 Biomolecular Engineering faculty member.

During this past decade, Computer Engineering faculty have taken leading roles in many innovations within what became the School of Engineering. Most obviously, the contributions of Founding Computer Engineering Chair Mantey (latter Founding Dean of Engineering) cannot be overstated. In addition to creating our department, his tireless efforts led to the creation of the 3-2 program, ISM, EE, the distance learning MS in CE, and the School of Engineering, and are now leading the creation of iNIST, the Institute for Networks Information Systems and Technology, a multi-center research institute. We have embarked upon many innovative academic programs including a combined BS/MS program to encourage undergraduates to continue on to graduate study; a distance-learning masters degree program that has just started graduating students; a newly revised and refocused undergraduate curriculum enabling students to specialize in computer systems, networks, systems programming, or digital design; a minor in Computer Engineering; and most recently an undergraduate degree in bioinformatics for which we also intend to seek ABET accreditation.

In the coming decade, we expect to continue innovation in engineering education in several ways, as discussed below. The most innovative programs over the next decade, however, will be ones we have not yet begun to think about.

1.1 Graduate Programs

The Department of Computer Engineering offers MS and PhD degrees in Computer Engineering. At present, we do not foresee great changes in our on-campus degrees, but will take part with other faculty in the School of Engineering in the expansion of distance learning programs and new on-campus degree programs.

As a minor enhancement to our graduate program, we recently reintroduced graduate student travel support for unfunded and underfunded research. These funds were unfortunately eliminated several years ago by the campus. We have restarted this program, which was quickly matched by other departments in the SOE.

1.1.1 Distance Education MS Program

Computer Engineering has been a campus leader in the use of videoconferencing for distance education. In 1997, we began a distance education version of our MS degree program specialized to network engineering. With the assistance of the campus and UCSC Extension, Media Services created one large (150 seats) and one small (35 seats) distance education classroom in Baskin Engineering, and one at UCSC Extension's Cupertino site. The first students graduated from this program in June 2000. At present, we have approximately 30 students per quarter taking classes from Cupertino. Primary issues with the program include the lack of an intermediate-size distance education room or a second remote site.

At the present level of enrollments, the program can support one on-campus faculty FTE. The instructional cost of the program is closer to two FTE, and we hope to achieve this level of enrollments in the next five years. School of Engineering plans to offer more programs through distance education will also bring some economies of scale to this program.

We plan to expand our distance learning offerings to include more general areas of computer engineering. The first expansion will be into video and multimedia because of its strong coherence with our network engineering program.

1.1.2 New Degree Programs

We will be working with the CBSE and the Department of Computer Science on two new graduate programs, one in Bioinformatics and the other in Software Engineering, and later with the CBSE to create programs in biomolecular engineering.

We will be working with all the departments in the SOE to create a program in Engineering Management, and in the longer-term hope to assist in the development of programs in Environmental Engineering and Engineering Ethics, and other multidisciplinary programs.

1.2 Undergraduate Programs

We will continue to review and refocus our undergraduate curriculum. Presently, we are working to define the core material of all of our required courses in an effort to maintain consistency between offerings and to identify concepts that are repeated too frequently or too infrequently in the curriculum. This review will form the cornerstone of our next ABET review under the flexible and demanding Engineering Criteria 2000 (EC2000) guidelines. We expect to expand our upper-division track offerings with the introduction of a signal, image, and video processing track for computer engineering majors. We will undoubtedly introduce other new concentrations in the future, such as in embedded systems. For our 2003 ABET review, we will seek accreditation for bioinformatics, and later hope to work with Computer Science to accredit a program in systems or software engineering.

In undergraduate research, we intend to work with the SOE and Campus to make it simpler for undergraduates to find research opportunities and also for us to publicize the excellence of our undergraduate research. Within the department, several research projects very strongly involve undergraduates in their work. This summer, we initiated a weekly social occasion for "undergraduate summer researchers, people who know them, and people who like snacks". We hope that events such as this will create a sense of community among our researchers at all levels. This fall, the Department created and sponsored (with the help of the SOE Undergraduate Office) the first Engineering Undergraduate Research Poster Symposium the day before classes. The event was located next to our undergraduate advising office, and was an effective way of showing new students the advantages and excitement of being at a research University. With the help of alumni donations to the Department, we were able to offer cash prizes to the top three presentations.

Computer Engineering has proposed to the NSF the formation of an Research Experiences for Undergraduates summer institute for underrepresented students, as discussed below and section 1.7.

We hope to find additional ways for the department to further encourage and expand undergraduate research opportunities as an extension of UCSC's uncommon commitment to undergraduate education.

1.3 3-2 Programs

Although created by CE’s founding chair, the Department is presently not involved in the 3-2 program. The Department finds that the 3-2 program is particularly helpful for attracting top entering students, and later may decide to get a computer or in electrical engineering degree at UCSC rather than a degree in a different field at Berkeley. The Computer Engineering BS/MS is a similarly effective recruitment tool.

1.4 Summer Programs

Computer Engineering expects that the School of Engineering will see strong enrollments during the summer. Re-entry and transfer students are expected to be particularly interested in summer session as these groups are more strongly focused on completing their university education to start their career. Finishing one year earlier will result in receiving a $60,000-80,000 salary one year earlier. Especially for students on financial aid or with families to support, this 25% acceleration in completion of the undergraduate degree will have a lasting effect on the student.

For these reasons, our summer offerings will concentrate on major acceleration and on transitioning from community college to the University of California.

In Summer 2000, we began offering CMPE 12C/L: Computer Organization, and in Summer 2001, we also offered CMPE16: Discrete Mathematics. Because of the lack of a state-supported summer session, these offerings are essentially public service, reducing our academic-year workload by 8 student FTE for the benefit of our undergraduate students.

With state-support, by 2005 we plan to be offering our core undergraduate computer engineering curriculum, including CMPE12C/L: Computer Organization, CMPE16: Discrete Mathematics, CMPE100/L: Digital Logic, CMPE107: Stochastic Methods, and CMPE110: Computer Architecture during the summers. We may also wish to offer CMPE185: Technical Writing and CMPE121/L: Microprocessor System Design over the summer.

Two of these courses (107 and 110) are taken by many of the students in our off-campus MS degree program. We expect that the students will be particularly happy to see course offerings for the distance-learning program available during the summer. Our undergraduate entry-level course CMPE16 may also be effective in the distance-learning format. It is a critical course for transfer students, and one that we rarely articulate with community colleges. We expect to initially try distance learning for this class, and depending on demand may offer it at the Silicon Valley Center.

We will also consider offering our general education courses, CMPE 3: Personal Computer Concepts, and CMPE 80N: Introduction to Networking and the Internet, during the summer depending on demand. Our primary focus, however, will be enabling motivated students to complete the difficult computer engineering requirements more quickly.

Our Summer 2000 12C/L enrollment of 34 was 10% of the full-year enrollment. Enrollments should be higher than under the current system once the summer is normalized, perhaps 20% of our FWS enrollments. Combining this with a projected to annual growth of 10% in course enrollments, we expect our summer 2005 enrollments to be a minimum of 360 headcount. If summer session is successful, and more students make use of this chance to accelerate to their education, we can expect to see 500-600 students.

To accommodate this growth in summer programs, Computer Engineering will need forward funding of 2-4 positions. An increase in staff, in particular undergraduate advising, will also be required.

1.5 Silicon Valley Center Programs

The UCSC Silicon Valley Center (SVC) is a planned research and educational site in Santa Clara for 120 faculty FTE. Because of the close ties between Engineering and Silicon Valley, we expect one third (40) of these faculty to be in engineering, and 10-20 to be in areas of computer engineering. Although this seems like a small number for an off-site computer engineering research enterprise, we expect the SVC programs to include large numbers of adjunct faculty and research professors to add vitality to this research and teaching enterprise. We see the development of several programs at the SVC, and look forward to leading some of these efforts and taking part in others.

The SVC may provide a new home for our Masters of Science in Network Engineering, currently housed at the UCSC extension Cupertino site. The planned development of research laboratories at the Silicon Valley Center will enable a fuller curriculum within the area of network engineering and in computer engineering in general. The construction of multiple distance learning facilities, both at the SVC and on campus, will enable a much wider range of courses during the prime offering periods for part-time study (morning, evening, and night).

The creation of more successfully bi-directional distance education facilities will enable faculty with homes, active consulting, or other commercial interests in Silicon Valley to teach from the Center and broadcast their courses to campus. This is, of course, a very delicate proposition as we must ensure that such programs do not eroded the quality of our on-campus education. For this reason, we presently see this as being primarily for graduate courses on topics that would otherwise not be offered.

As mentioned in the discussion of summer session above, we would like to offer several of our entry-level courses for transfer students live and via distance learning to the Silicon Valley Center and possibly other locations. The SVC will be far more convenient for many of our local community college students, and as such can become an effective way to transition students into their university education.

1.6 Internships and COOP Programs

In a related area, we have begun considering plans for a formalized field study course. With the normalization of summer session, this is a particularly appealing possibility. An effective intern program coupled with regular group meetings discussing the way the commercial world works could be an excellent means of providing advanced education and training for our students. If we are able to find appropriately focused projects in industry, groups of students could tackle a specific project as part of a senior design experience.

1.7 Promotion of Diversity

Computer Engineering has sponsored our student IEEE chapter, and took part in the recent launching of the Society of Women Engineers (SWE) on campus. With an overwhelmingly successful initial meeting (with 50 undergraduate, graduate, postdoctoral, and faculty women, as well as the SOE Dean and CE Chair), the group began an aggressive activity program. They have had two popular panels and run a well-attended thrice-weekly drop-in tutoring sessions for all students. In addition to continuing our strong support for these and other student organizations, we intend to work with the SOE to start a Tau Beta Pi chapter (an engineering honor society), and are presently working with the SOE and Natural Science's ACE Honors Program to propagate ACE's exceptional success in the teaching and retention of underrepresented students to engineering. We have also taken part in the development and use of Modified Supplemental Instruction on campus.

The Department has recently proposed an NSF Research Experiences for Undergraduates site. Modeled after the successful SURF program in chemistry, we hope to receive funding for inviting 12 underrepresented undergraduates from other institutions for a summer research experience. This program will increase diversity in our graduate program both by SURF-IT students applying to our graduate programs and also bringing word about the excellence of UC Santa Cruz back to their home campuses. The Department of Computer Engineering and the School of Engineering will be funding part of this program.

1.8 Interdivisional Collaborations

The bioinformatics programs and the Center for Biomolecular Science and Engineering are the most obvious current interdivisional collaborations. We expect this collaboration to continuing and grow over the next several years. Although this collaboration is primarily with the Natural Sciences division, we have also begun working with members of the philosophy department on the ethics curriculum for the bioinformatics programs.

1.9 Residential College Relationships

Professor of Computer Engineering F. Joel Ferguson was recently appointed to the position of Provost of Crown College. The Provost of a college is the head of the college’s fellows, manages the college advising staff, and presides over the college's academic ceremonies (such as graduation). Joel is the first CE or School of Engineering faculty member to hold the post of College Provost at UCSC and it is his primary goal to strengthen the ties between the School of Engineering (in which he is also Associate Dean of Undergraduate Affairs) and Crown College.

1.10 Student Admissions

In the past five years, our enrollment FTE workload has grown from 174 in 1996-97 to 298 in 2000-01. During this period of 71% growth, we had one new computer engineering hire. Four new faculty members will join us next year, a 38% growth in comparison to our size in 1996-97.

During the same five-year period, our undergraduate majors have increased from 198 to 303, and our graduate student numbers have increased from 70 to 145, including 63 in our off-campus MS in CE program. Because of our growth in faculty, we have been able to increase our on-campus admissions, and have received commitments from 41 new graduate students.

1.11 Faculty and Staff Resources

For the next 10 years, unconstrained enrollment growth would result in another doubling of our enrollments, leading to a degradation of our undergraduate and graduate programs. With the introduction of a school-wide admissions procedure, we can effectively target undergraduates who will succeed in the program, greatly increasing our major retention rate and ensuring that our programs will be of the highest quality. We plan to double our number of graduating majors during the next 10 years with only a 10-25% growth in undergraduate enrollments. Our largest workload increases will take place in the graduate program as we developed a research and graduate education program of the highest quality. We expect to reach 150 on-campus graduate students, and 75 off-campus students. As with all other engineering programs in the UC system, in order to maintain a program of the highest quality we will need a student to faculty FTE ratio of 15-17:1.

The Department presently includes 18 Computer Engineering faculty. Two (Lowe and Karplus) are expected to move to the Department of Biomolecular Engineering in 2-3 years. Thus, if we grow to 27 state-funded FTE during the next 10 years, we will be hiring 11 new state-funded FTE. Additionally, we expect to hire 1-3 FTE to support the instructional load of our distance education program (funded by program revenue), and to replace one retiring faculty member. Thus, we expect 12-14 recruitments prior to 2010. We will use both the new positions and the replacement positions to refocus our research on our target areas of research excellence.

If it were not for the initiation of summer session, we would propose an even hiring cycle of 1-2 positions each year (including new and replacement positions) until the achievement of our final size. However, the drive to introduce a new, full-fledged quarter of instruction indicates a need to accelerate hiring in the first 3 years. After that, we request 1 position per year until we have achieved full size.

We will also investigate, with the School and Campus, ways of providing permanent positions to our most exceptional lecturers, presently recurrently paid from TAS funds. Such a scheme would enhance our ability to include experienced, practicing engineers to complement our focus on engineering research.

Most of our positions are requests at the advanced Assistant Professor levels. This is critical to enable the recruitment of faculty who have spent several years in industry and are now ready to return to the academy.

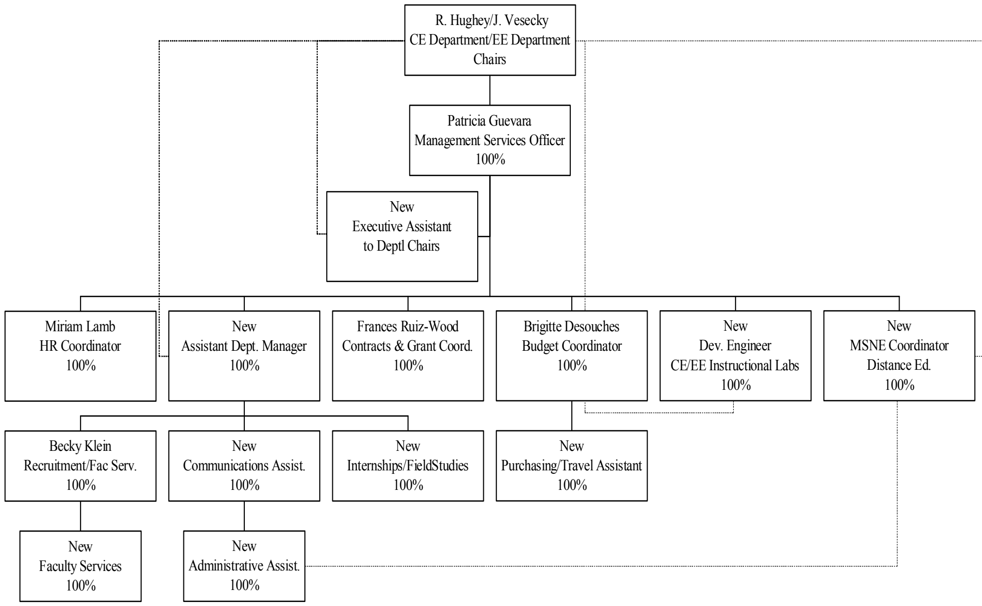
We will always advertise in the most general terms, for example most of our areas of excellence could be described as “Computer Systems” or “Computer Engineering” with various sub-focuses. In spite of our specific plans for the next ten years, flexibility must be the hallmark to ensure we recruit the best available faculty whether or not we were looking for their specific research area one year or the next. Such approaches were strongly endorsed by the recent state audit of gender inequities in UC hiring. Although as an engineering department we are doing quite well with 22% female faculty, this is far from the final goal of an even mix.

The research areas in the table below are further discussed in the next section. Salaries and instead of amounts are based on 2001-2 needs, and can be expected to grow significantly faster than the cost of living.

Year	Area	Subfield	Rank	Salary	Startup
2001-2	Computer Networks	Any	Assist II-IV	80,000	175,000
2002-3	Embedded and Autonomous Systems	Embedded Systems	Assist II – Assoc II	90,000	300,000
	Computer System Design	Cluster Computing	Assist II-IV	80,000	175,000
2003-4	Embedded and Autonomous Systems	Autonomous Systems	Assist II-IV	80,000	175,000
	Digital Media and Education Technology	Education Technology	Assist II-IV	80,000	175,000

2004-5	Computer Networks	Wireless Optical Networks	Assist II-IV	80,000	175,000
	Computer System Design	Reconfigurable Systems	Assist II – Prof IV	104,008	300,000
2005-6	Software and Systems Engineering	Any	Assist II-IV	80,000	175,000
2006-7	Embedded and Autonomous Systems	Sensor Nets	Assist II-IV	80,000	175,000
2007-8	Computer System Design or Design Technologies	Physical Design	Assist II-IV	80,000	175,000
2008-9	Digital Media and Education Technology	Multimedia	Assist II-IV	80,000	175,000
2009-10	Embedded and Autonomous Systems	Any	Assist II-IV	80,000	175,000

As a sufficiency of engineering research and office space becomes available, we intend to recruit Researchers faculty in our target areas of excellence. At this point in time, it is unclear whether these faculty will be primarily associated with the Department or with one of the 2 (and potentially more) Organized Research Units. In any case, we expect to see a slow increase in faculty in the Research title beginning in 2005 (with the availability of the Engineering II building), leading to 5-6 full-time Researchers. We expect that these faculty will advise graduate students and may occasionally teach graduate courses in their research areas. The positions will be entirely funded by research grants.



The growth of the department, its teaching, and its research, will also demand additional growth in staff. At present, we have only a half-time Department Manager, shared with Electrical Engineering, who also manages half of the Engineering Business Office. We are presently hiring an assistant department manager, and expect that one of these two managers will focus on Computer Engineering, and the other on Electrical Engineering, to ensure full-time departmental support. As our research funding grows, will need to add research accountants and other staff support. Also, to ensure effective relationships with alumni and corporations, at least part of a position will need to focus on outreach and communication.

As our research and educational mission grows, as well as those of Electrical Engineering and Biomolecular Engineering, we will need to expand the Baskin Engineering Lab Support (BELS) group, which primarily provides support for our hardware laboratories, to also cover our graduate academic mission in a manner similar to the SOE's computer support group.

PART II RESEARCH PROGRAM GOALS AND STRATEGIES

2.1 Target Areas of Research Excellence

We are presently focused on four core areas of computer engineering, and are collaborating with faculty in other departments on two additional areas. During the next 10 years, we expect to strengthen these existing areas and also emphasize the area of Embedded and Autonomous Systems. We propose to have approximately 5 faculty in each of our areas of excellence (not all in CE) to provide critical mass for strong research programs able to present and fund focused large projects with multiple PIs.

The existing areas include:

- Computer System Design (Brandwajn, Hughey, Madhyastha) studies the creation of computer and digital systems to solve problems. We currently perform work in parallel and distributed computation, performance modeling, field-programmable gate array (FPGA) and very large scale integration (VLSI) system design, and storage systems. Research strengths in computer science complement several of these areas. A subfield of the SOE target area of computer and embedded system design.

- Design Technologies (Chan, Dai, Ferguson, Larrabee, Schlag) includes both the hardware and software technology needed to design and build complex digital systems. Our current research includes Computer Aided Design (CAD) for nanoscale system design, CAD for FPGA design, and CAD for VLSI design and testing. Research strengths in electrical engineering complement several of these areas. A subfield of the SOE target area of VLSI and nanosystems technology.
- Computer Networks (Garcia-Luna, Obraczka, Varma) includes the technology, software, and algorithms required to make large networks of computing devices. Research areas presently include design and evaluation of protocols for wired and wireless networks, network switching, and internetworking research. A subfield of the SOE target areas of information technology and of communications.
- Digital Media and Education Technology (Langdon, Manduchi, Mantey, Tao) has an emphasis on computer systems and technologies for video processing. One of the most important uses up this technology for UCSC will be in distance education. Our current research includes image storage and retrieval, data and image compression, multimedia systems, image and video reconstruction and modeling, human-computer interaction, machine vision. Research strengths in electrical engineering and in computer science complement several of these areas. A subfield of the SOE target areas of human-computer interface and information technology.
- Software and Systems Engineering (de Alfaro) includes the design of complex software (software engineering) and hybrid hardware/software (systems engineering) systems. Computer Engineering faculty are collaborating with Computer Science faculty to create new academic and research programs in this area. Present strengths in Computer Engineering include formal methods for system design and analysis and embedded software. This is one of the SOE's target areas of excellence.
- Bioinformatics and Biomolecular Engineering (Karplus, Lowe) study the application of computers and technology to biomolecular data gathering and analysis. Computer Engineering is taking a major part in the development of new degree programs and the Department of Biomolecular Engineering, to which the programs and some of the faculty will transfer on creation. Present strengths within Computer Engineering include, protein structure prediction, high performance computing for computational biology, genomics, and microarrays. This is one of the SOE’s target areas of excellence.

We next discuss our areas of interest within our current areas of excellence and our proposed new research emphasis in Embedded and Autonomous Systems (a subfield of the SOE target area of computer and embedded system design).

2.1.1 Computer System Design

We presently have three faculty in the general area of computer system design and analysis. We would like to add three new researchers in this area working in cluster computing, reconfigurable computing, low-power system design, computer system design, or architectures for wireless systems. Obviously, we will not be able to find three faculty who cover all of these areas; our guiding principle will be to search for excellent faculty in all areas of computer system design, and then hire the best.

One of the most important positions is to find a senior architect in reconfigurable computer system design. Our ideal candidate would have experience in leading large hardware and software design projects to create cutting-edge computational systems. We select reconfigurable computing because of our existing strengths in computer-aided design for reconfigurable systems, VLSI design and testing, parallel systems, and packaging technologies. For this area, we need a lead computer architect to leverage our considerable strengths in the fundamental technology of this area to create a new and exciting research program. As such, this must be a senior appointment with an appropriate startup package to equip a design and digital electronics research laboratory.

We also seek a researcher in computer systems with an emphasis on cluster computing or metacomputing. Clusters, such as the rapidly growing one of the Center for Biomolecular Science and Engineering (CBSE), have become the solution of choice for cost-effective high-performance computation. However, there are many exciting issues in hardware, software, and algorithm development related to clusters. This position will leverage the CBSE cluster by using the 1000 processors both as a computational resource and a research platform. Metacomputing, the use of computers scattered about the Internet, such as in the ``seti@home'' project or an entire commercial enterprise, is closely related to cluster computing, and a researcher in either or both of these areas would be a tremendous asset to our School and Campus.

2.1.2 Design Technologies

Design technologies are the enabling tools and methods of computer and electrical engineering. Without sophisticated computer-aided design (CAD) tools, it is impossible to build and test chips with billions of transistors or systems with thousands of chips. The practice of building hardware systems has been revolutionized by the creation of these tools, and the ability of companies to create chips and systems that work on first implementation.

One of the earliest strengths of the Department was the strong focus on excellence in computer-aided design (CAD). We have five faculty members in this area, studying various aspects of VLSI, FPGA, and packaging computer-aided design and testing.

We would like to hire one additional position in this area, with an emphasis on the physical construction of digital systems, such as the mechanical and thermal design of digital systems, or (as with computer system design) low-power design.

2.1.3 Computer Networks

Computer networks, wired and wireless, are a core area of computer engineering and modern technology in general. The department presently has three researchers in this area, two working on protocol and algorithm issues for networks, and the other working on the physical design of computer networks.

We wish to find one researcher in wireless optical communication. Free-space laser technology has the potential to revolutionize the face of metropolitan networks. It enables point-to-point connectivity with bandwidths orders of magnitude larger than radio-frequency solutions. Free-space lasers can bypass geographical obstacles, thereby raising fewer environmental concerns than physical fiber installations. Unfortunately, free-space laser systems frequently have connectivity problems, leading to the need to create algorithms and hardware for self-healing network architectures.

We additionally plan to round out our networks research group with one additional researcher working on software and algorithms for networked systems or on hardware architectures for networking, depending on the focus of the wireless optical researcher.

2.1.4 Digital Media and Education Technology

Our 2000-2001 recruitments were particularly successful in the area of digital media. Our applicants were of such high quality that we shifted a second recruitment position to this field. We now have four faculty in this area. Digital media and education technology resonates strongly with our work in computer networks, EE's work in digital and image processing, and software engineering and CS work in collaborative system design. As with bioinformatics, the growth of image and video data and databases is staggering. In this area, we seek one additional faculty member in multimedia systems and one faculty member who works in education technology.

2.1.5 Embedded and Autonomous Systems

We propose the creation of a new area of excellence in engineering: embedded and autonomous systems. This will be an entirely new venture, though has strong collaborative resonance with all of our other fields, even biomolecular engineering, as lab-on-a-chip systems become integral parts of embedded and autonomous systems. Our focus will be on three related areas: embedded systems, sensor nets, and autonomous systems. We in particular are seeking researchers to design and build the systems, as several present faculty members in other areas have interests in the algorithms and methods surrounding embedded (de Alfaro) and autonomous systems (Manduchi), as well as the ad-hoc networks needed for the systems (Obraczka). The underlying sensor technology required to create sensor nets will leverage off of the SOE's efforts in remote sensing and environmental technology led by Electrical Engineering. In this new area, we seek four positions, including one tenured appointment to initiate the program.

Driven by the availability of cheaper, faster, and lower-power computing, and by the trend towards increased product functionality at lower unit cost, embedded systems have become the most widespread application of computing. Their introduction is causing a revolution in the design of consumer products, where embedded software accounts for an ever increasing fraction of product functionality. Powerful portable computing, together with miniaturized sensors and communication, is enabling new generations of consumer products. The embedded electronics of a common car now includes several processors connected by real-time networks, executing complex control tasks in strict coordination. At the high end of the scale, embedded systems on aircrafts and for industrial control test the limits of the complexity that can be handled in designs. Designing applications for embedded systems requires a deep understanding of computer systems, electronics, communications, real-time systems, and distributed computation, together with theoretical issues such as distributed algorithms, fault-tolerance, and concurrency. Research in new design methodologies plays a paramount role in supporting the trend towards higher integration, complexity, and robustness. This discipline encompasses many different engineering fields, ranging from networking, language and operating system support to algorithms for coordination of large-scale distributed systems, design methodologies for distributed real-time systems, and the design of distributed controllers.

Sensor nets, collaborative networks of tiny, inexpensive sensors, may enable pervasive applications, from smart machines that can self-diagnose and repair, to smart roads that notice accidents and provide alternate routs, to remote systems for interplanetary virtual presence. Embedded sensor devices can capture physical information, such as heat, light or motion, about an environment. Massively distributed sensor networks communicate with one another on a local basis, summarizing immense amounts of low-level information to produce information in a human-interpretable form, and allowing people (or computers) to respond intelligently. Sensor networks combine many computer engineering disciplines, such as low-power system design, computer system design, architectures for wireless systems, and networking.

Autonomous systems for everyday use (such as smart cars or smart houses) are now a reality. The enabling technologies (embedded computing, sensors, sensor processing and artificial intelligence techniques) have made tremendous progress during recent years. It is expected that autonomous systems will have a major social and technological impact, with applications encompassing medical robots, interplanetary exploration, aid for the motion-impaired, and unmanned rescue missions. We will seek researchers in the physical design of autonomous systems and the algorithm and software design needed for fields such as autonomous navigation and cooperative action.

2.1.6 Software and Systems Engineering

Software engineering, an SOE initiative program in Computer Science and Computer Engineering, focuses on the design and analysis of large software systems. Systems engineering concentrates on the foundations of system design and analysis. It encompasses multidisciplinary system design, including for example digital and analog hardware, software, and mechanical components. Computer Engineering has recently created a systems programming track that has a strong required software engineering component. For this track, we developed (with Jim Whitehead in CS) a senior design project, CS116. Over time, we will consider the expansion of these areas into an ABET-accredited undergraduate degree in Systems Engineering or Software Engineering, and will also work with the Computer Science department in the creation of graduate programs in software engineering. We have one faculty member in software and systems engineering; we seek additional positions to complement those in Computer Science. We will seek software engineers who have a focus on building complex systems in hardware and software or a general systems engineering focus.

2.1.7 Bioinformatics and Biomolecular Engineering

Computer Engineering is enthusiastic about the development of the Center for Biomolecular Science and Engineering (CBSE), and the impending creation of a Department of Biomolecular Engineering (BME). Computer Engineering has created an undergraduate degree in Bioinformatics, and is taking part in the creation of the graduate program. We have two faculty exclusively in this area, including Todd Lowe, the first engineering hire under the CBSE initiative. As with the formation of the EE department, CE expects to host many of the BME faculty prior to the formation of the new department.

We expect the graduate program proposal to be approved by 2002. With the enthusiastic support of the Dean of Engineering, three BME recruitments are taking place in 2001-2. If two of these are successful, we will work with the CBSE two complete the process of creating a Department among 5 faculty (David Haussler (CS), Kevin Karplus (CE), Todd Lowe (CE/BME), and the two new hires). Although Lowe was hired specifically for this program, CE will need a replacement FTE for Karplus.

The program is expected to grow to 12 faculty by 2010. This new department will certainly have a core research excellence in bioinformatics, but will also expand into other areas of biomolecular engineering: the application of engineering to DNA, proteins, and other biomolecular.

Computer Engineering looks forward to working with the new department in the development of bioinformatics and biomolecular engineering programs.

2.2 Participation in Cal ISIs, QB3 and CITRIS

Engineering is presently forming two Organized Research Units (ORUs): the Center for Biomolecular Science and Engineering (CBSE) and the Institute for Networks, Information Systems and Technologies (iNIST). Both of these ORUs will be research umbrellas overlapping the departmental faculty. The ORUs will provide common research support for the departmental faculty in engineering and natural sciences, as well as a framework for providing resources for research faculty.

The CBSE, directed by UC Presidential Chair of Computer Science David Haussler, is focused on bioinformatics and biomolecular engineering. The Center is intended to meet the challenges of the post-genomic era, ushered in by the completion of the Human Genome Project and the related genome projects for model organisms. The revolutionary technologies that have been developed to gather and analyze genomic information will help to forge a new understanding of biology with widespread applications to medicine, agriculture, and ecology. These technologies have been made possible by developments in structural biology, engineering, and computer science, and their further advancement requires a new blend of computational analysis, micromechanical robotics, microfluidics, bioelectronic chips, imaging, and new laboratory functional genomics methods. The CBSE has received several foundation grants to assist in the development of graduate bioinformatics programs that will hopefully be approved for 2002-03.

The iNIST, directed by Professor of Computer Engineering Patrick Mantey, is focused on networking systems, supporting technologies, and applications related to the Internet and data-intensive systems, overlapping many of the core areas of computer engineering research. The ORU will have several centers in different areas, the first one being a

Center for storage systems and databases. The goals of the ORU include the development and management of interdisciplinary research projects, being a coordinator of industrial relationships, hiring and managing research staff, and providing computing and networking infrastructure.

2.3 Silicon Valley Center

The SVC should have active programs in both the use of education technology and the creation of innovative teaching methods for distance learning and other aspects of modern education. We would like to see the development of a Center for Education Technology at the SVC. Several of our current and new faculty have interests in this area, and should be able to help develop this idea further, and also be able to collaborate with researchers at the SVC.

We propose to develop at the SVC a Center on the Design of Complex Systems, an idea originally proposed by UCB Professor Tom Henzinger. Faculty in EECS at UCB (Henzinger, Lee, Sastry, Varaiya) and in CE at UCSC believe that we are on the verge of a new systems theory, one that will focus on handling complexity through fundamental principles such as compositionality, hierarchy, concurrency, heterogeneity. The idea would be to build on the overarching theme of managing complexity in systems that are designed by humans (such as software, hardware, mechanical, and hybrid, mixed discrete-continuous systems), as opposed to analyzing complexity in systems that occur in nature, as in UCSC's seminal work on nonlinear dynamics. Among the obvious target applications are embedded systems, microprocessors, networks, and large software systems. The focus would be around design goals such as scalability, reliability, evolvability, which are very difficult to obtain with current design practices as the average system complexity keeps growing.

Engineering Management is a current focus of the School of Engineering for a new graduate program. There is a tremendous demand in Silicon Valley for advanced engineering management training. Our program will be unique in its dual emphasis of honing technological skills and learning the principles of management and finance. Two faculty from computer engineering have been asked by Dean Kang to take leading roles in the definition of this program and the recruitment of its founding program chair.

In the longer term, as our programs in bioinformatics and biomolecular engineering grow, the new department will undoubtedly wish to present biomolecular engineering and bioinformatics degrees live and through the distance learning at the Silicon Valley Center. We hope to see these programs in five years.

PART III CAPITAL AND RESOURCE DEVELOPMENT

3.1 Instructional and Research Space

We would like to see clustered research groups around our 5 primary areas. Multiple collocated research laboratories with plenty of visitor, graduate, and faculty office and meeting space. As we grow, we expect to increase the number of adjunct faculty teaching specialized courses, as well the number of postdoctoral and visiting researchers. Of course, as our externally funding research and teaching enterprises grow, we will also need to increase the level of staff support in all areas.

We are particularly concerned about our undergraduate teaching laboratories. Engineering design and debugging is a time-intensive endeavor, and hence is also space-intensive. In order to maintain an engineering program of the highest quality, as befits our uncommon commitment to undergraduate education, we will require additional undergraduate laboratory space in proportion to our growth in majors.

We are presently two laboratories short. We lack a dedicated space for CMPE121, our core computer engineering system design class. In CMPE121, students spend many extra hours in the lab debugging and enhancing their microprocessor systems. Students taking this course have been known to both sleep in Jack's Lounge and bring espresso machines to work.

In 2000-1, we introduced several tracks to our CE undergraduate degree. The networks track, one of the highest in demand, has a significant and unmet laboratory need. We are again revising this track for 2001-2, and our need for excellence and rigor in the program has required the addition of one more laboratory class. The two laboratory classes are Network Administration, and the senior capstone Computer Networks Project, and the latter is additionally receiving strong graduate student interest in its first offering. As we make similar expansions in the graduate program, we clearly require a year-round networks instructional laboratory for the graduate and undergraduate courses.

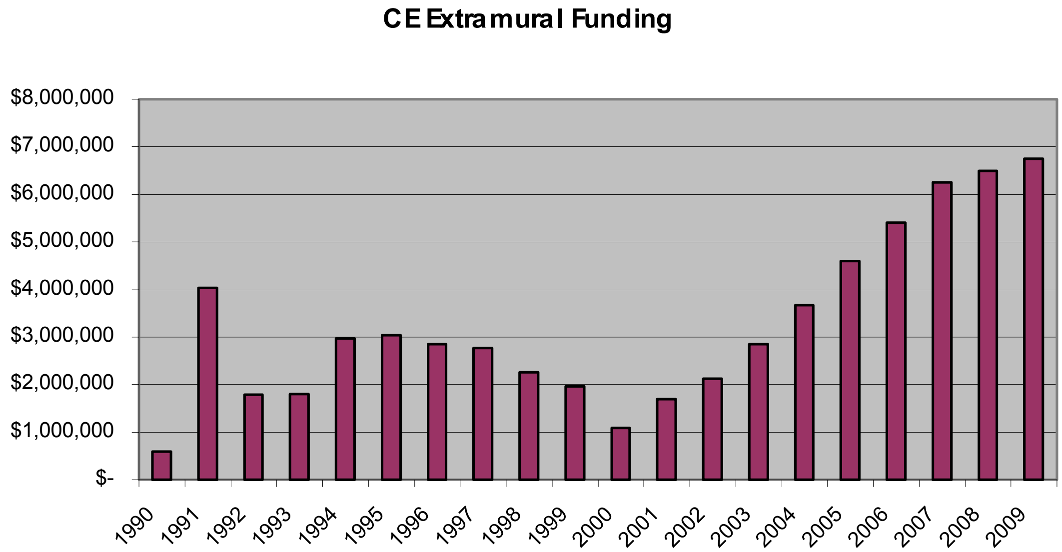
Thus, we have an immediate need of two additional dedicated instructional laboratories in 2002-3.

3.2 Extramural Research Funding

The department has a thriving externally funded research program. The majority of funds are from the federal government (DOE, ARPA, NSF, ONR, DOD), but we are also enriched with funding from several local companies, including: 3-Com Corporation, Affymax Research Institute, Alsi Systems, Altera, Edna Design, Hewlett-Packard, Hughes Research, IBM, Integrated Device Technology, Intel, LSI Logic, Lockheed, Lucent Technology, National Semiconductor, Raytheon, Santa Cruz Operation, Semiconductor Research Corporation, Silicon Graphics, and Xilinx.

During the most recent decade, our external funding has averaged $2.4M per year, not counting hundreds of thousands of dollars of gift and copyright income. Over the next ten years, as the SOE grows, we will be able to form more multi-PI projects and increase the average funding per faculty member. Our target is $6.5M per year in 2010.

We had a research funding decline in 1998-2001 (graph below, with estimates beginning AY01) due to several faculty taking full or partial leaves to work in industry. These faculty will be returning to full-time appointments in Fall 2001 and Fall 2002. Our overall target is to have a faculty member average of $200,000-250,000 of external funding (including grants, gifts, and other forms of income), much higher than our current $80,000. We expect to achieve $100,000 by AY2001 (for a total of around $2M), $200,000 by 2005 (for a total of $4.6M among 23 faculty), and $250,000 shortly thereafter. This will result in about $6.5M in funding by 2010 among 27 faculty, higher if we are successful in recruiting additional fee-funded faculty positions.



3.3 Private Funds Development

In addition to the external grant funding discussed above, Computer Engineering faculty have been successful in obtaining approximately $100,000 per year in external research gift funds, and $50,000 in other forms of external income, such as copyright and patent licensing. We look forward to increases in these numbers as we grow.

In an effort to increase alumni participation in and awareness of our programs, the Department sent a letter discussing many of the exciting changes in the School and Department to undergraduate and graduate alumni. We expect this to become an annual writing to alumni, and hope that it will assist our private funds development.

Most obviously, it is critical for the School and the Department to have professional development staff and professional industrial relations staff. As the department grows, we expect to incorporate external communications as part of a departmental staff position.

Part IV Summary

As we look forward to the next decade, Computer Engineering continues to see a vast potential for continuing positive impact on the curricular, research, and service programs of the department, School of Engineering, Campus, and University. In curriculum, we see leading or collaborative roles for CE in bioinformatics, biomolecular engineering, distance learning, engineering ethics, engineering management, environmental engineering, the Silicon Valley Center, software and systems engineering, and state-supported summer session. In research, we intend to achieve continuing excellence in computer system design, design technologies, computer networks, digital media and education technology, software and systems engineering, and embedded and autonomous systems. In service, we will maintain our commitment to the department, School, Campus, and University as Computer Engineering faculty take part in the Academic

Senate and perform administrative functions within and beyond the School of Engineering.

Computer Science Department
Long Range Plan

December 10, 2001

1 Introduction

The Computer Science Department was established in 1968 with three faculty as the Board of Studies in Information and Computer Science. The department currently has 17 permanent faculty and offers the M.S. and Ph.D. in Computer Science, as well as three different Bachelor's degrees.

1.1 Mission

The mission of the Computer Science Department is to develop and sustain first-rate education and research programs in computer science and information technology that integrate the fundamental principles of science with the sound practice of engineering. The Computer Science Department contributes to the educational mission of the Baskin School of Engineering by offering several different degree programs in computer science and information technology that prepare our students for productive careers at industrial and academic settings. In addition, the Computer Science Department offers a wide range of general education courses aiming to expose all UCSC students to the main aspects of information technology. At the research level, the Computer Science Department carries out a substantial research program that focuses on selected key areas of computer science and strives for synergistic interaction with several other disciplines in science and engineering.

1.2 Areas of Excellence

In January 2001, Dean Kang asked the departments of the School of Engineering to identify areas in their discipline that they will designate as areas of excellence and targeted for development. The computer science faculty welcomed the opportunity to formulate and articulate their vision for the future of the department as the campus grows and reaches its long-range student enrollment limits. After considerable deliberation, the computer science faculty arrived at a consensus that the following five areas are the targeted areas of excellence of the Computer Science Department:

- Bioinformatics
- Software Engineering
- Information Technology Infrastructure: Storage Systems, Database systems, and Computer Security.
- Machine Learning.
- Visualization, Graphics, and Human-Computer Interface.

A report containing the justification and the vision for each proposed area was submitted to Dean Kang in February 2001. All five proposed areas were incorporated in the Executive Summary of the Long-Range Planning of the School of Engineering, which was submitted to CPEVC Simpson on March 15, 2001. In Section 5 we present plans for achieving excellence in each of these areas.

2 Workload Projections

The Computer Science (CS) undergraduate programs (including Information Systems Management, ISM) have been a source of truly phenomenal growth over the past decade. CS undergraduate enrollments at UCSC have almost *doubled* from the 1995-96 to the 1999-00 school years. In 1999 the School of Engineering projected that CS would take five years for its undergraduate workload (not counting ISM courses) to grow from its 1998-99 level of 302 FTE to 402 FTE in 2003-2004. In just two years the CS workload (again, not counting ISM) has already grown to 395 FTE. The November 1998 Engineering School Intermediate Range Academic Plan projects 320 majors in the CS BA/BS degrees in 2005-2006, however in 1999-2000 we *already* had 426 majors (133% of our projected numbers five years from now).

Rather than improving, the workload situation for CS has continued to worsen. A message from the School of Engineering undergraduate office dated October 24, 2001 indicates that of the 1163 undergrads in the SoE, 635 are CS majors and pre-majors while another 157 are in the ISM program. These 792 students advised by the CS department are more than 46.5 students per ladder-rank faculty, about 2.5 times the campus average. We are working with the School of Engineering on several ways to address this problem.

Although most of this enrollment and advising pressure is due to the core CS programs, student interest in the ISM has also grown dramatically, and that program is also ahead of its aggressive headcount projections. We first discuss our workload projections for the CS courses, and then discuss the additional workload from the ISM courses offered through the CS department. The planned Information Systems/Technology Management (ISTM) department is expected to take over this workload. However, if that initiative is delayed, then the CS department will need the indicated faculty resources to continue the ISM program.

Computer Science is currently the 3rd most popular major for both incoming freshmen and for transfer students. This demand for computer science courses is not unique to UCSC, at virtually every other UC campus[1] the Computer Science program is impacted and rigorous screening procedures are used to select those students allowed into the major. Computer Science is a very popular major nationally, and it is clear that the UC system does not have sufficient capacity for the current demand. The increasing prevalence of information technology in everyday life will continue to make computer science an extremely popular major in the coming decades.

Our main lower division programming sequence (CMPS 12a, 12b) is required for all majors in the School of Engineering, and are required or options in other majors like Chemistry and Business Management Economics. Several of our upper division courses are required by the Computer Engineering degree's various tracks. Therefore, as other science and engineering programs grow, so will the demand for Computer Science courses. Furthermore, we offer several computer instruction courses specifically targeted to the general student body. The enrollment in CS courses has grown by an average of 40.2 FTE/year since 1995.[2] Our annual growth rate has ranged up to 28.9%, a shocking increase for a mature program. We see no reason (given sufficient resources) for these growth rates to diminish. Projecting 40 new undergraduate student FTE/year corresponds to a 10.1% growth rate at the start of the period, but only a 5 to 6% growth rate at the end of decade, and so is a very conservative assumption.

When projecting the faculty growth for Computer Science, we are aware that CS must shoulder an additional burden until the school's relatively new Electrical Engineering and Applied Math and Statistics departments come up to speed and start carrying a full load. Therefore our planning include a *temporary* gap between our justified faculty (based on the campus standard 18.7-1 FTE ratio) and the projected faculty

[1] The procedures used at UC Riverside are not clear, but it appears that additional screening procedures are used there.
[2] See *Instructional Load Summary* produced by the UCSC Office of Planning and Budget, and *TA Allocation Scenarios* (for 2000-'01 numbers) produced by SOE.

numbers. This also has the effect of spreading out the CS recruitment, requiring several years for CS hiring to catch up to our enrollments. Of course, temporary academic staffing funds will be needed to cover this gap. The number of faculty positions subsidized by the CS departments teaching load is indicated at the bottom of page 5. Note that these numbers correspond to the ``Very Limited'' (VL) enrollment plan and the gaps between the justified and projected faculty counts are even larger for the ``Open'' and ``Limited'' enrollment projections.

The CS department is at a crossroads. If we continue with unrestricted growth in the CS majors then there is no reason to project that undergraduate enrollments will increase by less than 40 student FTE/year. Since our new ISM degree program is just coming on line, the rate of growth is more likely to increase than decrease, as ISM majors must take 7 CS courses (in addition to ISM, Economics, Computer Engineering, and Math courses). The core CS mission will require about four additional faculty FTE per year if this policy is maintained, resulting in a department of 52 to 55 faculty in 2010-2011 (see the table labeled ``Open'' on page 5).

On the other hand, the School of Engineering is proposing ways to control admission to the CS majors through a selection mechanism like that used at the other campuses. For example, UCSD has a two-phase freshman admissions process where applicants indicate what major they are interested in. First students are admitted to the campus, and then the School of Engineering selects a fraction (about 1/4 last year) of those interested in CS to be admitted to the major.
Although the others are admitted to the UCSD campus, they are unable to become CS majors. With such a selection mechanism we will gain some ability to manage our exploding enrollment numbers. If a suitable screening mechanism is enacted then we expect 40 FTE/year increase for two years until the mechanism is fully implemented followed by a more manageable 15 student FTE/year (or 2 to 3% relative growth) for the rest of the planning period. This slower growth rate will greatly help faculty and other resources catch up with student demand, but there will still be a significant period where temporary solutions will be required. See the table labeled ``Limited'' on page4)

In order to be effective, any selection mechanism must be tunable so that enrollments can be stabilized despite potential swings in demand. A stricter admissions standard to the CS majors and their associated upper division courses could further slow the demand for the core CS curriculum. This path poses some difficulties, as the registrar is currently unable to use performance in prerequisite classes as an enrollment filter. Assuming appropriate selection and enrollment mechanisms are immediately established, the growth in the core CS courses can slowed even further.
The figures in the table labeled ``Very Limited'' on page4 illustrates this option, with 37 faculty involved in core CS activities in 2010.

At the graduate level, our past enrollments have remained relatively steady at about 60 FTE (about 3.5 to 4 grads per faculty member). This changed dramatically in 2000-2001 and 2001-02 as we have successfully recruited large numbers of new graduate students. The slowdown in Silicon Valley is also excellent news for our graduate program, enabling us to take advantage of the many computer professionals now seeking advanced Computer Science degrees.
In addition, a project-track alternative has just been approved for our existing MS degree and we are planning a new masters (M.S.) degree in Software Engineering. Finally, our on-campus research projects, industrial opportunities, and growing undergraduate program have often made it difficult to find qualified TAs. Some CS faculty have commented that they are less inclined to pursue external funds because of the lack of graduate student researchers while others import graduate visitors from other institutions. Therefore we are not only capable of supporting additional graduate students, but feel that the growth of our graduate programs is essential to maintain the department's health. Whereas in the recent past our attention has been captured by the growth of the undergraduate programs, we must now streamline and expand our graduate

programs. We conservatively project a steady growth rate in graduate workload reaching 4 or 5 graduate FTE per faculty member in 2010-2011. The resulting numbers are reflected in the tables on page4. We would like to grow our graduate programs as rapidly as possible while maintaining quality, and hope that recent and planned high profile activities will help our graduate program grow even faster than these projections indicate. Note that we are actively pursuing a new self-supported Masters in Advanced Studies (MAS) degree program in Web and Internet Engineering that will be discussed later. As the MAS program is to be self-supporting, its workload is not counting in our core CS projections.

Oct. 21, 2001

Open	99--00	00--01	01--02	02--03	03--04	04--05	05--06	06--07	07--08	08--09	09--10	10--11
Ugrad FTE	337.1	403	445	487	527	567	607	647	687	727	767	807
grad FTE	58	80	95	110	125	140	155	170	180	190	200	210
Total FTE	395.1	483	540	597	652	707	762	817	867	917	967	1017
FTE ratio	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
Justified Fac	21.1	25.8	28.9	31.9	34.9	37.8	40.7	43.7	46.4	49	51.7	54.4
Projected Fac	15	17	17	23	27	31	35	39	43	46	49	52
New hires	2	net 0	6	4	4	4	4	4	3	3	3	

Limited	99--00	00--01	01--02	02--03	03--04	04--05	05--06	06--07	07--08	08--09	09--10	10--11
Ugrad FTE	337.1	403	445	487	502	517	532	547	562	577	592	607
grad FTE	58	80	90	100	110	120	130	140	150	160	170	180
Total FTE	395.1	483	535	587	612	637	662	687	712	737	762	787
FTE ratio	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
Justified Fac	21.1	25.8	28.6	31.4	32.7	34.1	35.4	36.7	38.1	39.4	40.7	42.1
Projected Fac	15	17	17	23	26	29	31	33	35	37	39	41
New hires	2	net 0	6	3	3	2	2	2	2	2	2	

Very Limited	99--00	00--01	01--02	02--03	03--04	04--05	05--06	06--07	07--08	08--09	09--10	10--11
Ugrad FTE	337.1	403	445	487	480	485	490	495	500	505	510	515
grad FTE	58	80	90	100	110	120	130	140	150	160	170	180
Total FTE	395.1	483	535	587	590	605	620	635	650	665	680	695
FTE ratio	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
Justified Fac	21.1	25.8	28.6	31.4	31.6	32.4	33.2	34	34.8	35.6	36.4	37.2
Projected Fac	15	17	17	23	26	29	31	33	34	35	36	37
New hires	2	net 0	6	3	3	2	2	1	1	1	1	

ISM	99--00	00--01	01--02	02--03	03--04	04--05	05--06	06--07	07--08	08--09	09--10	10--11
Ugrad FTE (3/4)	18	24	30	36	42	48	54	60	66	72	78	84
FTE ratio	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
Justified Fac	1	1.3	1.6	1.9	2.2	2.6	2.9	3.2	3.5	3.9	4.2	4.5
Projected Fac	0	0	0	1	1	2	2	2	3	3	4	4
New hires	0	0	1	0	1	0	0	1	0	1	0	
Pos. Subsidized (VL)	7.1	10.1	13.2	9.3	6.8	4	3.1	2.2	1.3	1.5	0.6	0.7

The undergraduate and graduate workload numbers are combined for the various scenarios in the tables on page 5, together with the justified number of faculty based on current campus workload ratio of 18.7:1. Note that Campus Provost John Simpson has proposed a reduced 17.9:1 ratio and the ratio in engineering schools is typically even lower, so the faculty numbers justified in the tables should be treated as conservative minimums.

In addition to the core CS workload, the CS department currently administers the ISM major. This major is sponsored jointly by the CS and Economics departments, and requires four special ISM classes currently taught by CS faculty and lecturers. One of these classes has a high CS content, and there is a proposal to move it into the core CS curriculum. The other two courses, however, are more appropriately taught from a management perspective. We have projected the workload for three ISM courses not likely to be integrated into the CS curriculum separately in the table labeled ``ISM'' on page 5. The School of Engineering is proposing a new ISTM department that will be a better fit for these management courses. As CS is currently covering the ISM courses as well as administering the ISM program, it will need resources generated from these enrollments if the new department is delayed. These additional positions appear in an appendix to the hiring plan. If the ISTM initiative is postponed, we intend to us the additional positions associated with the ISM workload to hire faculty capable of teaching the ISM courses (like Software Engineering and Systems faculty) and temporary funds to hire lecturers and visiting/adjunct faculty to cover the more management oriented courses.

3 Programmatic Directions

3.1 Degree Programs

At present, the Computer Science Department offers three different undergraduate degree programs (B.S. in Computer Science, B.A. in Computer Science, B.S. in Information Systems Management), as well as a minor in Computer Science. At the graduate level we offer the M.S. in Computer Science with two different tracks (thesis track and project track) and the Ph.D. in Computer Science.

The Computer Science Department intends to put in place new degree programs in Software Engineering and also to explore the possible development of Master of Advanced Studies (M.A.S.) degree programs in selected specialized areas of computer science and information technology. In addition, it will pursue the development of joint degree programs with the Departments of Applied Mathematics and Statistics.

3.2 Existing Undergraduate Programs

The three undergraduate degrees currently offered by the Computer Science all have different aspects, as described below.

The B.A. in Computer Science is flexible program designed to allow students time to explore interests beyond the School of Engineering. This program is popular with students interested in breadth of education or pursuing a double major. Students in this major take a required core plus one of four depth sequences and a number of electives. Additional depth sequences being considered include Computer Graphics and Software Engineering.

The B.S. in Computer Science program was designed in 1995. It gives students more exposure to the central aspects of Computer Science, increasing their preparation for graduate studies or industry. Its structured nature makes it a natural candidate for accreditation, which the CS department plans to pursue in conjunction with Computer Engineering's accreditation renewal in 2003.

The B.S. in Information Systems Management was recently established (1999) and is a truly interdisciplinary degree. This program teaches students about the collection, manipulation, storage, distribution, and utilization of information in support of a business or public sector institution. Although managed by Computer Science, this program also has strong support in the Economics department and requires courses from four different departments in three different divisions (Math, Economics, Computer Science, and Computer Engineering) as well as four special ISM courses taught through the CS department.

3.3 Software Engineering Degree Programs

- M.S. in Software Engineering

  The development of a M.S. in Software Engineering is an item of top priority for the Computer Science Department. We envision the development of a proposal during the academic year 2001-02, campus and systemwide review during 2002-03, and establishment of the program in the fall of 2003. However this timetable may be delayed to allow input from the lead Software Engineering faculty expected to be hired this year.

  Although this degree program will originate on the Santa Cruz campus, we expect that it would also allow for distance delivery to the Santa Clara area, and could be part of the Computer Science Department's participation in the Silicon Valley Center.

- B.S. and Ph.D. in Software Engineering.

  The Computer Science Department will carefully evaluate the potential benefit of developing a separate B.S. degree program and a separate Ph.D. degree program in Software Engineering, or if minor modifications of current Computer Science programs can adequately serve these needs.

- M.A.S. in Web and Internet Engineering
  During the academic year 2000-01, the Computer Science Department submitted a proposal for a planning grant to develop a full proposal for a M.A.S. degree program in Web and Internet Engineering. This proposal has been approved by UCOP, and the development of the full proposal, which must include a feasibility study, will take place during 2001-02. This degree program is intended to be self-supporting and is to be originated at the Silicon Valley Center with distance delivery to the Santa Cruz campus. We expect that Computer Engineering's experience with their MSNE program will help us plan and implement this program.

3.4 Joint Degree Programs with Applied Mathematics and Statistics

The Computer Science Department intends to cultivate and maintain close ties with the Applied Mathematics and Statistics Department. We envision a productive collaboration both in research and in the development of joint degree programs between the two departments. Typical programs offered in other institutions (e.g., Rice University) in which an Applied Mathematics Department exists in the School of Engineering are M.S. in Computational Science and Engineering, and M.S. in Computational and Applied Mathematics.

3.5 Other M.A.S. Degree Programs

As the plans for the Silicon Valley Center take shape and a site becomes available for instruction, the Computer Science Department envisions the potential for Master of Advanced Studies degree programs for computer professionals wishing to acquire expertise in specialized areas of computer science and information technology. These areas may include:

- Computer Security
- Data Mining
- Software Reuse
- Human-Computer Interaction, Virtual Reality, and Digital Media.
- Information and Technology Management

4 Changes in Curricular Offerings

The Computer Science Department plans to implement a major expansion of both its graduate and undergraduate course offerings. The department also aspires to play a key role in transforming Crown College and/or developing Colleges Eleven & Twelve as colleges with an information technology theme.

4.1 Graduate Curricular Changes

In order to cope with the staggering increase in undergraduate enrollments and number of CS/ISM majors, in recent years the Computer Science Department has substantially increased the number of offerings of essentially all its undergraduate courses required for the B.S. or the B.A. in Computer Science, and the B.S. in Information Systems Management. This, however, has hindered the further development of the graduate curriculum in a systematic way. The time has now come for the Computer Science Department to embark on a major overhaul of its graduate course offerings. This will entail a revision of the breadth and depth requirements for the M.S. and the Ph.D. degree programs, and the introduction of new graduate courses in several key areas, including computer systems, storage systems, computer security, and software engineering. In addition, we envision the development of a course on graduate-level technical writing and presentation skills, which will be required of all students in the Ph.D. in Computer Science and the M.S. in Software Engineering degree programs.

The CS faculty are interested in collaborating with faculty from other departments and divisions in offering innovative graduate courses. One example is the interdisciplinary course being co-taught by Manfred Warmuth Winter 2001.

4.2 Undergraduate Curricular Changes

The Computer Science Department plans to introduce several new upper-division undergraduate courses to enhance its offerings in the Computer Science and the Information Systems Management degree programs. Our plans include the following new course development efforts.

- Develop alternative versions of the three upper-division CS courses required for the B.S. in Information Systems Management (ISM) degree that are specifically tailored to that program's students. This means that the CMPS 101 (Abstract Data Types), CMPS 115 (Software Methodology), and CMPS 180 (Database Systems) requirements for the ISM degree will be replaced by the new courses ISM 101, ISM 115, and ISM 180. Developing these courses may only be feasible if the positions generated by ISM workload (see tables on page 5) are added to the CS recruitment plan.

- Develop a new depth sequence in software engineering, which will be added to the depth sequences for the B.A. in Computer Science degree program. In addition, this sequence could form the core for a new B.S. in Software Engineering degree program.

- Develop new advanced upper-division courses to enhance the curricular offerings and to enrich the list of elective courses. As additional faculty are hired, courses in their specialties will be added to the following lists.

  - Second Term of Existing Courses
    Software Methodology II, Database Systems II, Artificial Intelligence II, Comparative Programming Languages II (Principles of Programming Languages)

  - New Courses
    Computer Animation and Visualization, Human-Computer Interaction, Systems Programming, Real-Time Systems, Storage Systems, Computer Security, Applied Logic and Formal Methods, Automated Reasoning & Verification, Computer Security

- Develop honors versions of existing courses. Our increased enrollments have required that we offer most of our courses multiple times during the academic year. One way to increase the prestige of the campus and the department would be to give one offering of each core course an "honors" designation. These "honors" offerings would offer more challenging assignments and perhaps more detailed coverage of certain topics. Giving our best applicants admission to the CS honors program would also be a valuable recruiting tool.

In addition to expanding our course offerings, we are continuing to search for better ways of presenting the core computer science material. One recent success has been Charlie McDowell's use of ``pair programming'' in the introductory programming course (CMPS 12a). We are also cooperating with Linguistics on a new computational linguistics series.

4.3 Colleges and General Education

On several occasions in the past two years, the Computer Science Department advocated an enhanced interaction between the School of Engineering and the Colleges. To this effect, the Computer Science Department suggested an information technology theme for one of the new Colleges. Recently, we were pleased to learn that a faculty member of the School of Engineering has been selected as the next Provost of Crown College. We look forward to the opportunity to work with the new Provost of Crown College. Several computer science faculty have expressed interest in contributing towards a revision of Crown College's core course, as well as in offering freshman seminars on information technology topics.

In addition, the Computer Science Department plans to develop new general education courses, such as Introduction to Virtual Reality, and Computer Ethics and Social Responsibility. Jane Wilhelms is working on a version of our computer graphics designed to be accessible to students studying the arts and digital media.

5 Initiatives

5.1 Bioinformatics

Undoubtedly, Bioinformatics is *already* an area of excellence of the Computer Science Department, the School of Engineering, and UCSC as a whole. Under the leadership of Professor David Haussler, the Bioinformatics Group has received national and international recognition at the highest levels of academia, government, and industry for its pioneering work and its crucial contributions to the human genome project. Consequently, the question about Bioinformatics at UCSC is not whether it should be an area of excellence, but what should be done to ensure that bioinformatics at UCSC retains its preeminent status in the post-genomic era.

As in the past, the Computer Science Department will continue to advocate and support the development of bioinformatics at UCSC. At the same time, we are well aware that the long-range plans of the School of Engineering include the establishment of a separate Bioengineering Department. Moreover, both the recruitment of bioengineering faculty and the development of graduate programs in bioinformatics/bioengineering are well under way. For these reasons, our long-range plan will not address the bioinformatics area in terms of faculty recruitment and degree programs. Until the new Bioengineering Department is in place, however, we will do our best to help in any way possible. This includes hosting bioinformatics faculty in the Computer Science Department with the understanding that at the appropriate time they will transfer to the Bioengineering Department and they will not count against the overall recruitment plan of the Computer Science Department

5.2 Software Engineering

Software Engineering represents one of the major programmatic initiatives of the School of Engineering; as such, it should be designated as an area of excellence of the Computer Science Department and the School of Engineering as a whole. The Computer Science Department stands ready to take the lead and successfully develop software engineering at UCSC. Dean Kang has indicated that the software engineering program should be mainly carried out of the Computer Science Department with the majority of software engineering faculty appointed at the Computer Science Department. We see an opportunity for UCSC to achieve national eminence in this area by hiring outstanding software engineering faculty, developing first-rate graduate programs, and establishing a high-profile research and educational presence at the Silicon Valley Center.

5.3 Information Technology Infrastructure

During the past decade, a "paradigm shift" has occurred in computer science. Indeed, the advent of the web and the explosion of the Internet has been the catalyst for fundamental changes and the emergence of new areas of research activity. While during the 1980s much emphasis was placed on high performance computing, during the past decade the emphasis has shifted to what could be described as *information technology infrastructure*. This encompasses the storage, maintenance, manipulation, transmission, and retrieval of information in an efficient and secure way. In this endeavor, several established areas of computer science, including programming languages, operating systems, distributed systems, relational database systems, and networks, play a significant role and contribute to new applications in a synergistic way. In addition, several other areas have emerged as new areas of growing importance; these include storage systems, heterogeneous databases, data mining, and computer security.

We envision Information Technology Infrastructure as an area of excellence of the Computer Science Department with particular focus on

- Storage Systems.

- Database Systems with emphasis on distributed databases, heterogeneous databases, and data mining.

- Computer Security.

Moreover, we view

- Networks and Wireless Communication

as an integral part of information technology infrastructure and believe that the strong presence of networks research in Computer Engineering will contribute to the successful development of information technology infrastructure as an area of excellence at UCSC.

Traditionally, the top four universities in database research have been UC Berkeley, Stanford University, University of Wisconsin, and University of Maryland. At present, UC Berkeley is restoring its eminence after the departure of Michael Stonebraker and his group in the mid 1990s. In recent years, both Wisconsin and Maryland have lost several prominent database systems faculty to other universities (CMU and UC Berkeley) and to industrial research labs (IBM Research). Also in recent years, the University of Washington is making an effort to establish itself as a top database research university through the aggressive hiring of outstanding database systems faculty. These universities, however, do not have significant presence in storage systems.

For the past few years, the Computer Science Department has been building a first-rate group in the storage systems area. Moreover, the department has strengths in the area of database theory. By hiring outstanding faculty in database systems, the Computer Science Department of UCSC will have an unusual opportunity to distinguish itself as one of the very few, if not the only, computer science department in the country that combines excellence in both storage systems and database systems. Moreover, augmenting this group with first-rate faculty in computer security will make it possible for UCSC to achieve excellence in the entire spectrum of areas encompassing information technology infrastructure.

Our current storage systems group is very strong, one of the strongest in the nation. With the recent departures from CMU, we have a real opportunity to become the best in the nation in this area. We note that Professor Long is the founding chair of FAST (File and Storage Technology) which is the preeminent conference in the field.

We envision synergy and interaction with the Bioinformatics Group, which is interested in both genomic databases and data mining of genomic data. We also believe that targeting this area of research will make it possible to establish strong ties with the database industry, which maintains a conspicuous presence in the region with companies such as ORACLE, SYBASE, and INFORMIX, and premier industrial research labs such as IBM Almaden. The same holds true for the expanding biotech industry of the region. Finally, we envision that several faculty in these areas of research could be headquartered in the Silicon Valley Center, where they will be better situated to take advantage of the proximity to the industry.

5.4 Machine Learning

Note: This section was written by Professors David Helmbold and Manfred Warmuth.

Machine Learning is an inherently interdisciplinary area that draws from computer science, statistics, and optimization theory. This area has traditionally been a strength of the Computer Science Department of UCSC. Our group has been one of the leaders developing the theoretical underpinnings of some of the most successful machine learning algorithms, such as Boosting, On-line Learning Algorithms, Multiplicative Update Algorithms, and Support Vector Machines.

Background:

Manfred Warmuth started working in Machine Learning in the late 80's motivated by his research connections with David Haussler who was at the University of Denver at the time. The only person we hired in this area was David Haussler. David Helmbold joined our faculty later with a background in Scheduling Theory and Parallel Computation, but became interested in Machine Learning after his arrival.

The specialty of our group has been Computational Learning Theory. The main international conference in this area is the annual COLT conference that was hosted by the Santa Cruz group five times since 1989. All three of us have served on COLT' s steering committee, as program chairmen, and as conference organizers. In addition to the COLT conference, several workshops have been held in Santa Cruz, such as a workshop on Sequence Prediction that reached out to researchers in Game Theory. Recently, David Haussler has focused on applying his expertise in Machine Learning to Bioinformatics. David Helmbold and Manfred Warmuth have continued their fundamental work on learning algorithms.

There are only very few groups in Computational Learning Theory with a comparable international reputation: Carnegie Mellon, MIT, AT&T labs, Royal Holloway in London, the Hebrew University in Jerusalem, and the Australian National University in Canberra. Some evidence of our current reputation comes from the large number of international scholars who make extended visits to our research group using their own funding.

Future of Machine Learning:

Machine learning techniques become even more essential as the amount of available data increases. Data mining and bioinformatics are two important application areas where machine learning techniques are required to deal with massive data sets. Other areas include character recognition, brain interfaces, text classification, and speech recognition. Any system that intelligently adapts its behavior to the current environment can outperform static systems. For example, David Helmbold and Darrell Long demonstrated the effectiveness of our on-line learning algorithms for predicting when to power down the disk in a laptop. Learning methods have the potential to improve everything from file systems to carburetors. Many of the recent practical successes in Machine Learning are essentially a transfer of theoretical results into applications, and several startups (such as WizBang! Labs in Pittsburgh and Peakstone in Sunnyvale) are exploiting this transfer from theory to practice.

Synergy:

Strengthening the Machine Learning group at UCSC makes sense because of the synergy between Machine Learning and the areas of Artificial Intelligence (Bob Levinson's work), Bioinformatics, Bayesian Statistics (AMS department), and the storage technologies focus area.

Strategy:

The visibility of our research group in Computational Learning Theory and the synergy with other efforts in the School of Engineering will allow us to attract the *best* people in the world.

We should first hire a senior star showing that we are serious about strengthening our group. People who have gathered valuable skills in industry might now want to return to academia while keeping their industrial connections. After that we should hire two (or more) junior people with expertise in particular application areas.

Not only will the use of cutting edge technology enable us to advance the state of the art in the targeted application areas, but the best theory is often motivated by practical concerns. We should also explore the possibility of creating soft money positions.

The COLT community is part of a wider Machine Learning community based on the ICML, UAI, and NIPS conferences. Although we are well known in this wider community, our goal is to make Santa Cruz one of the premier places. Our main competitors in this respect are Stanford, CMU, MIT, AT&T Labs, and Berkeley.

A number of other academic institutions are trying to do the same thing. UC San Diego is recruiting for several positions and the group in Canberra just announced four new positions in areas related to Machine Learning. Our existing strength and the synergy with other foci in our school give Santa Cruz a unique opportunity to expand its reputation in the wider area of Machine Learning.

5.5 Visualization, Graphics, and Human-Computer Interaction

Note: This section was written by Professors Suresh Lodha, Alex Pang and Jane Wilhelms.

The advent of the web and the explosion of the Internet are changing the way people live, use their senses, communicate and learn. The emphasis on high performance computing in 1980s have led to explosion of data, while our ability to cope up and understand this data has lagged behind. It is important to harness and interact with this data or information in meaningful ways in order to support scientific endeavor on one hand and provide universal access on the other.

Visualization has emerged as one of the most important ways to assimilate data or information that has traditionally been presented in the textual or tabular form. The importance of utilizing other senses such as sound, gesture, pose, haptics and smell, in order to create a compelling scenario for learning, exploring, and discovery has given rise to fervent research activities in the area of virtual reality interfaces. Concomitant is the need to replace the familiar keyboard and mouse interface with something immediate and personal through design and development of transparent user interfaces that have the potential to provide universal access to all of us -- rich and poor, men and women, young and old, people with disabilities and those engaged in other activities. Communities are being built over large distances that desire to collaborate and share. Individuals and corporations are struggling to deliver the information in effective ways to capture users' attentions by learning to master the digital media in effective ways. Confluence of these challenges need to be met by research activities in the area of visualization, graphics, human-computer interaction, collaborative and distance learning, user interfaces and digital media.

In order for this vision to take shape, some of the key components needed are top quality research, collaboration and synergy within and across disciplines, and availability of a large showcase facility that encompasses virtual reality gadgets. UCSC currently offers top quality research in the areas of visualization and graphics. The faculty also have an excellent track record of collaboration across disciplines including physicists, astronomers, bioinformatics researchers, meteorologists, oceanographers, cognitive psychologists, and musicians. UCSC as a campus also offers an unparalleled potential for collaborative research across disciplines. UCSC also brings a unique strength of having close working ties with several agencies within the Silicon Valley. The most prominent collaboration perhaps is with NASA Ames Research Center, which has generously funded the research of graphics faculty for many years resulting in several joint publications, seminars and exchanges. Other noteworthy collaborations include Lawrence Livermore National Laboratory and Silicon Graphics. The graphics group also has worked with other groups within the department -- with the bioinformatics group and with the systems group -- for visualizing protein alignment data and real time environmental data. It is noteworthy that the UCSC is one of the leading institutions in the area of graphics and visualization within the UC system in spite of the presence of such "heavyweights" as Berkeley, Los Angeles, and San Diego. What is needed to put the UCSC in the leadership role in this field is the synergy within the subareas -- from graphics and visualization onto human-computer interface, virtual reality and digital media. This need for synergistic collaboration has emerged so recently that the other institutions have hardly had the time to catch up with this emerging need. Hiring two or three top-notch researchers in these areas, some with Silicon Valley connection, will propel UCSC to the national front in the area of graphics and visualization. Concomitant with this is the need to allocate large physical space to allow the development and acquisition of a showcase facility with large displays and virtual reality multi-modal gadgets to explore and demonstrate human-computer interaction and collaborative learning in reality. Availability of such a facility is one of the most important factors in building the reputation in this field and attracting top-notch researchers.

In summary, the area of visualization, graphics and human-computer interaction is poised to capture the national attention as one of the most promising research area within the computer science. UCSC can build on its great strength, track record, and potential for top quality research in this field and synergistic collaboration with scientists, social scientists, and artists. Addition of a few top notch scientists in the subareas of human-computer interaction and virtual reality along with the availability of a top-notch display showcase/virtual reality lab, UCSC is poised to be a national leader in this field.

5.6 Machine Vision

Another area where we may be able to quickly achieve national stature is in the area of Machine Vision. This area is a natural area of opportunity for us due to the synergy with the Machine Learning, Graphics, and image processing groups already here.

5.7 Participation in Silicon Valley Center

As indicated above, the Computer Science Department plans to actively participate in the Silicon Valley Center operation at both the educational and the research level.

At the educational level, we envision that the M.A.S. in Web and Internet Engineering degree program will originate in the Silicon Valley Center. The same holds true for other M.A.S. degree programs that the Computer Science Department may put in place in the future, as stated earlier. In addition, parts of the M.S. in Software Engineering degree program may be offered through the Silicon Valley Center, even though the program itself will originate at the Santa Cruz campus.

At the research level, we envision that faculty in database systems, computer security, and human-computer interaction may be headquartered in the Silicon Valley Center, assuming appropriate office and laboratory space becomes available.

5.8 Participation in Year-Round Operation

Year-round operation poses significant challenges for the Computer Science Department. The first challenge is pedagogical, namely we firmly believe that most of our required-for-the-major courses cannot be taught effectively in a five-week session. The second challenge has to do with the availability of regular faculty to teach over the summer, given that the great majority of the computer science faculty have extramural summer support and that many major computer science conferences in which our faculty present papers take place over the summer. Another challenge is the availability of adequate instructional support over the summer, including Teaching Assistants, readers, and laboratory facilities. Note that many of our graduate students have GSR's or go to industry over the summer, so attracting adequate TA support will be an additional challenge.

For the first few years, we believe that we can offer the key lower-division courses CMPS 12A and CMPS 12B over the summer using our dedicated Lecturers, provided there is a satisfactory resolution of the issue of the length of the summer session and also adequate levels of compensation and instructional support are secured. In addition, we could employ Lecturers to teach general education courses, such as CMPS 2, CMPS 10, CMPS 60N or CMPS 60G. Another possibility would be to offer a summer "bridge" course designed to solidify the preparation of transfer students for our upper division courses. It may be appropriate to offer such a course at the Silicon Valley Center.

6 Faculty Recruitment Plan

During the academic year 2000-01, the Computer Science Department had 17 ladder-rank faculty. In addition, as a result of the 1999-00 search, an appointment for a senior software engineering faculty member has been under consideration. During the academic year 2000-01, the Computer Science Department contacted searches for one Assistant Professor position in computer systems, one Assistant Professor and one Associate Professor position in database systems, and one Assistant Professor in software engineering. None of these searches resulted to a recruitment this year and so these searches will be repeated in 2001-02. This gives a total of 22 faculty positions currently allocated to the Computer Science Department.
In addition, the Computer Science Department participated in a joint search with the Computer Engineering Department for an Associate Professor position in software engineering.

We envision a total of 40 computer science faculty at the time the campus enrollments reach their long-range limit in 2010. This number includes 6 faculty hired as part of the Software Engineering program and 4 faculty hired as part of the Information Systems Management program. To this effect, we note that existing plans for the School of Engineering forecasting 110 faculty in 2010 allocate 8 faculty to the Software Engineering program, 4 faculty to ISM, and 27 faculty to Computer Science proper. Thus, the projected total of 40 computer science faculty is entirely consistent with the above and the enhanced plan to have between 125 and 140 faculty in the School of Engineering in 2010-11.

6.1 Hiring Plan by Area

We plan to hire faculty whose research expertise will fit in one or more of the targeted areas of excellence of the Computer Science Department, as described in Section 1.2. In addition, we plan to hire 2 or 3 faculty in key areas of theoretical computer science, such as algorithms, computational complexity, principles of programming languages, and/or cryptography. To this effect, we note that at this point of time the current group of 2 faculty in theoretical computer science (plus 2 in Machine Learning) cannot adequately cover the key theory courses that are an integral part of the undergraduate curriculum (CMPS 101, CMPS 102, CMPS 130, CMPS 132) and the core graduate curriculum (CMPS 201, CMPS 210). Indeed, the increase in enrollments has necessitated offering most of these courses several times each year; moreover, the faculty who can teach these courses are also called to teach graduate courses on other topics, such as combinatorial algorithms, machine learning, neural computation, and logic in computer science. We also note that no faculty in theoretical computer science has been hired since 1988, so there is a sense of urgency in providing continuation and renewal in this fundamental area. Finally, our plan preserves the option of hiring two or three faculty positions in some other established or emerging areas of computer science research.

In the extremely competitive Computer Science marketplace, each year we must have the flexibility to consider reordering our hiring if another focus area has a significantly stronger applicant pool. We are running a pilot recruitment on that model this year. Not only do our requested positions often have more than one alternative area associated with them, but also request the flexibility to swap the order of areas in order to go after the strongest candidates available.

The ``Very Limited'' projections require hiring 20 new faculty based on the core CS enrollment plus 3 new faculty based on the enrollments in the ISM courses. Our current plan is to hire the following numbers in the various areas.

- Information Technology Infrastructure: 9 new faculty in three subareas.
  - Database systems and database mining: 3 new hires, including senior lead to be hired in current search
  - Computer Security - 2 new faculty
  - Operating Systems, Storage Systems and Compilers - 4 new hires.

- Software Engineering: 4 new hires, including a senior lead in the current search.

- Machine Learning: 2-3 new hires.

- Graphics, Visualization, Human Computer Interaction, and Vision: 3 new faculty

- Algorithms and Theoretical Computer Science: 2-3 new hires

- Information Systems Management: 1 senior position to lead the ISM program. It is expected that this person's research will fit with one of the other targeted areas.

There is some overlap between the Machine Learning and the Algorithms and Theoretical Computer Science areas, we plan for each area to hire two new faculty, with a fifth hire expected to fit into either the two areas.

Note that this hiring plan assumes the ``Very Limited'' enrollment scenario where demand for courses required by the major is immediately controlled by an appropriate selectivity mechanism. If the ``Limited'' or ``Open'' scenario is chosen, then our hiring plans can be advanced. This advancement will allow the outlined research clusters to be completed before 2010 and provide additional positions to reinforce the existing clusters and/or target additional areas. The increased instructional load is certain to require additional positions in the Algorithms/Theory and the Operating Systems/Compilers areas. Reaching 5 faculty members in each critical area would indicate hiring additional candidates in the Databases, Security, and Machine Learning (or Theory) areas. However, Computer Science is still a rapidly developing discipline and in six or seven years we will have a much better prospective to evaluate where those additional positions can best be applied.

6.2 Distribution of Faculty by Area around 2010

The hiring plan for the ``Very Limited'' scenario will help organize the department's research foci into clusters of 3 to 6 faculty. Groups of this size doing closely related work will simplify the advising and training of Ph.D. students as well as facilitating high quality research programs. Furthermore, such clusters will make it easier to attract large research grants and contracts than individual faculty working alone. In addition to the collaboration within clusters we expect synergy between clusters and with the other departments in the School of Engineering and across the campus.

In 2010, the ``Very Limited'' plan will give us a department looking something like the following:

- Information Technology Infrastructure
  - Database Systems and Data mining (3): One senior lead to be hired in current search, plus 2 other new hires.
  - Computer Security (3): Martin Abadi as senior lead, plus 2 new hires.
  - Storage Systems, Operating Systems, Compilers (7): 3 current faculty led by Long (Long, Miller, Brandt) with 4 additional faculty to be hired. Additional contributions can be made from McDowell and Pohl. This area tends to involve very large projects, so a larger than usual cluster is warranted.
  - Networks (+5): The fourth part of the Information Technology Infrastructure is a focus area of the Computer Engineering Department, and they currently have three faculty in this area (Garcia-Luna, Varma, Obraczka) and plan on hiring two more.

- Software Engineering (5+1): One current junior faculty (Whitehead) plus de Alfaro in Computer Engineering. Plan to hire a senior lead in current search plus 3 other new hires.

- Machine Learning (4 to 5): 2 current senior faculty (Warmuth, Helmbold) with plans to hire 2 to 3 additional faculty.

- Graphics, Visualization, Human Computer Interaction (6+1): 3 current Professor/Associate Professors (Wilhelms, Pang, Lodha) plus Assistant Professor Tao in Computer Engineering. Plan to hire 3 new faculty.

- Algorithms and Theoretical Computer Science: (4 to 5+1): Two current senior faculty (Kolaitis and Van Gelder) as well as Professor Schlag in Computer Engineering. Plan to hire 2 to 3 new faculty, and new hires in Machine Learning and Security may assist in covering this fundamental area.

- Other areas (artificial intelligence, experimental computer science, programming languages) (3 to 5): 3 faculty currently (Pohl, McDowell, Levinson), with plans to hire 0 to 2.

- Bioinformatics, Information Theory (2). We have two senior faculty (Haussler and Tanner) in these areas of interest to the planned Biomolecular Engineering and the Electrical Engineering departments respectively.

It must be emphasized that the preceding area breakdown was based on the ``Very Limited'' enrollment projections which require a highly selective process controlling admission to the upper division program. With the less stringent ``Limited'' projections, we envision the department having 44 faculty (including 3 from ISM workload) working in the following areas in 2010.

- Database Systems: 4-5

- Computer Security: 3-4

- Compilers, Operating/Storage Systems: 8-9

- Software Engineering: 6

- Machine Learning: 5

- Graphics, Visualization, Human-Computer Interaction: 7

• Algorithms and Theoretical Computer Science: 5-6

• Artificial Intelligence: 2-3

• Other Areas: 2 faculty

7 Research Funding, Development and External Relations

The Computer Science Department is obtaining increasing amounts of support from external sources. Although we feel that faculty should be evaluated based on the merits of their research rather than the number of dollars found, we realize that external funding drives opportunity funds that benefit the department, school, and campus. Although yearly award totals fluctuate wildly, the $3,932,819 brought in by CS faculty during in 2000-01 is a record high for the department. To illustrate to volatility of these numbers, the CS faculty brought in $1,184,985 during the previous 1999-2000 year and $2,908,546 in 1998-99.

Another measure of the departments upswing in external funding is the level of graduate student support. The following table indicates the number of student quarters funded by TA support, GSR support from faculty research accounts, and competitive Fellowships (from NSF, for example) awarded to our students.

	95-96	96-97	97-98	98-99	99-00	00-01	01-02
TAs	39	39	39	51	56	61	68
Fac.GSRs	49	51	57	84	79	80	109
Fellowships	NA	NA	NA	NA	10	15	20

Table 4: Quarters of graduate student support by type and year. "Fac. GSRs" are GSRs supported from faculty research accounts, and the Fellowship number counts only competitive awards (I UCSC block funds).

The CS faculty (and Darrell Long in particular) are actively participating in Cal ISI CITRIS (Center for IT research in the Interest of Society). Although the call for faculty proposals has not yet been issued, we expect that many of the CS faculty will participate. This is a program that fits especially well with our Information Technology Infrastructure focus area.

Faculty of the Computer Science Department maintain close relationships with major research laboratories and high tech companies, including IBM Almaden Research Center, HP Labs, Bell Labs, Lawrence Livermore National Laboratory, NASA Ames Research Center, SRI International, Silicon Graphics, National Semiconductor Corporation, Los Alamos National Labs, Sandia National Labs, Storage Systems Research Center, Ricoh, and DuPont Pharmaceutical Laboratories. Other targeted companies include Microsoft, Oracle, and Agilent. As the Computer Science Department builds its areas of excellence, we expect the development of successful relationships with other high tech companies, especially with the major database companies in the greater Bay Area.

The Computer Science Department also wishes to establish closer contacts with its alumni and cultivate a long-term relationship with them. It is unfortunate that thus far the Development Office of the School of Engineering has not succeeded in putting in place a plan for developing and sustaining alumni relationships. We are prepared to work with the Development Office of the School of Engineering towards this goal. Moreover, we hope that the Development Office will provide more direct support in pursuing and sustaining external relations, instead of leaving it entirely to individual faculty members to establish these relations.

8 Facilities and Infrastructure

8.1 Undergraduate Instruction

Computer Science relies on the campus Communications and Telecommunications Services (CATS) to support its undergraduate instruction. The primary resources used by CS are the SPARC workstation lab in BE 105 and a PC lab in BE 109. All programming courses for the major schedule sections in these labs. In addition, CATS runs several smaller PC and Mac labs around campus that are often used to support CS courses for non-majors. There is often great contention for machines and section time in the 109/105 labs, and a second SPARC lab is needed to accommodate the anticipated enrollment growth. These labs are managed by the CATS whose main charter is to support general purpose and administrative computing as opposed to specialized instructional support. Any department is theoretically capable of scheduling sections in these labs, but recently their use has been dominated by CS (and CE to a lesser extent). We are finding it increasingly difficult to find suitable classrooms for our expanding enrollments. It appears that there is a general shortage of classroom space. This is particularly painful for us as the dramatic increase in enrollments often means that we are scheduled in classrooms with inadequate seats. For one course (ISM 150) being offered Fall '01 we have been trying to obtain a larger room since the beginning of June without success, and when a replacement was found across campus there were problems with the video system We need additional nearby classrooms with adequate video projection, multimedia, and networking capability. We understand that the campus is undergoing a severe space crunch, but the space shortage has a disproportionate effect on rapidly growing programs like Computer Science.

8.2 Research and Office Space

Currently the CS department has only limited space to house its lecturers and visitors. Last year many staff, lecturers, and visitors were relocated to provide office for the school's incoming faculty. Although we are able to provide small offices for our full time, long-term lecturers, we rely on shared space in half of a trailer to house the entire school's short-term visitors and lecturers. We estimate that CS is about 7 offices short, with additional offices required as additional faculty are hired.

We are also chronically short of space for graduate students. Although graduate students supported by research projects are usually housed in their employer's lab space, eight of the 17 CS faculty do not have available lab space as of this writing, although it should be noted that plans exist to provide lab space for half of these eight. The remainder of our graduate students (including those supported by TA-ships) share two general graduate rooms, and we are unable to allocate desks to many of the PhD students and TAs.

9 Budget Plan

10 Personnel Plan

Our Personnel plan requests startup packages in excess of $200,000 for our new faculty. We face tremendous competition for quality Computer Science faculty at all levels. Recent conversations with U.C.~Berkeley indicate that their startup packages for Assistant Professors are approximately $300,000, and U.C.~Santa Barbara indicated that their startup packages for Assistant Professors are in the $250,000 to $300,000 range. In order to be competitive with our sister institutions, we are asking for $230,000 from the school and central administration for our current recruitments, with a modest three-to-four percent increase each year. (Note: Information from other UC campuses is not yet available.)

We expect that candidates will spend their startup funds primarily on summer salary and graduate student support. This is especially needed for new junior faculty until they have a chance to obtain external funding. We ask a similar amount for senior faculty for planning purposes. Some senior faculty may come with existing funding and thus need less support while others who are currently in industry may require larger packages not only to get started, but also to help lure them away from the private sector and compete against other academic offers.

Two other problems have the potential to cripple our program. The first is the lack of quality affordable housing for junior faculty. The second is the failure of the engineering pay scale to keep pace with nationwide salaries in Computer Science. Last year, two of our graduates received entry-level offers of $80,000 from Johns Hopkins University. This is far more than we can offer our junior faculty, and dangerously close to the amount our associate professors earn with over a decade of academic experience

University of California
Santa Cruz

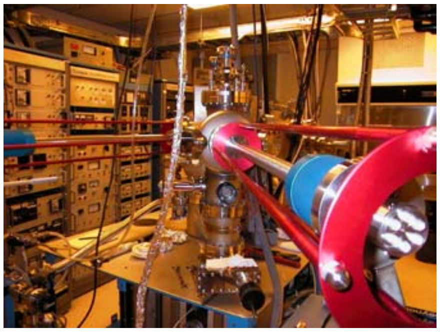
School of Engineering

Electrical Engineering

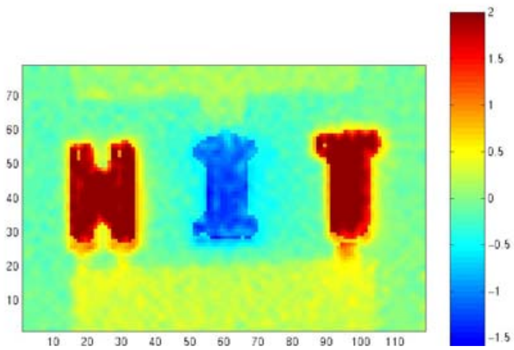
Strategic Plan

2001-11

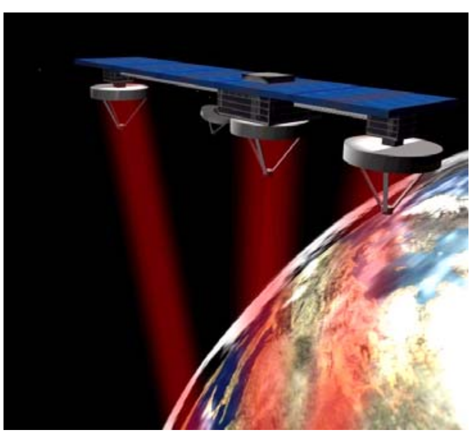
October 22, 2001



Molecular Beam Epitaxy
Machine fabricates micro
and nanostructures



Thermal image of
micro – refrigerator
and heaters on a chip



Student Team Design
for satellite producing
1 ft resolution Earth
images using
interferometric optics

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INTRODUCTION AND MISSION STATEMENT

The field of electrical engineering began with the earliest practical applications of electricity and magnetism of benefit to mankind. Outstanding contributions to the field were made by Gauss, Hertz, Ampere, Maxwell, Marconi, Edison, Steinmetz, Von Neumann, Bardeen, Shockley, Hewlett, Packard, Grove and others, many of whom once or presently work right here in Silicon Valley. From this beginning California as a whole has become the biggest high tech employer in the country during the past three decades, employing over 700,000 workers -- more than twice as many as the next closest state. The demand for high tech workers is so great that California is no longer able to educate all the engineers needed within the state -- with the greatest shortages in computer engineers, electrical engineers, systems analysts and computer programmers.

Nevertheless, UC education of engineers has remained flat at approximately 2,400 baccalaureates, 1,100 Masters and 470 Ph.D.'s annually. The California Legislature and industry are actively encouraging UC to enlarge its engineering programs in order to supply sufficient workers and retain high tech companies in California. Former Governor Pete Wilson earmarked $6 million in the 1998-99 State budget expressly for UC engineering initiatives addressing the shortage of engineers. Current Governor Grey Davis has continued this support for engineering education in the University of California. His 2001-2002 Budget includes $33 million in seed money for a fourth Institute for Science and Innovation - the Center for Information Technology Research in the Interest of Society (CITRIS). The School of Engineering at UC Santa Cruz is a major participant in CITRIS. The UC President's Engineering Advisory Council (PEAC), in its 1997 report, stated UC must increase undergraduate engineering enrollment by 4,500 students to meet the State's needs. UC President Richard Atkinson strongly supports engineering education growth, and UC is committed to adding at least 800 engineering students annually through 2005-06.

It is no surprise then, that the founding of a School of Engineering at UCSC has been an important answer to a significant need. Even so, it was no small time in coming, with 36 years and 4 attempts before the UC Santa Cruz School of Engineering was founded in 1997 under the leadership of Chancellor M.R.C. Greenwood with stimulation by Mr. Jack Baskin's generous gifts. The further creation of the Electrical Engineering Department in 1997 was the first major growth step for the new School, while the proposed graduate program in EE will complete and considerable enhance the EE Department.

A vigorous Electrical Engineering program gives engineering greater visibility at UCSC, while the offering of another choice of engineering major to undergraduate and graduate students. This new department is attracting even more engineering students to the campus—students whose interests and expected socio-economic background would serve to enhance campus diversity. Additionally, a cornerstone of the campus academic planning effort has been to capitalize on the opportunities afforded locally. For example, UCSC Electrical Engineering will play a key role in the development of UC's Silicon Valley Center at NASA Ames Research Park in Mountain View, California. The Electrical

Engineering program also provides synergy with environmental programs at UCSC and in the Monterey Bay region. The topics of instrumentation, communications, signal and image processing, electronics and remote sensing are critical to the plans for the development of the University of California's presence at Fort Ord, as they are integral components of environmental measurement, monitoring and modeling.

The Electrical Engineering Dept. plans to focus its resources on three key areas, namely:

- Photonics and Electronics
- Communications, Signal and Image Processing
- VLSI design, Micro- and Nano-technology

We also participate in the UCSC campus-wide STEPS (Science, Technology, Engineering, Policy and Society) initiative on the environment by providing expertise in remote sensing, instrumentation, networks and data processing.

This document discusses vision and strategic planning for the Electrical Engineering Department and its place within the School of Engineering, the University of California at Santa Cruz and the worldwide engineering community it serves.

Mission Statement

To build a high-quality, sustainable teaching and research program that will inspire graduates and undergraduates in the theory and practice of electrical engineering with special emphasis on photonics and electronics, communications, signal and image processing, VLSI design, micro- and nano-technology, electromagnetics and remote sensing. The Electrical Engineering Program strives to serve Silicon Valley and the nation, while providing satisfying careers in teaching and research to faculty and staff.

PART I ACADEMIC PROGRAM GOALS AND STRATEGIES

1.7 Graduate Programs

The Electrical Engineering Graduate Program will come into being when the Graduate Program Proposal is approved by the Office of the President of the University of California and the Regents. The Graduate Program Proposal document was developed by the EE Department in 1999 and submitted by the School of Engineering to the Faculty Senate in September of that year. This proposal has been reviewed by numerous Senate committees and revised several times in light of their advice. In the spring of 2001 the proposal was approved by the Faculty Senate Graduate Council and forwarded to the Office of the Executive Vice Chancellor and Campus Provost, Dr. John Simpson for consideration. The proposal was approved by Provost Simpson's Office and submitted to the Office of the President of the University of California in September 2001. It is now under consideration by the Coordinating Committee on Graduate Activities (CCGA) and we anticipate final approval this academic year.

The EE Department faculty has been recruiting graduate students during the approval process and these students are currently being housed very kindly by the Computer Engineering Department. At present there are some 20 students under the supervision of EE faculty and we anticipate this number to grow rapidly as shown in Fig. 1 below. In summary by academic year 2011-12 we anticipate some 90 graduate students, supervised by 21 teaching faculty and a combination of adjunct and research faculty.

The initial layout of our graduate program is contained in the aforementioned graduate proposal and we will not repeat it here. Research program goals and strategies, of which the graduate program is an integral part, are covered in Part II below. However, there are some new initiatives that have developed since the writing of the Graduate Program Proposal and that are not covered in Part II, as follows:

- **Masters Program for Part Time Students from Industry**

In our Graduate Program Proposal we propose a masters program in electrical engineering that requires a thesis. Such a program fits well with young students going to university full time. However, an MS degree without a thesis would fit part time students much better, especially those from industry. Stanford's experience with their Honors Co-op program has shown that a course-only Masters program in EE works exceptionally well. Industries participating in the program contribute financially to Stanford and reap great benefit in recruiting excellent employees who come in response to this program with Stanford.

Experience by Computer Engineering with the UC system has shown that an MS with course work only is not allowed under UC policy. We will seek a solution that allows an MS program without a thesis, probably using a comprehensive exam or capstone design course.

- **Coterminal Masters Program**

We also plan integrating teaching / Industrial experience in a 5 year co-terminal master degree program. The student would spend 6-9 months (some during the summer) in a company for extensive internship or gain teaching experience in a community college. This program should enhance employment opportunities for students and companies and community colleges will have access to young, bright engineers.

1.2 Undergraduate Program

In 1965, UC Santa Cruz was founded on the basis of a strong commitment to undergraduate education. The Electrical Engineering department supports, and will continue to support, this commitment to excellence in its undergraduate program.

1.2.1 Target Statistics

Since its inception in 1997, the EE department has grown to an undergraduate population of 100 EE majors and 9 faculty in Fall 2001, corresponding to a student-faculty ratio of 12 (including graduate students). In order to satisfy the continuing demand for electrical engineers, we are planning to increase the number of undergraduate students to ≈ 250 and the number of faculty to 21 in the academic year beginning 2011. As shown in Fig. 1 below, this trend in undergraduate numbers, coupled with graduate student numbers, will produce the UC-typical student-faculty ratio of 15 by academic year 2005-06 and possibly earlier.

We will seek to have the electrical engineering undergraduate program accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) within 3 years (ABET review in 2004 – 05). In preparation for the ABET review, we will establish procedures for student outcome assessment, build course files with necessary documentation and records, and build up undergraduate instruction labs.

1.2.2 Undergraduate Curriculum Initiatives

Perspective on curriculum innovation: It has been said that the task of a university is to weld together imagination and experience. This cannot be done without practicing teaching and research as an integral whole. It would indeed be disingenuous to suggest that yet another ``revamping'' of the standard EE curriculum or the introduction of a few new courses would accomplish this formidable task. What is required is not only that courses be designed from a basis that promotes both technical know-how *and* research acumen, but also that overall research programs be designed such that they may naturally involve able students at both graduate and undergraduate levels. It is, without question, difficult to do all this within the confines of a long-running and well-established curriculum, however effective it may already be. The new Department of Electrical Engineering at UCSC provides for a unique entrepreneurial opportunity in this direction, for both faculty and students. While it may be fairly argued that our new department will encounter numerous challenges in terms of infrastructure, recruiting, and so on, it is also true that a new department will offer an unusually flexible framework for the development of a truly innovative curriculum. While the EE department benefits from past experience in the existing Computer Engineering and Computer Science departments at UCSC, many course have been (or are being) developed from the ground up, and therein lays the opportunity.

One of the areas that is often neglected in a traditional engineering education is the impact of engineering on society and the responsibilities that go along with this exercise of power. Among these is the need to stress the responsibility to make engineering decisions consistent with the safety, health and welfare of the public and to disclose promptly factors that might endanger the public or the environment. Understanding of the relationship between accurate engineering estimates, conclusions based on data, and their relation to public policy and political decision-making will be highlighted. Additionally the social contexts in which engineering decisions exist need to be appreciated. This extends beyond the understanding of technology to an appreciation of its appropriate application and potential consequences; the above are examples of the knowledge needed to make ethical engineering decisions. Further practical ethical considerations need to be put forth as well that relate to situations occurring in the work place, such as personal conduct, conflict of interest, discrimination, falsification of data and the honest assessment of technical competence in both oneself and others.

What we envision is the development of an undergraduate curriculum where courses and projects are integrated seamlessly. The necessary tool to accomplish this is that courses be thematic in content. That is to say, while a course will teach the basic material effectively, it will also have an ongoing narrative that explains why the materials being taught are of relevance in the practice of electrical engineering. One way to accomplish this is to identify and set out an appealing and technically interesting research problem at the start of the course and gradually solve the problem to completion by the end of the course, using the accumulated knowledge conveyed throughout the term. This approach would serve to provide ongoing motivation for the material and is useful not only to give cohesion to the material from each lecture to the next, but also as a frame of reference, and a measure of what has been taught and learned. Class projects will be an integral part of each course.

The above model can be regarded as a blueprint for teaching courses at both the graduate and undergraduate levels. It is a dynamic framework in that the particular research problem used to motivate the course material may change from year to year, drawing upon the teacher's own ongoing research experience, yet the basic course material may remain unchanged.

Out into the World: The other side of the proverbial coin is the issue of engaging students in learning and research *outside* the classroom. At many leading Engineering schools such as those at MIT, Caltech, and Stanford, some variant of a system of mentorship has been put into practice in which undergraduates are paired up with professors and their graduate students through a coordinated effort by the school. Undergraduates are able to participate in these programs for credit, receive stipends, or work as volunteers. Students choose specific projects to learn about a potential major, investigate an interesting area outside a major, gain practical skills and knowledge for a possible career or graduate school experience, get to know faculty, find out what research is like, or because they find a particular area to be exciting and challenging. We propose a similar, highly structured program here at UCSC. The initial step toward this goal will be the development of a 2-unit undergraduate seminar in which faculty members from EE, and other departments, will describe their research programs to students in informal and interactive discussions. The hope is that by exposing students to research problems early on we may provide the critical motivation and interaction required to truly integrate the faculty's research with the students' learning experience and in the process spark their creative interests.

The current curriculum for a Bachelor of Science degree in Electrical Engineering is centered around three tracks: Electronics and Optoelectronics, Signals and Communications, and Control/Instrumentation. In addition to a number of required general courses, students follow their individual interests by picking two elective courses from their preferred track. In the future, we are planning to increase the number of courses offered in each track as well as creating additional, separate tracks in optoelectronics and circuit design. In order to do this, new courses, such as “Optics and Photonics”, “Semiconductor Optoelectronics”, “Advanced Analog Design”, and “Integrated Circuit Layout and Design” will be developed.

In addition, several innovative approaches to enhance the undergraduate experience will be undertaken, as follows:

- Radio Design and Construction Course: We are currently planning a radio design and construction course based on a course taught to freshman engineering students by David Rutledge at Cal Tech. We plan to offer a more advanced version of this course with significant individual design included so that it can constitute the senior design project required for the BS degree in EE if desired. This idea is to develop the understanding needed to design and construct a radio link, implement this knowledge in the construction of a radio link involving transmitter, receiver and antennas. The individual student would then design and construct a system using this link for communication, control, monitoring, etc. We strongly believe that this integration of much of the material learned in the undergraduate’s first three years would fix the concepts learned and provide the student with the design experience so needed for success in the student’s future career. The course is being planned and submitted for approval this year and we plan to offer it to students for the first time in 2002-03. Lecturer Steve Petersen is playing a leading role in this undergraduate initiative. Steve has won several undergraduate teaching awards, including this year, and is an excellent asset for this class.

- Integrated Projects: Student motivation is generally much higher when the practical application of the material taught is obvious. Therefore, we are developing classes where the lecture and projects are integrated. While presenting the basic material, the course has an ongoing narrative, which draws on this material with the goal being to solve an appealing and technically relevant problem by the end of the term.

- Freshman Seminar: We propose to take the lead in developing an introductory seminar course in the School of Engineering entitled "Perspectives in Engineering" (modeled after courses in engineering at UC Berkeley and physics at UCSC). This course will consist of a series of lectures by faculty and practicing professional engineers to provide students, *especially undeclared engineering students*, with information on the various engineering disciplines to guide them toward a choice of major. In addition, students who have already selected a major will benefit from these lectures by learning more about their respective field. Lecturers will describe their research activities, how they made their own career choices, and indicate future opportunities, including opportunities for student involvement in ongoing research programs. This course will be recommended for all *freshman engineering students* and will involve faculty and researchers throughout the School of Engineering as well as outside lecturers.

- Remote Learning: Over the next decade, remote instruction will become more and more important. We are exploring the use of web-based virtual experiments as well as web-based real experiments with remote control of instruments. An NSF Curriculum Development Grant has already been established to demonstrate the proof of concept for this approach.

- Undergraduate Research Program: For all EE students, active participation in departmental research at an early stage is an important, motivating and often determining experience. An institutionalized program, which oversees and coordinates the assignment of interested undergraduate students to participating faculty, is most effective in offering such opportunities. Undergraduates can be part of a research group for a quarter or more and earn academic grades or be paid out of faculty grants for their work. Coordination of this program for the entire School of Engineering should be carried out under supervision of a staff member.

- Multidisciplinary Classes: Many research efforts in the future will require joint efforts between multiple departments in order to be successful. Such efforts will include all or any of the disciplines in engineering, physics, biology, chemistry, and medicine. Exposing students to multidisciplinary subjects early in their undergraduate career helps sharpen their awareness of these problems. An ideal means to accomplish this would be an introductory science class or lecture series at the freshman level co-taught by faculty from different departments. In this way, the students get an overview from experts in their respective fields. Topics for such a class could include nanobiology, nanobiochemistry, or optical methods in biology and chemistry. Environmental research is also a natural topic for such a multidisciplinary course.

- Education Abroad Program: Spending part of your undergraduate years in a foreign university is an invaluable experience from both an educational and a personal development standpoint. The Electrical Engineering department will encourage and support study experiences for undergraduates abroad as well as visits of foreign students as part of foreign exchange programs. These efforts can be coordinated with the corresponding office at UC Santa Cruz. In addition, personal contacts with the German Academic Exchange Service are already in place and will be cultivated further to promote exchange programs with Germany. We also plan to offer both undergraduate and graduate students the opportunity to spend time at the planned Silicon Valley Center, discussed in Sec. 2.3 below.

1.2.3 Student outreach

For a young and growing department, effective outreach initiatives at both the undergraduate and graduate level are of paramount importance to ensure both sustained growth (shown in Fig. 1 below) and high quality of the department's student body. At the undergraduate level, the following specific programs are envisioned for effective recruitment of outstanding high-school graduates:

- Internet Presence: An informative and attractive web site is indispensable as a means of reaching out to prospective students who do not have the opportunity to visit the school. Therefore, we propose to maintain a professional quality web page that provides comprehensive information about the exciting opportunities for Electrical Engineering at UC Santa Cruz. The EE Department developed the first departmental web page in the School of Engineering and we plan to build on this success. Matthew Kolostro will continue to be a key resource in accomplishing the goal of a professional quality web page.

- Brochures: Another effective element to attract students is traditionally printed brochures that advertise the Electrical Engineering programs. A brochure presenting both undergraduate and graduate opportunities is to be developed by a professional designer and to be mailed to high schools, parents, and other universities. We have solicited and received inputs from high school seniors on their views regarding an effective brochure.

- Faculty initiatives in developing links to community schools: Faculty will put in additional personal effort to improve the recruiting process. This will include speaking engagements and the visit of science fairs at high schools in the vicinity. We strongly recommend that the School of Engineering take the lead in establishing a campus-wide coordinator for faculty visits to both elementary and high schools as well as community colleges. In this way the faculty can be matched to the needs of individual schools and an orderly process established that could be continued with individual schools on a continuing basis. Existing programs at the national level such as NSF's "In the Schools" program can be used as launching pads for our local activities and help attract the best students for our program.

- Internships and industrial cooperation: We plan to develop internships in close collaboration with industry to provide encouragement and valuable experience for students interested in pursuing our majors, thereby enhancing the quality of our graduates. These programs, which are currently being planned, will be discussed in greater detail in Sec. 1.6 below.

1.2.4 Innovative Teaching Methods for Engineering

There are many positive features of emphasis in this area. It fosters collaboration with industry (employee training) and fits well with UCSC's emphasis on undergraduate education, creating a bridge with the rest of the campus. Joint work with the Education Department, Humanities, Art and

Psychology are possible. Emphasis on minority education (different learning styles) would fit well with relation to the New Center on Diversity and Tolerance on Campus. Emphasis in this area would distinguish UCSC from Stanford, Berkeley, UCSB (excellent research universities, but they don't emphasis teaching). Here are some initiatives we plan to consider for implementation over the next 10 years.

- Smart classrooms: These would feature integration of labs with lectures, the use of web-based virtual experiments and web-based real experiments, i.e. remote control of instruments. An NSF Curriculum Development Grant proposal for the class EE145 (Properties of Materials) has been submitted at the proof of concept $75K level. If successful, national dissemination will be in 2 years and $500K can be requested.

- Student design classes: EE 127/128 are in place to give students team design experience on real conceptual designs. We could develop course segments following the development of a real product in a company: The students would see the different stages in product development. For example, the development of the first Spectrum Analyzer at HP could be taught using retired people with lots of industrial experience, probably from HP itself. Combining such segments with traditional classrooms would offer students a real feel for successful product development.

- Integration of Research/Teaching: Learning a new subject by starting to work on a concrete problem, for example:

Undergraduate level: A specific example can be used to develop a course, such as the radio course discussed in Sec. 1.2.2 above. EE 127 & 128 currently allow students to do team design work by developing a conceptual design for a system, such as the Earth View – Third Millennium spacecraft for imaging the Earth at 1 ft. resolution. Work in the design class is integrated into research on interferometric imaging. A paper was given at the American Institute for Aeronautics and Astronautics Meeting this summer in Albuquerque describing the work of the EE 127/128 class last year and will appear in the Proceedings of the AIAA Conference.

Graduate level: Research problem / current literature would be used in a class.

Innovative teaching methods would be related to California Institutes for Innovation in Science, see Sec. 2.2 below. A possible source of interest and funds is at HP. The HP Way has been very successful as a model for a high tech company. What is the HP Way? Ask Packard Foundation to fund a Center of Excellence for Teaching in Electrical Engineering (*HP Way in Education*).

1.2.5 Workload Projections

EE Department faculty workload can be viewed in terms of student faculty ratio or in terms of courses taught. From the former point of view we show (in Fig. 1 below) faculty, undergraduate and graduate student numbers and the student to faculty ratio. The numbers are real data through academic year beginning 2001 and projections beyond that point. The student to faculty (or workload) ratio is simply the sum of the undergraduate and graduate EE majors (with graduate students having a 1x weighting) divided by the number of ladder rank faculty – FTE numbers in each case. Our goal in terms of student to faculty ratio is 15, a typical number for electrical engineering departments. This number is perhaps a little lower than that for departments without the large number of laboratory classes that are needed for an electrical engineering education. We currently have a student to faculty ratio of about 8 and project reaching our goal of 15 by 2006-07 with significant increases each year.

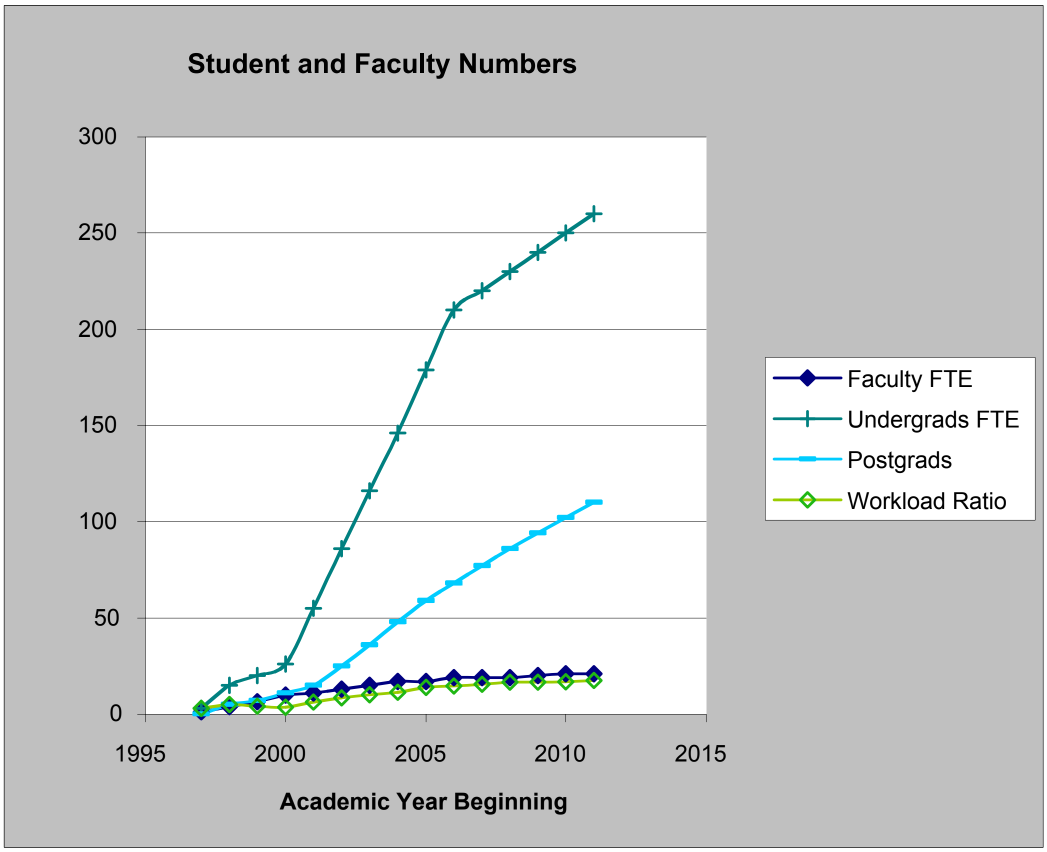


Fig. 1. Numbers of actual and projected students and faculty and the student to faculty ratio (workload ratio) over the period 1997 to 2011. See also Tables 1 and 2 and Fig. 5 below.

We have designed our undergraduate and graduate curricula around three current focus areas in photonics and electronics, communications, signal and image processing, and VLSI, MEMs and nanotechnology (see Fig. 3, below). With the authorized 11 EE faculty FTE (as of academic year 2002-2003) we will have the capability to teach about 30 courses per year with EE faculty, augmented by qualified lecturers. The current undergraduate program calls for 14 courses per year. We have proposed a graduate program calling for a further 23 graduate courses. About 7 core graduate courses would be taught every year and about 16 every other year or less frequently depending on graduate student needs. Thus, the full complement of undergraduate and graduate courses would require about 30 courses per year. The full authorized complement of 11 EE faculty FTE (available for teaching in 2002-03) plus the several lecturers we now use and future adjunct and visiting faculty can handle this teaching load. As we increase our faculty beyond the 11 planned for next year we will be able to offer a wider variety of both undergraduate and graduate courses.

1.3 3-2 Programs

3-2 programs are designed to offer undergraduate students the opportunity to begin engineering study at UCSC, but plan to finish at another UC campus where programs are offered that are unavailable at UCSC. We plan to participate in 3-2 programs, but have no new initiatives planned in this area.

1.4 Summer Programs

As a result of the constraints of our current faculty and staff, we are able to offer only a very limited summer session at present. The components of the plan are composed of the following courses and more details are in the following table.

2 EE 195 Senior Thesis: This would be the typical senior thesis with whatever faculty members are available in the summer and are willing to supervise a student on their senior thesis project. We projecting here that some ladder faculty who will be available on a once a week or so basis and could supervise a senior thesis with help from the telephone and email.

3 EE 103 Signals and systems: This is a regular course also taught in the academic year that we think could be taught in the summer by a lecturer. There are several candidates available. The lecturer would have to be excellent since the faculty are very concerned that the course be effective -- it is the basis for higher-level courses.

4 EE 1XX Research/Design Internship in Industry (or a research institute). The idea here is to have a coordinator who will place students with trusted people in industry (or research institutes) on an internship basis (with pay). The student completes a project during the summer and writes up a report that is graded. Prof. Vesecky did this once on a summer job with Temco Electronics while an undergraduate and found it very effective. We believe that we can find people in industry and at research institutes (NASA Ames, SRI, etc.) that can do this sort of thing and make it very worthwhile. It would be an elective. We have allowed a couple of years to begin this effort, beginning in 2003. Staff to coordinate this activity would have to be hired.

Table 3: Summer Session Plans: 2002-05
Electrical Engineering

Estimated

Summer	Course	Instructor	Enrollment	Units
2002	EE 195 Senior Thesis	Staff	2	5
2003	EE 103 Signals and Systems	Staff	5	5
	EE 195 Senior Thesis	Staff	3	5
	EE 1XX Research/Design Internship in Industry	Staff	5	5
2004	EE 103 Signals and Systems	Staff	7	5
	EE 195 Senior Thesis	Staff	3	5
	EE 1XX Research/Design Internship in Industry	Staff	7	5
2005	EE 103 Signals and Systems	Staff	10	5
	EE 195 Senior Thesis	Staff	4	5
	EE 1XX Research/Design Internship in Industry	Staff	7	5

In the years after 2004-05 we plan to expand our summer offerings in several ways, as follows:

1. Trial runs of prototype courses designed for the regular academic year

2. Special courses given by visitors, both faculty and research. These courses would likely be primarily for graduate students.

3. Basic undergraduate courses. We plan to offer EE 103, beginning in 2003-04 and plan to expand that offering with other basic undergraduate courses, such as EE70/70L (Electronic Circuits), EE135/L (Electromagnetics), EE 145/L (Properties of Materials) and EE 171/L (Advanced Electronics). We plan strict criteria for instructors of these courses (above qualifying for the lecturers pool). This is to insure that the summer courses are taught to the same standard for quality and grade requirements as regular academic year courses. For example, instructors would need to be approved by the faculty who regularly teach these courses. In the more far term future we envision some of these courses being taught at the Silicon Valley Center.

1.5 Silicon Valley Center Programs

There is more to the connection between UC Santa Cruz and Silicon Valley than the short drive between them. Electrical Engineering at UC Santa Cruz will play a key role in developing the 25-acre University of California Silicon Valley Center (currently under development by NASA, local industry, and the University of California) by providing both academic and research programs at both the undergraduate and graduate levels. Although planning for the Silicon Valley

Center is still in the formative stages we offer the following plans for graduate and undergraduate students over the next ten years:

1. Graduate students would complete academic degrees while living at the Center and working part-time in industry – especially after completing course work at the UCSC campus. This would be especially efficient for students working on collaborative research topics with industries in the Valley. For example, graduate students with thesis topics requiring the use of industrial laboratories, either at the Center or elsewhere in the Valley, could work very effectively from the Silicon Valley Center. The no-thesis Masters Program discussed above (Sec. 1.1) would fit naturally at the Silicon Valley Center.

2. Undergraduate students would spend a year living, working as interns and taking courses at the Silicon Valley Center in much the same way as they would at an overseas campus. We have several faculty who live in the Valley and hence could teach there without inconvenience. Faculty who live at a distance from the Silicon Valley Center could live at the Center for a period to teach and to do research as they would at an overseas campus.

3. Some undergraduate and graduate courses would be offered at the Silicon Valley Center, primarily for part-time students who work in the Valley.

4. Internship and CO-OP programs described below would be implemented wholly or in part at the Silicon Valley Center

1.6 Internships and CO-OP Programs

Much of the true education of an engineer takes place out side of the classroom and university. For many engineers the experience that most motivates them to excel in academic engineering is their first contact with actual engineering projects in an industrial setting. Not only does much learning occur outside of the classroom but motivation is also increased and career choices reinforced. We propose the development of internship programs in partnership with industry as one way we can participate in this important process of development.

Additionally one key to enrolling highly qualified students in our program is to provide incentives to attract students to the major. The prospect of a relatively well paid summer jobs along with the attraction of participation in real world projects can be a powerful draw, especially when this allows students to see the relevance and use of their academic preparation.

We propose three levels of summer internships: sophomore year as low-level technician, junior year as technician, senior year as engineer. Students who have work experience also have more appreciation for classes and often do better than other students. By spending 3 summers in a company, students will do more useful work.

We have made a good start at ASML (formerly Silicon Valley Group) in Scotts Valley and National Semiconductor is encouraging us to develop programs aimed directly at specialties of Electrical Engineering design that are in short supply. Corporate internships and other incentives will benefit both this department and local industry by encouraging enrollment in our program. We will be actively developing and publicizing internship opportunities at other industrial concerns and the National Laboratories at Los Alamos and Livermore as part of this effort.

1.7 Promotion of Diversity

The EE Dept. promotes diversity in all aspects of its programs. Beginning with faculty recruiting we promote diversity through advertising in journals likely to be read by minority candidates, such as the list provided by UCSC's Academic Human Resources. (Need examples). We also promote diversity in our undergraduate and graduate recruitment and presently have a very diverse student body at both the undergraduate and graduate levels. We plan to continue to encourage diversity by making visits to local area community colleges and schools. The UCSC admissions office currently has a program (EPAC) to facilitate visits by faculty to schools. We call for a more proactive program in this area that would feature recruitment of faculty willing to make visits and the promotion of visits by these faculty using a campus wide UCSC coordinator. If UCSC could offer community colleges and schools a menu of possible UCSC visitors and then coordinate the visits, an effective and efficient program could be run to recruit a more diverse and high quality student body.

1.8 Interdivisional Collaborations

Collaborations with other divisions are a natural activity of engineering departments. In Electrical Engineering we have established relationships with departments and ORU's in Natural Sciences, e.g. Physics, Earth and Marine Science, Center for Adaptive Optics and IGPP. We plan to continue such collaborations and are making a special effort to work with the new NSF Center of Excellence in Adaptive Optics. Two of our faculty (Peyman Milanfar and John Vesecky) and one emeritus faculty housed in EE (Don Wiberg) are working with this center. Faculty from Astronomy and Astrophysics are collaborating with Prof. Vesecky in teaching his Design Course (EE127/128), which is doing a conceptual design of an interferometric imaging system for extrasolar planets. This system would operate in solar orbit between Mars and Jupiter.

Both EVC Simpson and the Faculty Senate's Committee on Planning and Budget strongly encourage development of environmental engineering programs that would create a tie with existing strong programs on campus (such as the Earth Sciences Department and the future STEPS Institute). EE chair, John Vesecky, is actively involved in remote & environmental sensing research that contributes to these programs and could be a good basis for future growth in environmental engineering program elements within the School of Engineering.

1.9 Residential College Relationships

The residential college system is one of the unique aspects of the University of California at Santa Cruz that lends it its special character. Within this system lie many of the traditions and history of this institution. Beyond a purely residential function such as the college system at Harvard performs, the college systems at UCSC provides the core courses which provide a focused program of intellectual inquiry for incoming students and also serves to attract like minded students into closer contact.

The electrical engineering faculty, being one of the newest on campus, by-and-large has not yet had extensive contact with the colleges nor deep knowledge of university history and traditions. We plan to involve ourselves as college fellows throughout the various residential colleges, both to gain a better understanding and appreciation of the unique history of UCSC, to allow faculty in other departments a greater chance to learn about the activities in the school of engineering, and provide input useful to the development of our programs. Greater participation in the college system will also allow us to contribute more to the early years of students lives on this campus as currently almost all of our courses are given only in the upper division.

With time, and the development of greater understanding of the college system, and integration in to the traditions of this campus, we would be supportive and instrumental in the development of an engineering related theme at one of the new colleges. This should, in our view, involve a theme and core course that would prove interesting and valuable to a broader student population than just those whose academic interests tend toward engineering. This is to assure that one of the greatest and most lasting contributions of the university experience, the contact that students and faculty have with a broad spectrum of diverse people and viewpoints is not undermined. The intent would be to also attract non-majors who might have a special interest in the theme but not engineering as a career. One example of a theme that might serve as an attraction for engineering faculty and as a focal point for a School of Engineering oriented core program might be, for example: *Technology in Service of Society*. Such a theme might investigate the history and impact of technology on society, for good and for ill, the social and political pressures that influence technology policy and development, and the ethical dilemmas faced by both technologists and the public whose opinion shapes our technical and political world. Given the rapid technical change we are experiencing, particularly in information technology, its ever increasing presence in our daily lives, its great promise for freedom, productivity and enlightenment, its potential for erosion of our sense of freedom, privacy, and control, and its environmental consequences, the time seems appropriate to bring a dialog on these issues to the broader student population.

We would also encourage faculty participation from outside engineering and continue to encourage engineering faculty to affiliate with other colleges.

1.10 Student Admissions

Continuing improvement in quality of the student body is essential to the long-term success of the EE department. The following items can be addressed in the short run to improve the student quality.

Selective Admission: We support the establishment of selective admission to the Electrical Engineering major. The current approach, which is to admit anyone and then to disqualify them, does not serve the students in our judgment. Admission would be base on grades and test scores at the freshmen level with performance in the initial years taken into account for transfer students. Continued standing in the major would require the maintenance of an acceptable grade point average in classes for the major. Additionally we seek the freedom to review and select those students that, while perhaps not satisfying all the requirements for UC admission, perhaps because they “march to a different drum”, have demonstrated good quantitative ability and a commitment to the pursuit of intellectual endeavor. This would be in keeping with the unique culture of UCSC. While we do not wish to discourage enrollment in our major during this period of departmental growth, we feel that even the appearance of selectivity will enhance the attractiveness of our program and enhance our capability to attract some of the best students. This would also bring our admission procedures inline with the practices of other campuses in the UC system. A number of concerns, however, need to be addressed regarding our unique position. Our major does not suffer the same need for selectivity as, for instance, Computer Science and so blanket admission to the School of Engineering might not serve us well at this time. We are, however, sensitive to the need to keep our admissions, course offerings and requirements in harmony with Computer Engineering to facilitate the transfer of students between these very similar major programs. It is viewed as critical for the growth of our department and its reputation within the broader electrical engineering community that we graduate well-qualified and capable students that are on par with those matriculated throughout the UC system.

Target SAT’s: While standardized tests are not perfect indicators of future student performance, they do serve to help distinguish the exceptional students first. As such, we must strive to recruit students with higher SAT scores, specifically in the analytical and quantitative sections of the exam. But in the interest of both fairness and to be realistic, this increase must be phased in gradually over time. This can be done over the course of 5 years quite effectively. A modest 5 percent annual standard increase in the average analytical and quantitative score of admitted students will result in an increase of roughly 30 percent over 5 years. This can be significant, raising the average admit score, for example, from a meager 625 to almost a perfect 800 (Fig. 2).

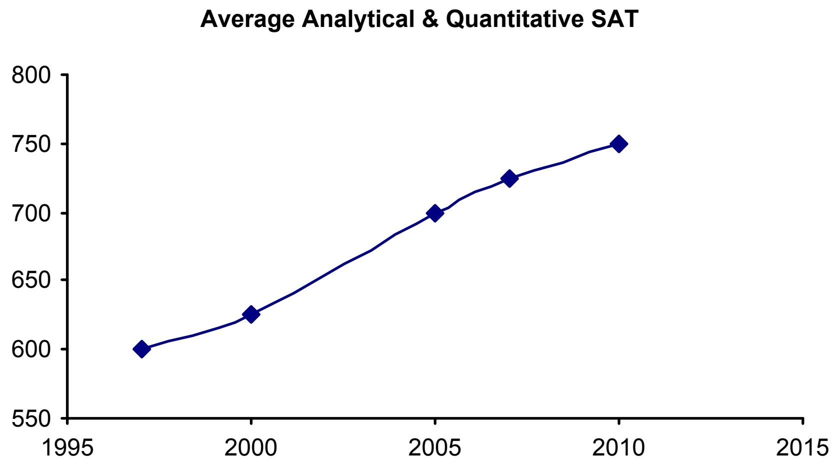


Fig. 2. Current and projected SAT scores of UCSC EE undergraduate recruits.

Recruiting: Significant improvements in the recruiting efforts and outreach will be effective in attracting additional high-achieving students to the UCSC EE program. This outreach effort will require significant effort on the part of the faculty and staff, with additional investment on the part of the school to allow time for faculty to be directly involved in speaking engagements, science fairs, and other outreach activities at schools around campus and locally around Silicon Valley as well. Existing national outreach programs, such as the NSF "In the Schools" program (see http://www.nsfoutreach.org) can be used as a launching pad for our local activities. Student involvement in the outreach activities will also be a critical factor. By providing incentive and motivation (as in the UCSC Ambassadors Program) to existing and graduating students, we can directly reach communities of students and their parents and peers who may be outside the immediate vicinity of the campus or Silicon Valley.

Expense-paid visits for the most exceptional students (minority or otherwise) should be productive because they will not only see the campus, but will have an opportunity to interact with professors, sit in on classes, and mingle with fellow students. This will leave an impression that will be difficult to duplicate in any sort of mailing or web presence.

Web site and Marketing Improvements: With the increased reliance on the web for information, it is natural to expect that students will do a significant amount of research on campuses of their choice online before ever setting foot on the respective campuses. Our web presence is therefore our first impression. Our current website (http://www.ee.ucsc.edu) is very basic and lacks specific information designed for recruitment purposes. A redesign of the web page with professional help and development may cost as much as $5000 or more, plus an annual maintenance cost. Considering the crucial and timely nature of this investment, it should be a very high priority item on the list of short-term investments. Additional marketing material, based on, or in conjunction with the online material should be professionally produced in traditional print and mailed directly to high schools, prospective students and parents, and other universities.

Again, this process can be costly, incurring an ongoing cost of several hundred dollars per year, but is a crucial and worthy investment, with long-term benefits.

At present we need to work harder to attract a high quality student body at both the undergraduate and graduate levels. We have many high quality students now, but need to attract more.

1.11 Faculty and Staff Resources

The most critical part of our long-range plan is to recruit and retain outstanding students, faculty and staff. In the area of faculty we plan to hire using the approach made famous by Fred Terman at Stanford in the post World War II era. This approach is to hire in the senior-faculty-leadership positions first and then use these leaders to recruit the excellent students, faculty and staff that these leaders will attract. This approach was very successful at Stanford and has worked well at many other universities. Retaining good people means providing an educational, research and work environment in which they can flourish. We need to hire about a dozen new tenure track and a dozen research faculty over the next 10 years or between one and two per year. To support these faculty we need offices, support staff and quality students. By establishing an outstanding faculty, and we are very happy with the ones we have, we will have the key resources to do excellent work in research and teaching and attract the students we need.

Our top priorities now are to hire at the leadership level (including targets of excellence) to establish the centers of excellence we propose and to provide the resources for these leaders to be successful. Our focus areas for the EE Department are stated in the mission statement at the beginning of this document, namely:

- Photonics and Electronics
- Communications, Signal and Image Processing
- VLSI design, Micro- and Nano-technology

In the first three areas we plan to assemble centers of excellence on a national scale, in addition we will participate in the UCSC campus-wide STEPS (Science, Technology, Engineering, Policy and Society) Institute on the environment by providing expertise in remote sensing, instrumentation, networks and data processing. We have established leadership in all the areas above except for VLSI design, micro- and nano-technology. This academic year (2001-02) we have been authorized to hire a leading professor in the area of VLSI, MEMS and nanotechnology as shown in Table 1 below. This spreadsheet details the timing of the faculty hires and the areas in which these faculty specialize.

Table 1. Electrical Engineering Faculty Recruitment Plan

Academic Year Beginning	Total Faculty	New Photonics & Electronics	Faculty Communications, Signal & Image Processing	Added VLSI, MEMS & Nanotechology	STEPS Participation
1997	1	1	0	0	0
1998	4	1	1	1	0
1999	6.5	1	1	0	0.5
2000	7	0	0	0	0.5
2001	9	1	1	0	0
2002	11	0	1	1	0
2003	13	0	1	1	0
2004	15	1	1	0	0
2005	16	0	0	1	0
2006	17	0	1	0	0
2007	18	0	0	1	0
2008	19	0	1	0	0
2009	20	1	0	0	0
2010	21	0	0	1	0
2011	21	0	0	0	0
Totals	21	6	8	6	1

To support the teaching faculty in Table 1 we will require support staff as shown in Table 2 below. This table shows the time line summary of personnel needs for EE Dept. growth over the next 10 years to support the proposed undergraduate and graduate strategic plans. We also show research personnel needs that are discussed in Part II, Research Program Goals and Strategies, below.

Table 2

EE Dept. Recruitment Plan for Academic and Research Personnel

Academic Year Beginning	Teaching Faculty	Administrative Staff	Technical Staff*	Adjunct Professors	Research Faculty	Post-Doc Research
1997	1	0				
1998	4	0.5				
1999	6.5	0.5				
2000	7	2.25				0
2001	9	2.25		0	0	1
2002	11	2.75		1	1	2
2003	13	3.25	0	2	2	2
2004	15	3.25	1	2	3	3
2005	16	4.25	2	3	4	4
2006	17	5.75	4	3	5	4
2007	18	6	4	4	7	5
2008	19	6	4	4	9	6
2009	20	6	4	5	10	7

2010	21	6	4	5	11	8
2011	21	6	4	6	12	9

*Note that Technical Staff would be funded by state and extramural funds on 50%-50% basis

With such rapid growth one must ask is such large growth in faculty consistent with the expected growth in undergraduate and graduate students? In Fig. 1 above we address this issue by showing the growth by academic year 2011-12 to some 250 undergraduate students majoring in EE -- this is in line with previous projections. We project some 92 graduate students (≈ three graduate students for each teaching and research faculty) by academic year 2011-12. This means a student/faculty ratio of 15 by academic year 2005-06 and a ratio of over 20 by 2011-12. (The student to faculty ratio is simply the sum of the undergraduate and graduate EE majors (with graduate students having a 2x weighting) divided by the number of ladder rank faculty.)

We think that these estimates of undergraduate student numbers are conservative, given the increasing pressure by the state and UCOP to increase enrollments in UC, especially campuses like Santa Cruz that are able to grow. For graduate students we think the projection of about 90 graduate students in 2011-12 is also conservative. If we take three Ph. D. students per research and teaching faculty and add in masters program students the graduate student numbers could reach well over 120 in 10 years.

Our most urgent need is for additional administrative staff. Currently all School of Engineering Departments have one half-time person, our department managers, who each work for two departments. We are currently hiring an additional half-time department staff person to assist the half-time department manager. We hope that will remove one of the most serious impediments to progress. The extra half-time assistant manager will speed completion of essential work and make for an environment where faculty are not distracted from their primary tasks by the need to do work that should be done by administrative staff. However, as student and faculty numbers grow, more staff will be needed as shown in Table 2

PART II RESEARCH PROGRAM GOALS AND STRATEGIES

Our goal in ten years is to be in the top dozen EE Departments in the US in our major thrust areas of research and graduate studies while maintaining an outstanding undergraduate education program. We propose to hire some 12 new faculty, about four in leadership positions. We also propose hiring some dozen research faculty. These would be supplemented and complemented by adjunct faculty, postdoctoral students and administrative and technical staff as discussed in Sec. 2.6 below. By 2011-12 we project undergraduate and graduate student bodies of 250 and 92 respectively. Further information on EE Dept. research is available on the EE web page (http://www.ee.ucsc.edu)

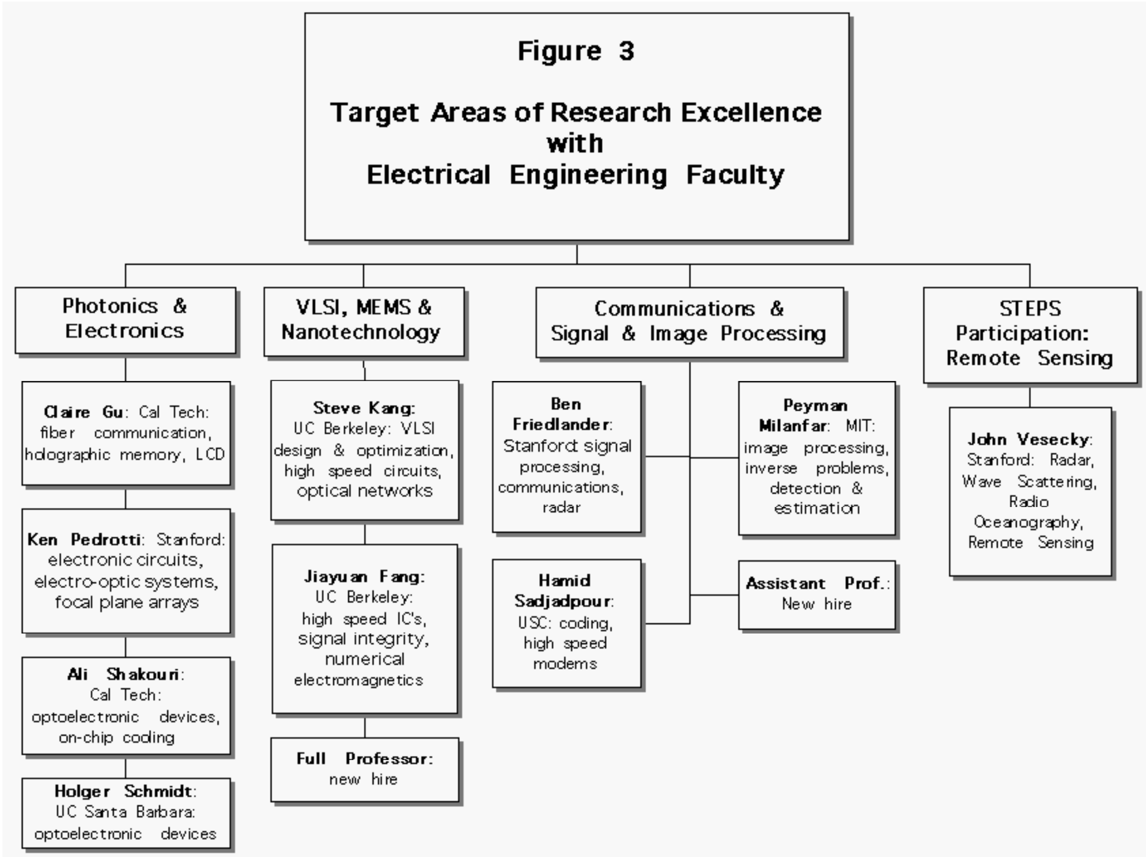
The most critical part of our approach is to recruit and retain outstanding students, faculty and staff. We plan to hire using the ‘star’ approach used with great success by Stanford when they hired Fred Terman. This approach advocates hiring in the senior- faculty- leadership positions first and then using these leaders to attract excellent students, faculty and staff. Retaining good people means providing an educational, research and work environment in which they can flourish. Our approach to the EE Dept. research program is one that serves EE students, faculty and staff, fitting well with the School of Engineering, Engineering ORU, UCSC campus structure and UC system wide structure.

2.1 Target Areas of Research Excellence

The general areas of excellence in the Electrical Engineering program cover a set of important areas of the forefront of electrical engineering with excellent opportunities in research and funding. These focus areas match the needs of industry, especially Silicon Valley. Our major thrust areas in research and both undergraduate and graduate education are as follows:

- • Photonics and Electronics
- • Communications, signal and image processing
- • VLSI, MEMS and Nanotechnology

These focus areas are illustrated in Fig. 3 with the faculty currently in place or authorized for hire. The teaching and research areas listed above will provide the ‘critical mass’ for strong graduate and research programs in electrical engineering. Future growth is currently focused on VLSI design and nanotechnology with the arrival of Prof. Steve Kang as the new Dean of Engineering and a new leadership position authorized for hire next year. We also have a state-of-the-art molecular beam epitaxy (MBE) machine as the basis for research into optoelectronics and nanodevices.



Photonics and Electronics are already strongly represented within our current faculty, covering a broad range of research interests from LCD displays, analog circuit design, to integrated optoelectronic and photonic devices. Proposed growth in the photonics/electronics area (see Table 1, Sec. 1.11) will further strengthen our existing faculty. Fiber optic communication and optoelectronic circuits have expanded rapidly in the last decade due to the very large increase in internet and wireless traffic. We think that this trend will continue. A new professor this year is Dr. Holger Schmidt, whose research in optically controlled optical switches will greatly strengthen the photonics and electronics area. We hope to hire a world-class researcher for the endowed Kapany chair in optoelectronics in the near future. Faculty research in photonics/electronics group will complement the effort in VLSI/Nanotechnology and will create a bridge with the more theoretical research in signal and image processing and communication.

VLSI/MEMS/Nanotechnology is one of the key engineering areas for the 21st century. In nanotechnology there have been several large initiatives at the National Science Foundation and Department of Energy (see also the special issue of Scientific American, September 2001). There is already a California Center of Excellence in nanotechnology at UCLA/UCSB, UC Berkeley MEMS Center, and UC San Diego’s extensive work on Bio-MEMS. A strategic niche for UCSC is related to the California Center of Excellence in Biotechnology at UCSF/UCSC. UCSF does not have engineering school. UCSC’s EE department can have a significant impact in this center by hiring people at the interface of electronics, nanomechanics, chemistry, optics and biology. We would focus on topics such as, novel sensors, intelligent chips (labs on a VLSI chip), novel imaging techniques and the use of chemistry/biology for new devices and IC's. In the VLSI design area we are developing a Center for Integrated Circuit Design that we hope will supply the VLSI circuit designers so needed in industry. We plan a special emphasis on analog chip design.

Bio-nanotechnology is an attractive option. Conventional nanotechnology areas are already covered: California Center of Excellence at UCLA/UCSB, UC Berkeley MEMS Center, UC San Diego (Bio-MEMS). A strategic niche for UCSC is related to the California Center of Excellence in Biotechnology at UCSF/UCSC. UCSF does not have engineering school. UCSC's EE department can have a significant impact in this center by hiring people at the interface of electronics/nanomechanics/chemistry/optics/biology. This would complement the Bio-informatics work of Prof. David Haussler of our Computer Science Dept. We would focus on topics such as, novel sensors, intelligent chips (labs on a VLSI chip), novel imaging techniques and the use of chemistry/bio for new devices and IC's.

To succeed in this area we would need to hire a world-class professor in the field (both strong research and strong teamwork). This person would develop the rest (example Gary Leal left Caltech and started Chemical Engineering at UCSB 10 years ago. Now they are one of the tops in the country, another example is EECS at UCSB, one of the leaders in III-V semiconductor-based electronics and optoelectronics. They started ~15 years ago).

<u>Communications, signal and image processing</u> combines a group of closely related fields, all important to communications systems as well as other fields. Wireless communications is experiencing explosive growth which is expected to last for quite some time. In the future there will be increased integration of various sensors with communication devices and networks. As an example, small low cost cameras are going to be used extensively for monitoring, recording, and surveillance. The communication, processing and managing of information from a large number of distributed sensors presents many challenging research problems and is an exciting high-growth field of study. The communication, signal and image processing group will focus on the engineering problems and opportunities arising at the confluence of these three sub-disciplines. We are particularly pleased to have a new faculty member in this area, Dr. Hamid Sadjadpour. He specializes in information coding and the design of related hardware, such as DSL modems.

There is significant opportunity for interplay between this focus area and the MEMs & nanotechnology area mentioned above, i.e. VLSI/MEMs/nanotechnology for communications & signal processing. This would be another likely niche for the UCSC EE Dept. in the MEMs/nanotechnology area. Concrete examples of this type of work would be:

- MEMs for wireless applications, mechanical resonators for high Q filters, MEMs variable capacitors or inductors that could allow the realization of higher Q components.

- MEMs RF switches, much greater current capability, breakdown voltage, isolation and lower loss than transistors.
- MEMs for optical switching, filtering etc. (extremely commercial at the moment, but are there higher risk things to investigate?)

STEPS: Remote sensing is the EE Department's participation in the campus wide environmental initiative using the STEPS approach (Science, Technology, Engineering, Policy and Society). Prof. Vesecky has interests in remote sensing instrumentation systems, electromagnetics and wave scattering. He is very well suited to contribute to the engineering aspects of this initiative and the related campus institutions, such as the newly formed Institute for Geophysics and Planetary Physics (IGPP).

2.2 Participation in Cal ISIs, QB3 and CITRIS, and other Cross Disciplinary Collaborations

UC Santa Cruz will play a key role in two new California Institutes for Science and Innovation established recently by Governor Gray Davis. The Institute for Bioengineering, Biotechnology and Quantitative Biomedical Research (QB3) will be centered at UC San Francisco with major research components at UC Santa Cruz and UC Berkeley. The second Cal ISI is CITRIS, the Center for Information Technology Research in the Interest of Society.

The QB3 institute promises to lead the next revolution in biomedical research, integrating physical, mathematical, and engineering sciences to create powerful new techniques for attacking biological problems of such enormous complexity that they have simply remained unapproachable—until now. The institute will foster new technology and collaborations for projects such as development of artificial tissues that mimic those found in the human body, advanced medical imaging techniques and computer-assisted analysis to improve the detection and treatment of diseases, such as prostate and breast cancer. Another focus will be bioinformatics--computing methods to sift through the volumes of data generated by the human genome project and other new developments in biomedical research.

The EE Department role in QB3 will likely be through UCSC's Center for Biomolecular Science and Engineering at UC Santa Cruz, directed by Computer Science Professor David Haussler. The areas where EE Dept. faculty can contribute are summarized as follows:

- New semiconductor, MEMS and nanotechnology devices, such as the micro cameras that travel through the human gastro-intestinal track collecting images that detect abnormalities like polyps that are the forerunner of colon cancer and micro array analysis devices for applications in biomolecular engineering, such as detection of a large set of pathogens by detecting the antibodies they produce.

- Advanced signal and image processing techniques to produce medical data, especially images that can be interpreted more easily and with more reliability for diagnosis.

The CITRIS institute aims to bring the benefits of information technology to challenging problems in areas, such as transportation, education, emergency preparedness health care and the environment. Business and private donors have pledged more than $173 million to CITRIS over four years, including nearly $50 million from industry and $124.5 million in individual donations. Along with the $100 million from the state and an expected $83 million in private and federal research grants and contracts, CITRIS would receive total funding of more than $356 million over four years. Among the 13 corporate sponsors are Intel Corp., Microsoft Corp., Nortel Networks Corp. and Sun Microsystems, Inc.

Areas where EE faculty can contribute to CITRIS are summarized as follows:

- Building on UCSC's very successful REINAS (Real-time Environmental Information Network and Analysis System) project, develop an advanced real time system for gathering, processing, archiving, analyzing and transmitting to the user a wide variety of environmental data. An example would be gathering anemometer and radar data on winds over the coastal region from Bodega Bay to Pt. Sur. These data would be assimilated into a wind field model, providing winds everywhere in the region on a 2-km grid on an hourly basis for use in weather forecasting, boating, crop dusting and other activities in which surface winds play a role.

- Special environmental sensors for use in the system above that would sense quantities, such as soil moisture, toxic substances and disease indicators, allow this information to be transmitted by wireless and other links to a REINAS type system with public access via the internet and wireless modes.

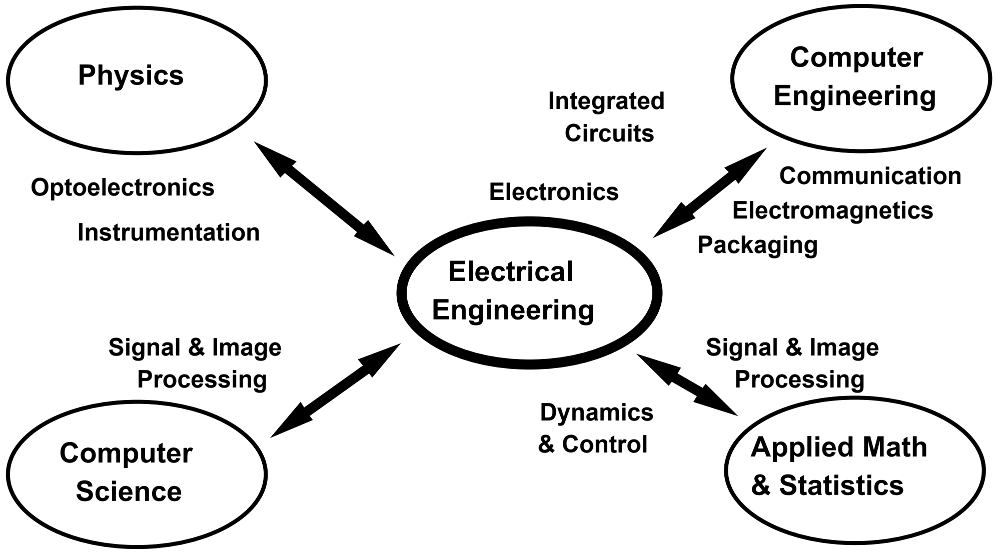
- New devices for optical communication and data networks, e.g. optically controlled optical switches, inexpensive optical data storage devices and advanced data coding and transmission techniques.

- Advanced image and signal processing methods for applications in transportation, education, emergency preparedness, health care and the environment.

- Our work on virtual and real teaching laboratories will be coordinated and expanded within the CITRIS effort on smart classrooms.

In addition to collaborations with other UC campuses and other research community the EE Department plans to continue existing collaborations within the UCSC campus and develop new ones as illustrated in Fig. 4 below.

Fig. 4. Electrical Engineering Affiliations



EE faculty complement the work in the Physics and Chemistry Departments in Division of Natural Science. For example, EE expertise and laboratories in nanotechnology and optoelectronics fit well with Nat Sci's new initiative in the Applied Physics program.

EE has a strong emphasis on engineering education and novel techniques for web based virtual and real laboratories and active learning. We plan to work closely with Education and Psychology departments in order to evaluate students' needs and assess the effectiveness of the novel teaching techniques. NSF strongly encourages such multidisciplinary collaborations between engineering/science and humanities.

Within the School of Engineering there are many natural collaborations as shown in Fig. 4. This network, consisting of EE faculty as well as 10 specific affiliated faculty in other departments, allows us to develop research collaborations as well as offer high quality graduate EE education in optoelectronics, electronics, integrated circuits, fiber optic and wireless communication, signal and image processing and remote sensing. Other areas of specialization will be added as the School of Engineering's projected expansion grows to well over one hundred faculty FTE over the next ten years.

There will also be a lot of opportunity for synergy and collaboration inside the EE department between main focus areas. For example, Profs. Milanfar, Pedrotti and Shakouri are already collaborating on a new imaging hardware and software for thermal analysis of integrated circuits. MEMs components are also becoming increasingly used for communication and signal processing applications (RF switches, resonators, variable capacitors and inductors and photonic switching).

2.3 Silicon Valley Center

There is more to the connection between UC Santa Cruz and Silicon Valley than the short drive between them. Electrical Engineering at UC Santa Cruz will play a key role in developing the 25-acre University of California Silicon Valley Center (currently under development by NASA, local industry, and the University of California) by providing both academic and research programs at both the undergraduate and graduate levels. Students could complete academic degrees while living at the Center and working part-time in industry. Graduate students could complete much of the research phase of their education as part of the center, in collaboration with scientists and engineers from other UC campuses, NASA Ames and Silicon Valley companies using planned and existing research facilities. Many of the initiatives proposed above would benefit greatly from implementation at the Silicon Valley Center.

2.4 Pacific Rim Roundtable for Technology and Society

The Pacific Rim Roundtable for Technology and Society provides opportunities for collaboration with institutions in Asia. Since much of the research and manufacturing in semiconductor and other electronic and optical systems are in Asia, this area provides the School of Engineering with a very large group of potential collaborators. Below we summarize some ideas for taking advantage of the opportunities available in the Pacific Rim:

- Develop research and intern relationships with local industries that are based in the Pacific Rim

- Develop relationships with educational and research institutions in the Pacific Rim, for example the Centre for Remote Imaging, Sensing and Processing headed by Prof. L. K. Kwoh at the National University of Singapore.

- Develop student exchange programs with Pacific Rim Universities

- Target professional meetings in the Pacific Rim for participation.

2.5 Relationship and Support from Industry and Government Laboratories

A key issue for the success of the new electrical engineering program is to benefit from the close proximity to Silicon Valley and the high tech companies in the bay area. Similarly it is beneficial to have research relationships with government and research laboratories. With respect to industry we have existing relationships with a number of firms as outlined below:

- Recently, we have received several RF test equipment items (list price ~$800K) as a donation from Lucent Technologies to support our research and teaching laboratories

- Faculty with interests in optoelectronics have developed a research collaboration with K-2 Optronics, sharing equipment and research projects.

- AMSL (formerly Silicon Valley Group): We have made contact with the AMSL facility nearby in Scotts Valley. AMSL are manufactures of innovative equipment for semiconductor fabrication lines. They also have a plant in San Jose. They have indicated interest is both research collaborations and internship programs. We have met with the principles in this effort at AMSL and have invited them to visit us at UCSC in October. At the October meeting we will finalize the first steps in establishing these programs.

Our future plans regarding relationships and support can be summarized as follows:

- We are already establishing joint research projects with high tech companies through the UC SMART and Micro programs, e.g. with Agility Communications, and plan to continue and expand this effort.

- The School of Engineering has made contact with National Semiconductor who provided the keynote speaker, Dr. Dennis Monticelli, at this year's faculty retreat. National has a special interest in analog integrated circuits that fits well with faculty interests in the photonics and electronic group.

- Recruit companies, especially those with whom we already have contact, to sponsor graduate students via fellowship and graduate internship arrangements. We are fortunate to have current Dean Steve Kang and Founding Dean Pat Mantey to help in making the initial contacts at companies with shared interests.

- Industrial Affiliates Programs are run by many top universities, e.g. Stanford, Illinois, Michigan, etc. We plan to use this vehicle for establishing and fostering relationships with industry. This may be by participating in a School of Engineering Program or by having a smaller EE Dept. Affiliates Program. We suggest that the best approach be investigated by an SoE committee to recommend a path toward and effective Affiliated Program.

The same ideas discussed above with a view toward industrial partners can also be used with government and other research laboratories. However, there are some special cases worthy of mention as follows:

- UC has a special relationship with the two national laboratories managed by the UC, Livermore and Los Alamos. Both these laboratories offer graduate fellowships to UC students who will engage in joint research with staff at these government laboratories. We plan to investigate programs at these laboratories, especially Livermore since it is close, to see where the best matches in research interests lie. A new faculty appointment in Astronomy, Claire Max, will be particularly helpful as she is former director of and works half time at Livermore in the Institute for Geophysics and Planetary Physics (IGPP).

- SRI International at Menlo Park, California is a large nearby research institute with a wide variety of interests. Professors Milanfar and Vesecky already have extensive contacts and joint research programs in place at SRI. We plan to investigate areas of mutual interest and plan to expand research and internship opportunities.

2.6 Faculty and Staff Resources

The research establishment of a first class electrical engineering department requires research personnel in addition to the teaching faculty and graduate students, in particular

- Research Faculty whose main interest is research and are funded by research grants although they may teach classes from time to time

- Research Staff including technical and administrative appointments

- Post Doctoral Research Fellows

We plan to recruit personnel in these categories as shown in Tables 1 and 2 above. We show these recruitments graphically in Fig. 5. We plan to make the research faculty equal in status with teaching faculty and have roughly

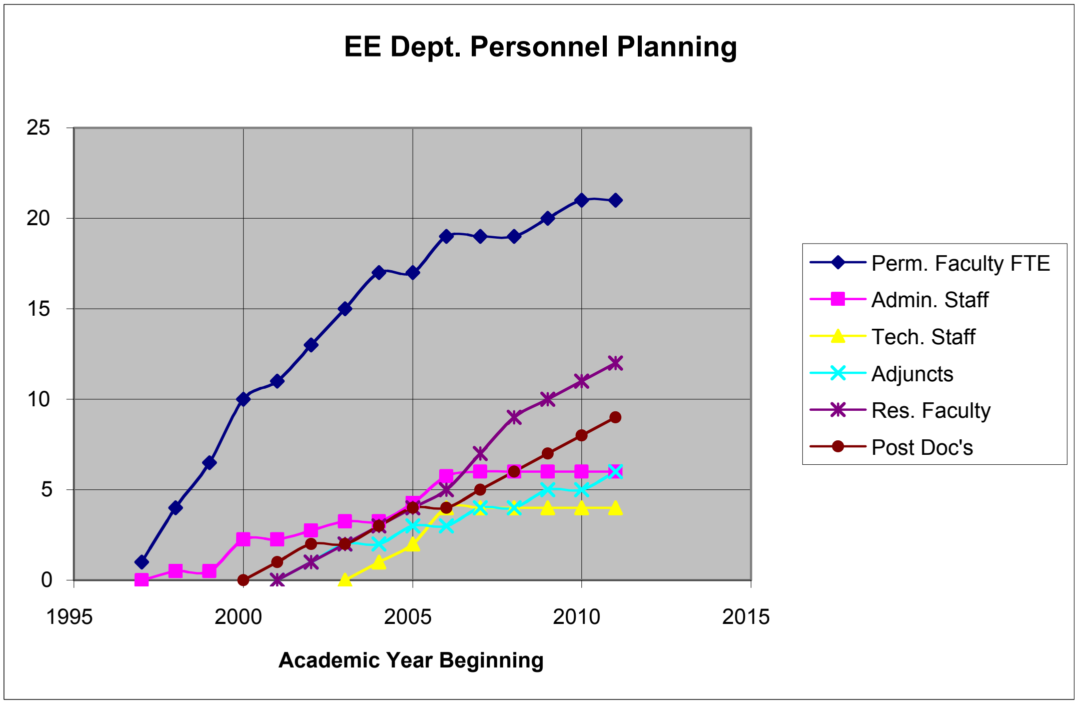


Fig. 5. EE Dept. personnel planning in support of research. Note that a substantial contribution to the research effort is planned to come from research faculty.

equivalent recruitment, promotion and merit review procedures. The main difference being that the teaching faculty focus on teaching and are ladder rank (tenure track) faculty in the UC system and the research faculty focus on research and are supported primarily by research funds, intra and extra mural. This system has worked very well at Michigan and other first class engineering schools. Adjunct faculty would also contribute to the research effort although on a part time basis.

There are several trends to note in Fig. 5. We comment on each curve in turn in the order shown in the figure legend. The number of teaching faculty (blue diamonds) is more rapid in the start-up phase of the EE Dept., lasting until about 2004. After this time the growth in teaching faculty is less rapid, but significant. The administrative staff (magenta squares) jumped upward between 1999 and 2000 because the School of Engineering was established and the SoE Business Office took business activities, previously done by the School of Natural Sciences. After this time the administrative staff is planned to grow slowly to 6 by 2011. The technical staff (yellow triangles) presently consists of Bob Vitale and Dave Meeks whose main task is to support the instructional laboratories and student design/research projects. They also support research on an as needed basis. As time passes we plan for the technical staff to grow as people are hired to work on large research projects that need support beyond what graduate students can do, e.g. building hardware for large systems. We plan a significant increase in Adjunct Professors (green X’s) to a level of six or more by 2011. In the UC system Adjunct Professors must go through the same appointment process as regular faculty and thus this appointment is far more than a temporary or honorary one. We visualize Adjunct Professors as coming mainly from industry, such as people who are fellows in their company and can spend significant time in the EE Dept. over a long time span. We anticipate that adjunct faculty will supervise research projects, teach and strongly participate in supervising graduate students. We plan to have research faculty (purple X's) play a very significant role in the life of the EE Dept. and simultaneously in the INIST (Institute for Networking and Instrumentation Science and Technology) Organized Research Unit (ORU) now underway under the leadership of Prof. Pat Mantey. These research faculty would have principal investigator status and maintain themselves and their support from research grants as is done at other first class engineering schools. As shown in Fig. 5, we plan for a slowly rising number of research faculty reaching a number about half that of the teaching faculty by 2011. Postdoctoral research fellows (red dot's) will form another strong component of the research establishment, reaching about nine by 2011. Thus, teaching and research faculty would have about one postdoctoral fellow for every three faculty.

Part III Capital and Resource Development

3.1 Instructional and Research Space

To estimate EE Dept. needs for instructional and research space we have used the student and staff numbers from Tables 1 & 2 to drive estimates for the number of rooms required in seven different categories. The results are shown in Fig. 6 below. Next we summarize how the estimates were made in each of these categories as follows:

- Teaching and research faculty offices: the number of offices is simply the total number of faculty (teaching and research) and 160 sq. ft. are allowed for each

- Administrative and technical staff offices: one office is allocated for each staff position and 130 sq. ft. are allowed for each office

- Post doctoral research fellow offices: two postdoctoral fellows are allocated per office and the office size is 130 sq. ft.

- Graduate student space: five graduate students are allocated a 300 sq. ft. office on the average

- Research Laboratories: the number of research labs is taken to be 2/3 of the number of faculty with some labs being shared – each lab is 400 sq. ft.

- Teaching Laboratories: we allocate one teaching lab per 40 undergraduate majors which means we would require two more such labs by 2011 – each lab is 1000 sq. ft.

- Teaching Classrooms: we allocated one teaching classroom of 600 sq. ft. per 66 undergraduate students

- Infrastructure Rooms: these are storage rooms, seminar rooms, video conference rooms, etc. that are not offices, laboratories or classrooms, etc. with an average size of 400 sq. ft.

As shown in Fig. 6, these factors result in a requirement for departmental instructional and research space of about 9,000 sq. ft. in the current academic year (2001-02) rising to about 29,000 sq. ft. in academic year (2011-12). The majority of the space is related to research and the graduate program and is typical for a department of the size contemplated here.

In these estimates there are various assumptions that affect space planning for the School of Engineering and the campus as a whole. For example, these estimates include all projected needs for research space. The INIST ORU may indeed supply some of these space needs. Also we have not included any space for undergraduate computer labs under the assumption that the UCSC campus wide CATS organization will supply that space as they do currently.

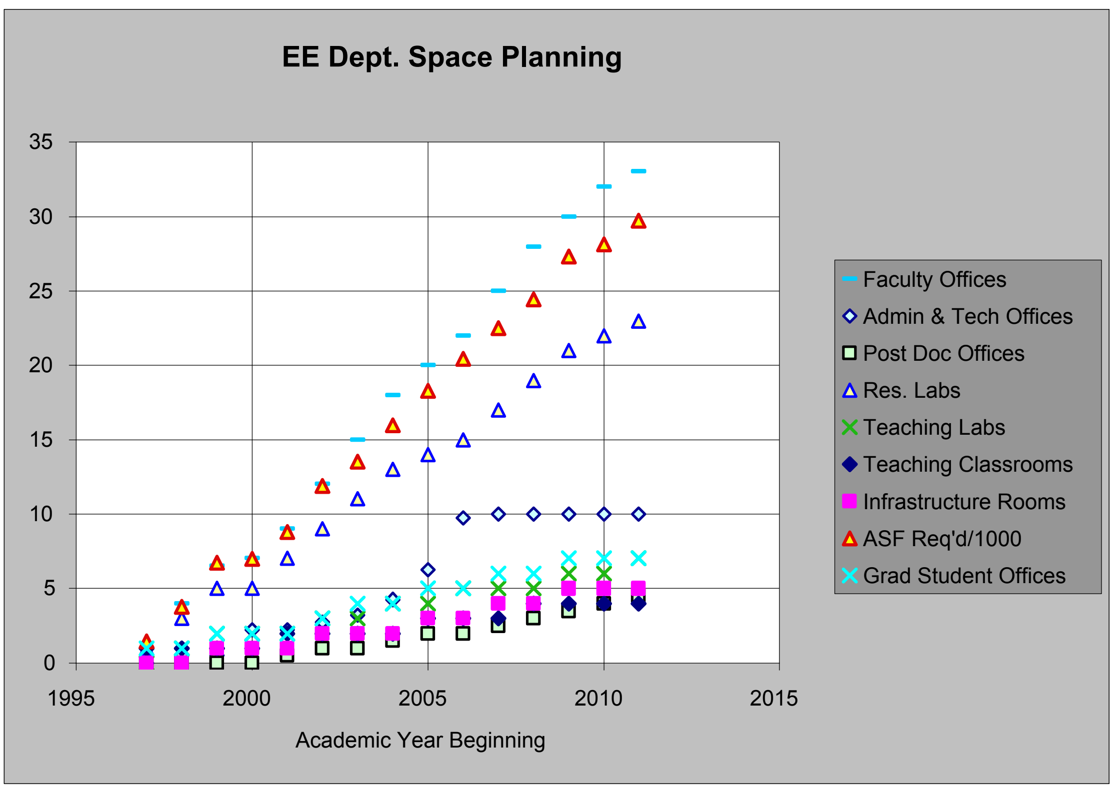


Fig. 6. EE Dept. space planning time line for the academic years beginning in 1996 and continuing to 2011.

3.2 Extramural Research Funding

The electrical engineering faculty currently bring in about $1 million per year total to the UCSC campus and another $ 0.3 million per year at other campuses (to cover research still in place at other universities, such as Michigan and UC Davis.) Not counting our two faculty who are new this year, Holger Schmidt and Hamid Sadjadpour, we have about $200,000 per year per faculty in extramural funding. Our goal is $300,000 per year per faculty on average. Those engaged in laboratory and hardware programs will be above this value and those engaged in analysis and computation intensive programs would be less.

In the future as research and adjunct faculty are recruited the extra mural funding levels will necessarily rise significantly. To have a substantial research program a research faculty must attract about $500,000 in funding to cover the faculty member's salary and support graduate students and post doctoral fellows. An adjunct faculty member could be expected to bring in about half that of the research faculty if engaged in research. If we take the faculty numbers from Tables 1 & 2 and project that the teaching faculty will reach the goal above and that half the adjunct professors will be active in research, the EE Dept. extra mural funding level should be about $ 13 million per year. For comparison the Atmospheric, Oceanic and Space Science Dept., containing the Space Physics Research Lab. in the College of Engineering at Michigan (Prof. Vesecky was formerly the Director of this research laboratory) had an extramural research budget of $15 million/year with a complement of about 17 teaching and 20 research faculty. So we think that this projection is realistic.

A <u>very important point in the encouragement of extramural funding for faculty</u> is positive feedback. We recommend the following to implement this positive feedback:

- Faculty and staff who secure grant or gift funding should receive public recognition, e.g. at faculty meetings and SoE meetings

- Faculty and staff who secure grant or gift funding should receive a portion of the money that is returned to the university as opportunity funds. That is, a faculty member should have proportion of the 'opportunity funds' deposited in their unrestricted funds accounts for them to invest in future research opportunities as they see fit.

3.3 Private Funds Development

Since the EE Dept. has only been in existence for a few years, we do not have a cadre of alumni to draw donations from and have not made contact with potential donors to the Department. However, we do have some ideas to put in place to encourage private giving to the School of Engineering.

School of Engineering alumni should be tracked and kept in contact with the school after their graduation. Ideas to make this happen are as follows -- some have already been discussed elsewhere, but are included here for completeness:

- Free email accounts at the soe.ucsc.edu mail server – graduates often make use of a second email account outside of the one associated with their business for confidential matters, family and friends.

- A School of Engineering Newsletter, either on paper or electronic that is sent to alumni on a quarterly basis

- A distinguished alumni award each year with the recipient asked to come to campus and present a seminar or 'fireside chat' with a reception or dinner to follow

- Personal connections by the faculty and alumni are the key to soliciting private donations. We plan to request a briefing at a faculty meeting by our SoE development officer to alert us to opportunities, techniques and procedures concerning private donations.

- Members of the faculty and staff who successful solicit private donations should receive recognition and a portion of the donation for use in their research and teaching programs.

Part IV Summary

The ten-year strategic plan for the Electrical Engineering Department set forth above has a number of key features that are worthy of emphasis. We discuss them below in roughly the order of priority.

The heart of our strategic plan is to recruit and retain very high quality teaching and research faculty. Thus far faculty recruiting has been exceptionally successful. The excellence of the School of Engineering as a whole and the exceptionally pleasant location of UCSC are significant recruiting advantages, but the high cost of living and especially the high housing costs are a disadvantage that can be offset by attractive salary levels and consulting opportunities. We plan to continue the high standards used thus far in hiring and increase the quality of our candidate pool by devoting more faculty and staff time as well as funds to recruiting efforts. Our strategic plan calls for the EE Dept. to recruit teaching and research faculty from the current 9 faculty to a level of 21 teaching and 12 research faculty by academic year 2011.

To make an impact on a national and international scale the EE Dept. must focus its resources on a few areas of excellence. We have chosen the following:

- Photonics and Electronics

- Communications, Signal and Image Processing

- VLSI design, Micro- and Nano-technology.

These areas are on the forefront of modern electrical engineering and are top priorities for Silicon Valley industry. The research program as well as the undergraduate and graduate academic programs will be built around these focus areas.

The EE graduate program plan begins with the approval of the graduate program proposal that was approved by the UCSC Faculty Senate, Campus Provost and Chancellor and is now under consideration by the UC Office of the President. Implementing this program will mean recruiting a graduate student population rising to some 90 graduate students by academic year 2011. We plan to make the graduate program accessible to students who work full or part time in industry as well as involving graduate students in joint research projects with industrial research centers.

The EE undergraduate program is in place with the first graduating class of about a dozen students finishing in academic year 2000. We plan to increase the undergraduate population to some 250 EE majors by 2011. Within this program we feature an emphasis on mathematical analysis of problems as well as laboratory and design work. Internship in industry will play a vital role in attracting high quality students as well as working closely with technology companies.

The research program revolves around the focus areas above. We plan to make extensive use of adjunct and research faculty to expand our research program, working closely with the School of Engineering ORU, INIST. By 2011 we plan to add 6 adjunct and 12 research faculty as well as 9 postdoctoral research fellows. Coupled with graduate students, research staff and 21 ladder rank faculty we plan to have some 150 people involved in the research enterprise ten years from now. We project an extramural research budget of some $13 million per year by academic year 2011.

To support the EE teaching and research program we will require some 30,000 sq. ft. of space for instructional classrooms and laboratories, research laboratories, faculty staff and student offices and workspaces.

The EE Dept. faculty, staff and students are committed to implementing our strategic plan in order to accomplish our mission of building a high-quality, sustainable teaching and research program that will inspire graduates and undergraduates in the theory and practice of electrical engineering, serving Silicon Valley and the nation, while providing satisfying careers in teaching and research to faculty and staff.

Assessment of Graduate Program in Information Systems and Technology Management

Prepared by
By Prof. Ram Akella, SUNY/UB

Executive Summary

A new Graduate Program in Information Systems and Technology Management (ISTM) will be uniquely positioned to meet the needs of High Tech firms in Silicon Valley and elsewhere. This will enable UCSC to penetrate Silicon Valley at the executive level, and build on (and beyond) the current successful undergraduate program in Information Systems Management (ISM). The program will meet needs expressed by senior executives and managers engaged in managing businesses with a uniquely tight integration between business processes and information systems, through a corresponding integration between technology, management and industry, at SOE, together with SSD. The proposed program has a high potential for strong enrollments, and will draw upon inter-divisional collaboration, as well as external partnerships, such that with UC Berkeley. The resultant use of the IT/IS strengths of CS/CE and of other strengths of the economics and psychology departments, together with executive participation, will enable success and self-sufficient operation of a high quality program with key senior hires. I have validated industry needs by consulting with several key executives (attached list in Appendix 1).

Background

The Role of IT/IS:

The role of IS and IT has become increasingly clearer in the past decade. These technology resources play three key roles within both private sector and public institutions: 1) to support organizational efforts to improve productivity and profitability, 2) to allow the broadening of the scope of employee tasks, activities and even entire jobs through extensive computer support and 3) to support key business strategies (such as Supply Chain Management and Data Mining for Customer Relationship Management) to achieve and sustain a competitive advantage. The motivation of companies to pursue the use of IS and IT in these three roles is obvious. The demands of the global economy put a premium on creating an agile, resilient and responsive organization. Managing the creation, implementation and support of computer-based systems requires knowledge of this technology by those running the business and a close working relationship with those charged with the direct responsibility of IT. This dictates the need for people to be trained to specifically address these organizational requirements with leading-edge Information Systems and Technology Management approaches that are compatible with an environment that places a premium on time to bring new products or services to market and to then replace them with newer products or services and the time-to-decisions within the organization.

Thus the role of IS and IT in productivity gains has been clear over the past decade. However the recent downturn still indicates that there is a significant gap between Information Systems and Technology and the ability to use this most for sustained profitability, namely the Management of this Technology. This requires a deep and simultaneous understanding of IS, the elements of the specific technology under consideration such as semiconductors, computers, telecommunications, or biotechnology, and the economics underlying the high tech business including investment, supply chain management, and the economics of e-business.

Status of Comparable IT/IS Programs:
Many graduate (and undergraduate) programs have recently started offering degrees or are in the process of doing so, in IS/ISM or IT, with a technology and Business Administration/Management focus, including UC Berkeley, MIT, Stanford University (IT/IS in the MBA program and an Engineering program under discussion), San Jose State, Santa Clara University, Georgia Tech (B.S. in Information Systems Engineering and M.S. Certificate in Enterprise Engineering, both under development), and Carnegie Mellon (both the very successful campus program, as well as the newly proposed Carnegie Mellon IT Program at the NASA/Ames site, in the Bay Area). These programs have become popular, as increasing enrollments indicate, as in the case of the masters program offered by UC Berkeley's School of Information Management and Systems (SIMS) (an increase to 33 admits, during the third year, compared to the first year admits of 22, with a blip to 50 during year 2), and the CMU program (30 in 1995 to 149 in 2001). However, discussions with major industries indicate certain significant gaps in the existing programs, which can be filled through this new, uniquely designed program. Even factoring in the current downturn, it is anticipated that self-sufficiency in enrollments can be attained by 2005, at the latest (assuming hiring a lead faculty member by Fall 2002, and the proposal and acceptance of a MS program by 2003, with corresponding additional hires). Since the proposed program is a combination of several programs, estimating the potential enrollment needs to be achieved by considering the subset of students enrolled in IS & IT programs (e.g. UC Berkeley's SIMS enrollment), as well as MBA programs with an IS/IT emphasis (as at Berkeley's Haas Business School, or at MIT's Sloan School of Management). In my estimation, the enrollment figure for the first plateau would be between 60-100 students, centered at 80, in steady state. This is based on the program strengths (30-150 students) at major schools and local Bay Area school enrollment levels. In addition, modularized courses in the program would prove very effective for the MAS program courses, and also for industry outreach courses that are business management, executive, and/or engineering oriented. Together with these and increasing enrollments, the program size might then reach 150-160 by the end of the decade, if UCSC takes an aggressive and pro-active approach, with corresponding resource needs.

Industry needs:

- Typical issues faced by CEOs and CIOs of high tech include:
    - What IT architecture will enable my business strategy?
    - What software infrastructure do we need to put in place to respond to changing business needs?
    - Should IT be developed in-house or should it be outsourced? And to whom should it be outsourced?
    - If developed in-house, how do I make the build versus buy decision?

- What basic enterprise software and additional customization do I need to coordinate my design, process, and manufacturing teams?
- How much of the problem is due to lack of efficient business processes?
- What software do I need to manage my multiple sites, suppliers, and customers, together with the supply chain inventory? What type of database architecture and industrial strength databases do I need?
- What type of additional relationships can I find in all marketing, sales, design and operations data I am collecting, through data mining techniques, that will enable me to increase profitability? How can I attract more customers by understanding their (unstated) needs better?
- How do I identify the common data needed by different functions such as design, marketing, and operations, and arrange to set up databases, as well as data marts and data warehouses for the proper indexing of data, as well its analysis to obtain useful insights?
- What networks do I need to use, and what bandwidths, protocols, hardware and software caches, and web server architectures are most effective for my evolving needs?

As can be seen, the ISTM Program requires faculty with expertise in databases (CS/IT), data mining (CS/IT), computer and telecom networks and protocols (CS, CE, EE), and domain expertise in the business area (Management and economics component of ISTM).

Other questions posed by executives and CEOs of high tech and software firms include:

- To execute my business strategy, should I invest more in business development, marketing, engineering, or operations? Or should I consider acquisition/partnership?
- How do I determine the right acquisition partner/candidate?
- Which of these alternate projects should I invest in? How does this impact my ROI (Return on Investment)
- If the company I am acquiring completes my product portfolio, but has a completely different IT system, is it worth acquiring? Can I believe their market forecasts?
- What should my debt to equity ratio be?
- Should I introduce new products or ramp yields on current products to maximize ROI? How do I do it?
- How should my team be configured – people with similar skills or diverse skills? How are the appropriate responsibilities, rights, and incentives determined to maximize firm individual profit?
- What is my business model?

CEOs and other executives of start up companies face issues such as:

- What should my growth plan be? Should I grow engineering around my product (suite),
  or should I grow marketing?
- What should my stock allocation be between founders, executives brought in, employees, directors, VCs (Venture Capitalists), etc.?
- What type of executive should I hire for marketing? Should I go by head hunters, word of mouth, or VC suggestions?

- •Should my effort be in business development and alliance formation, or product development? Are there natural transition points?

Note that these questions require both an in-depth understanding of the domain of software and high tech (such as semiconductors, computers, telecommunications, and bio-tech) and business functions such as operations, strategy, marketing, finance, costing/pricing/accounting, and business processes such as product development with associated resource management. The need for close interplay between information systems and technology management is evident in all these issues. Without a proper business systems and domain understanding, the data needed, and the way the data is to be organized and analyzed, would not be clear, just as incomplete IS/IT understanding would bring the operation and profitability of a company to a low ebb. Many companies collect data they never use, or cannot take critical business decisions quickly enough to be effective, due to limitations in their modeling and analysis of their businesses or in their IS/IT.

Furthermore, this interface area of ISTM described above is one in which the major software industries are investing resources, as the next big growth area, in addition to growing their original key competency areas in IT and software infrastructure (such as Oracle's database strengths or Microsoft's operating system capabilities). Executives mentioned the growth of Siebel Systems (in Customer Relationship Management-CRM) and SAP (Supply Chain software) as striking instances of growth, and their investments in related areas in their own companies. Discussions with senior executives indicate their increasing investments in domain understanding and expertise, as a key differentiator in growing business (see the executives and companies in Appendix 1).

In summary, there is strongly expressed industry need, particularly in Silicon Valley and high tech, to train potential executives and managers, who are outstanding new college hires, or excellent engineers with a few years of experience, or even managers, with identified executive potential. In particular, these executives see the need for a new MS program training mature and experienced students with:

- Depth in information systems and technologies
- An excellent understanding of domain technologies such as semiconductors, computers, telecommunications, bio-tech and software
- A deep understanding of business processes and leading edge methods for managing these high tech environments, drawing upon the best IS/IT technologies

These MS graduates would be on fast track careers, which under ideal conditions, would result in a CIO, COO, CEO type of career path.

A UCSC Solution: The proposed ISTM (Information Systems and Technology Management) Program

Program Theme and Value proposition

Thus, there is clearly a strong need for an integrated program that combines in depth understanding of Information Systems Technology with Business Management, with a high tech focus. While there are several good programs in each of these areas, there appears to be virtually no integrated program that combines both areas and domain expertise. Consequently, it would be timely to initiate a program which combines both features, differentiated from other programs which are strong in one or the other, but not in both. Such a program would have significant potential for additional synergies from the perspectives of enhancing excellence, technical collaboration, and resource growth in the CS/CE/EE/BME areas, while achieving national and international impact. This strategy of achieving excellence with a compact base of resources exploits the fact that executive level interactions often result in a broad spectrum of interactions including more funded research support of technology areas. Senior faculty in the ISTM area would engage with executives in developing the teaching and research thrusts. Areas such as CS/CE/EE/BME would thus have additional colleagues (sharing overlapping interests) to work with on an extended set of research and teaching interests, as also additional resources that might potentially result from the additional engagements with industry at the executive and other levels by ISTM faculty. The increasing requirement of agency funding for industrial participation makes this point doubly important. The synergy and the need for growing an ISTM program and faculty are very similar to the situation in BME (Bio-Molecular Engineering) where the new program (department) faculty possess both overlapping and complementary research and teaching interests as a whole, while individual faculty either have unique new skills or overlapping skills, with respect to faculty in biology and engineering. I provide some indicative possibilities, which are not necessarily exhaustive, of the synergies between ISTM and SOE (CS, CE, EE, AMS), at a minimum, and possibly additional synergies with SSD (Economics, Psychology), and the Arts Division (Digital Art and New Media).

CS/CE/EE/AMS	ISTM	SSD
Networks	Pricing, risk management, Costing	Corporate Finance, M&A
	Trading and supply chain networks	Financial Engineering
Modeling/Simulation	High Tech E-Business	E-Commerce
Decision Support	High Tech Operations	Microeconomics
Databases	Enterprise Systems	
Data Mining	Data mining, data marts, data warehouses	Digital
Multi-media	Large-scale transformation of data to	Media Innovation
	information and knowledge for Extended	(Arts Division)
	Business Process Optimization	
	High Tech marketing	Marketing
Visualization	High Tech Strategy	Strategy
Software Engineering	Product development and process development	
Systems	IT Strategy and the impact of technology	
	High Tech Entrepreneurship	Leadership

Academic Planning and Coursework

For initial planning purposes, the incoming student population will be drawn from a CS (technical) or ISM or business undergraduate major, although CE, EE, and other students can also easily fit in, with some additional remedial coursework. Work experience is significantly more important, and it is anticipated that a majority of the incoming students will be from Silicon Valley, although exceptionally strong students without work experience will also be admitted. The two major groups are likely to be engineers with experience and technical background, with a desire to be trained to be managers, or managers desiring to obtain a stronger technical background, and to further strengthen their capability in Information Systems and Technology Management. The base ISTM program coursework is balanced between the technical and management components. Additional electives will need to be developed, with the management and interface electives being developed as part of the ISTM program, while the technical ones will primarily be those from CS (and possibly CE, EE, BME, and AMS), with some additional ones being developed to suit the specific needs of this program.

Indicated below is an extended list of courses that are appropriate for the ISTM program, and several can be taught almost immediately, and others as the area is staffed. The departments or disciplines from which faculty will be drawn are indicated in parentheses. Observe that this structure is similar to, and a graduate version of, the undergraduate ISM program, which has CS and Economics courses. A total of 9-12 courses will be required to complete the degree, depending on the candidate's background, with 4-5 management courses, and a like number of technical courses. The expectation is that the candidates will learn in areas complementary to their original strengths; the minimal core and electives can thus be covered typically in 9 courses, which would take about a year. Also, an efficient use of modules and modular courses, and the production and availability of routine materials such as basic accounting via distance learning or on-line (synchronous and asynchronous) will lead to an effective use of faculty and student time. This will also free up the time needed for learning state-of-the art and leading edge materials through a combination of faculty lectures, guest seminars (leading academics and executives), and the peer socialization that is crucial for learning and long term networking.

<u>Management Core and Electives</u>: (by ISTM) – To take 4 or 5 courses at least

- Product, Process, and Design Management-I (Core)
- Product Development and Process Management-II
- Managerial Finance and Accounting-I: Product and Process Finance (Distance Learning based Accounting will be a Pre-requisite)
- Managerial Finance and Accounting-II:
- Operations Management
- Supply Chain Management and E-Business I
- Supply Chain Management and E-Business II
- Business Strategy and Information Systems
- High Tech Marketing
- Technology Strategy and Management, including Research Management
- Managing High Performance Technical Employees
- High Tech Entrepreneurship
- Information Economics

<u>Management Electives (by SSD)</u>:

- Economic analysis (Econ 200)

Corporate Finance (Econ 235)
Financial Engineering (Econ 236)
Leadership

Information Systems/Information Technology: (By CS, CE, EE)

Storage and Database systems for enterprises (CS, CE, EE) – advanced course
Computer communication networks for enterprise systems (CS, CE, EE)
Software Engineering
Systems Management
Network Management
The option of taking more technical courses from CS/CE/EE/BME

Technology and Management

System Integration
Data Mining
IT Architecture for Enterprises and Exchanges
E-Commerce
Agents and bots
Practicum (either in depth project at work, or extended internship)
Twenty-first century business leadership (Capstone or seminar course)

Additional Electives

Arts Division: Digital Art and New Media
Digital Media Innovation
AMS: Analytic electives, e.g. Bayesian Decision making
Statistics

Program Positioning

These management courses in ISTM will need to be taught with a high tech focus, based on extensive industrial interactions (in contrast with a more traditional orientation towards consumer products etc.). The material needs to be taught from a managerial and executive perspective, backed by the technical depth that Silicon Valley executives often achieve and expect, in turn. Consequently, the instructors must be academics with extensive industrial interactions at the managerial and executive level, at the senior level, and junior hires must be outstanding in raw ability, analytic and research training, as also in communication, and mentored by the senior faculty. Exceptionally qualified managers from industry with appropriate credentials need to be cultivated and hired, as also other or part time instructors.

Excellence and Uniqueness: The program would be unique, in attracting top quality engineers and managers with technical and analytic depth, and training them further along these dimensions, and enhancing their ability to solve integrated business problems. This filtering and program training will enable candidates to perform with depth, sophistication and speed at a level not commonly achieved by those trained in typical business schools (where the training is adapted to a diverse set of backgrounds, and cannot require the technical or analytic rigor that the ISTM program can attain).

I expect that the resulting positive feedback cycle will result in a program with exceptional quality and impact, particularly given the quality of Silicon Valley candidates, in terms of ability, drive, and industrial exposure.

Curricular Integration in Program: Thus, the uniqueness of the proposed program curriculum lies in integrating information systems, technology, and management (models). In addition, further integration is achieved by strongly coupling courses and industry projects to problems arising at the participant's work location. This will in turn result in MS level research or industry product development projects, or projects resulting in increased profitability and growth of the company. I would also recommend integrating courses ranging from those dealing with decisions in a large firm to those dealing with a small entrepreneurial venture in its early life phase.

Partnerships for Potentially Enhancing the Program: Additional partnership with other UC units/campuses such as the Haas School of Business at UC Berkeley, or the Anderson School of Management at UCLA, or the School of Management at UC Davis, for required or elective courses (when they are available at the required level of depth and rigor), would further strengthen the quality and perception of the offering, in competing with less rigorous MBA programs.

Other Programs: Additional courses can be added, developed, and taught during the next phase. These could include a wide-ranging set of courses. For several alternate programs, with varying focus and balance between Information Systems, Technology, and its Management, it may be educational to glance through Appendix 2, where several different program curricula, at schools such as UC Berkeley, MIT, Carnegie Mellon, Northwestern, and Georgia Tech, etc. are attached. Other schools such as Stanford are in the process of developing ISTM like program, with an Industrial and Systems focus, as at Georgia Tech. Of the existing programs, the highly successful Carnegie Mellon program appears similar in flavor. However, the proximity of Silicon Valley, and the access to high tech, and the close coupling with CE, EE, in addition to the CS component, would be a key differentiator of the proposed UCSC ISTM program. It appears that locating the program at the Silicon Valley Center would result in the maximum impact and synergy. The quality of the program candidates would also be exceedingly high, much in the same way that is being observed in the undergraduate ISM program.

Unique Sub-Programs The courses mentioned above can be clustered into career theme Sub-Programs such as those listed below (The cooperating departments are indicated in parentheses, BME = Bio-Molecular Engineering, ISTM = UCSC SOE+UCSC Economics + UCB Haas):

1. IS/IT and E-Business (CS, CE, EE, and ISTM). Target: Large users of technology considering the adoption of e-business in a significant way.
2. Software Engineering & Mgmt (CS, ISTM). Target: Software Engineering & Management.
3. Bio-tech Management (BME & ISTM): Focused on the growing demand in managing Bio-Molecular Engineering and BioTech.

4. Design/Manufacturing Process Management (CE, EE, ISTM).. Focused on process-oriented industries such as semiconductors.

The proposed program is unique in terms of the tight integration (and depth), and the focus on high tech. The value proposition is indicated in the following table, where the proposed program is contrasted with other comparable programs such as those at UC Berkeley, Stanford University, and San Jose State University.
Positioning of UCSC ISTM Program vis a vis other programs in the Bay Area

	Quality	Cost	Integration
Stanford	H	H	?
Berkeley	H	M	?
San Jose State	M	L	?
Santa Clara Univ	M	H	?
UCSC	H	M	H

(H = High, M= Medium, L= Low)

Program Resource Needs

Faculty and other Resources Needed to Execute the Proposed Program

I next consider the Full Time Equivalent (FTE) Faculty required in order to meet the proposed course and program needs. The minimum projected enrollment numbers of the proposed new program translate into around 4 faculty slots or Full Time Equivalents (4 FTEs). This is based on UC norms, and without considering the additional benefits accruing from executive level interactions and the positive impact on research and support in the ISTM areas, to other departments such as CS. Thus, starting with faculty strength of around 2-4, corresponding to the initial enrollments, the final faculty strength would be in the range of 10-12, by 2010. For reasons indicated below, it appears feasible to start with a modest FTE increase, and then increase more with the program growth. Currently, faculty in UCSC SOE – in CS/CE/EE – are already active in ISTM (and can be further augmented). Faculty in areas such as Finance, Accounting, and Organizational theory can initially be drawn upon from the UCSC SSD and UCB Haas. The areas of High Tech, Marketing, E-Business and Supply Chain Management, and Design/Manufacturing can be covered through the hiring of an initial senior lead faculty member in 2001-2002, followed by cluster hiring of 2-3 in 2002-2003. That is, the initial program can be sustained with existing (or future) CS, CE, EE faculty teaching a significant set of courses in the curriculum, with the rest being possibly covered by a minimal group, including the initial senior hire, and possibly another lead faculty member in the Information Systems and Technology Management related area, plus two additional hires and/or external part time participants (experienced and senior industry personnel). Furthermore, new hires in CS/CE/EE/BME/AMS could potentially be interested in the research and teaching areas of ISTM. As industry executives in major software and high tech industries indicate, this area is considered a significant growth area. This plan would fit within the projected UC Budget. Thus, initially the Program/Faculty can be resident within the CS/CE/EE departmental umbrella, with the potential, following growth, of being enhanced to a department, when the program growth is significant enough. As the program grows, a combination of cluster hires of two every two years in concert with SSD, would enable combining excellence with critical teaching and research mass.

Recruitment of outstanding faculty can be achieved by drawing upon:

The excitement of an innovative new program producing "super" Managers or Executives mastering the use of IS/IT and the Management of Technology in the Information-based economy of the 21st Century

The proximity and attendant interaction and learning possibilities provided by Silicon Valley, with corresponding intellectual and monetary rewards

The stimulus of new research arising from interacting with executives and others in dynamic high tech companies populated by driven achievers who are extremely bright

The synergies within and without ISTM, SOE, UCSC (including SSD), and UC (including Berkeley, UCLA, etc.)

Associated Ph.D. Program: An associated strong Ph.D. program in this area is highly desirable, as detailed below, for the following reasons:

- The ISTM area is evolving, with strong potential, and need for research to identify and address key issues in depth, at the doctoral level.
- The tight integration in this area and program, between research and teaching, faculty and industry, require developing doctoral students who participate in the research, and also help masters project work with industry.
- Strong doctoral programs, such as those at Berkeley and Carnegie Mellon, support this tight research and teaching integration, in terms of size

As with the program/faculty, the ISTM doctoral program will initially be resident in CS, with links to CE/EE/BME/AMS, and SSD. When the ISTM program/faculty reach a critical mass, the doctoral program will transition to the new ISTM department, with the program and faculty.

Appendix 3 also lists some typical Ph.D. thesis titles in this area, at major schools such as UC Berkeley, and Carnegie Mellon University. I next discuss the nature of doctoral research in this area, as represented by completed and ongoing these and research:
It is important to note that much of the growth in this area during the past few years has been accelerated, with theory lagging the implementations. Consequently, there is a great need for rigorous, scholarly research to obtain the potential gains from the technologies, as also to develop more complete technologies based on sound theory. As an example, while B2B exchanges had been much hyped, even major exchanges such as Covisant (the automotive exchange) lack an economic framework for their operation, which limits the potential gains for the suppliers and manufacturers participating in the exchange. Research in this area is recognized as crucial. Related issues of Supply Chain Management are recognized by virtually all businesses today. A third issue of importance in the software and high tech industries is the decision of the mix of new products versus product revisions to maximize profitability, taking resource usage into account, as well as a host of uncertainties in the development process as well as the business environment. A related issue is that of product and process learning, part of which requires integrating

and analyzing disparate data sets using different Information Management Systems, in the important area of high tech. Other issues range from the drivers of software value chains and consequently IT outsourcing to the efficient use of data mining techniques in environments ranging from complex semiconductor manufacturing to supply chains. Yet another issue is the development of new techniques for trading off risks and potential gains of new technologies, building on concepts from finance, but incorporating new technology and information elements. Also, the anticipated new Web service enabling technologies could potentially require economic analysis and decision making for distributed software development and integration, paralleling the economic analysis of manufacturing and distribution networks. All these require a rigorous doctoral program with depth and breadth.

Internal and External Benchmarking:

Given that UC's emphasis is on quality, it is important to develop metrics for ISTM quality, and use the metrics for planning, execution, and accountability. Given the growth of the undergraduate ISM (Information Systems Management) Program, and the contemplated industrial inputs and impact, I anticipate a very successful program.

It is anticipated that discussions with the campus provost, deans of other units such as SSD and Arts, chairs, and senior faculty will enable a more coordinated and concerted strategy for maximum success and impact.

Next, presented below is a comparison with several other major national programs in this area. Appendix 2 has links to several of these programs. Each of the programs has its own unique features. Since these programs are interdisciplinary, some of the numbers are rough estimates, while others are actual numbers (e.g. UCB SIMS numbers are precise, while the CMU doctoral numbers are based on estimates). I have contacted program directors and/or faculty and staff in several cases, to obtain these numbers. In the table below, the faculty number outside the parentheses indicates the faculty positions dedicated solely to ISTM (or comparable programs), while the slots in parentheses are the complementary slots at the CS department (and the business school, in the case of CMU).

University	Faculty	MS Students(2-year)			Ph.D Students	Track		
		2001	2002	2003		Mgmt	Tech	Degree
UCB	12(+3)	22	50	33	15	M	M	Yes
CMU	10(+3+3)	90	110	149	15-20	H	H	Yes
NWU	13	26	32	32	12-15	L	M/H	*
MIT	7(+5)	(103+13+5)** x 2			7-12	H	L	Yes
UCSC (proposed)	2->12	40-150			4->20	H	H	Yes

* =Stand alone one year program , **= New Product development, IS/IT+E-Biz(per year)
GIT: Still an early stage program, led by ISyE (Industrial and Systems Engineering)
Stanford: Early stage program, under discussion in Engineering, and also covered as an IS/IT stream in the Business School

Additional Synergies

Sketched below are some elements that enable additional synergies and that could help the program grow, and potentially benefit in turn:

- A Center, as part of one of the SOE ORUs (Organized research Units), could provide a link to research and industry for the program, where masters theses based in industrial problems could lead to Ph.D. theses, awarded through the UCSC SOE/SSD units, collaboratively.
- In this regard, some of the concepts and faculty from areas/topics such as data mining, very large scale transformation of data to information, and on-line trading communities, would fit very well with newly initiated programs such as the STEPS (Science, Technology, Engineering, & Society) Institute, There would be two way synergy in interacting and learning mutually from different problem domains, while the conceptual similarities can be exploited, especially in research Theme 1 (Global Biodiversity from Genes to Ecosystems) since a supply chain network is an industrial eco-system.
- Another potentially interesting interaction for ISTM would be with the Center for Intellectual Property Management, in studying the economic trade-offs in licensing and other risk-reward options available to IP (Intellectual Property) developers.
- The recruitment of executives to be partners, teachers, and mentors in the program would ensure that the industry relevancy, that is the unique hallmark of the program, is achieved, as also the integration of the program and industrial culture into SOE.
- Finally, the proposed Pacific Rim Round Table, and university partnerships in progress, such as those with the major universities in Singapore, Hong Kong, India, China, Japan, and Korea, would further enhance the cultural and other learning so key to the program graduates.

Conclusion:

At the current junction of growth at UCSC's SOE, the proposed program in Information Systems and Technology Management has extremely high potential on a wide variety of fronts including intellectual, resource generation, and national and international impact.

Appendix 1: List of Potential Executive and other Contacts for Inputs Through Visits and Questionnaires

1. **Software Firms**:
   Oracle: Jnan Dash, VP (Completed)
   Infosys: Phaneesh Murthy, Member of the Board (Completed)
   Siebel Systems: Tom Siebel, CEO
   Microsoft
   Adobe

2. **Semiconductor Manufacturers (CEO/VP):**
   Intel:Mike Splinter, VP
   LSI Logic: Bill Nelson , VP

3. Computer firms: IBM, HP, SUN

4. Networking firms: Cisco, Nortel

4. Peripheral makers, instrumentation firms: Seagate, Agilent

6. Semiconductor equipment firms:
   Applied Materials: Ashok Sinha,VP, David Fried, VP for E-Business, Jim Morgan, CEO

7. Consulting companies in Strategy and IT:
   David Mark, Jim McRory, Shyam Lal, McKinsey Business Technology Office, Silicon Valley(Completed)

8. **Indian Entrepreneurs**:
   Suhas Patil (Cirrus Logic)
   Kanwal Rekhi
   Vivek Ranadive, Tibco
   Desh Deshpande (Sycamore)
   Narinder Kapany

9. **Academics:**
   UCB: Messerschmit
   CMU: Ramayya Krishnan (Completed)
   NWU: Larry Henschen (Completed)
   MIT: (Debbie Berechman-MS, Sharon Cayley – doctoral)(Completed)
   GIT: John Bartholdi (Completed),Lu?

Appendix 2: Major University Programs

1. UC Berkeley: http://www.sims.berkeley.edu/
2. Carnegie Mellon University: http://www.mism.cmu.edu/
3. Northwestern University:http://www.ece.northwestern.edu/ITP/
4. Georgia Institute of Technology: http://www.isye.gatech.edu/information/
5. Massachusetts Institute of Technology: http://mitsloan.mit.edu/ (See Tracks: e-Business and Marketing, IT and Business Transformation ; also see New Product and Venture Development, Operations and Manufacturing)

Appendix 3:Ph.D. Areas and Titles in ISTM

Sample
Software Value Chain Drivers and IT Outsourcing
Operational Integration of Supply Chains and B2B Exchanges
Speeding up Software Development Processes and Value Chains

CMU
Human Computer Interaction
Software Productivity
Evaluation of Information Systems
Corporate Telecommunication Networks
Business Value of Information Technology
Software Production
Computer Support for Real Time Dynamic Decision Making
Connecting Households
Electronic Data Interchange and Inter-organizational Systems

UC Berkeley
Economics of information technology, machine learning
Information security and privacy
Computer-supported cooperative work (CSCW) and computer-mediated communication
Information-retrieval system design
Organizational informatics and telecommunications and information policy
Language understanding and indexing
Economics of information
Analysis and Implications of Information Network Externalities
An Analytical Approach to Deriving Usage Patterns in a Web-based Information System
A Functional Model of Information Retrieval Systems and Processes
The Egocentric Social Networks of Software Designers: An Empirical Study of Their Association with the Features and Quality of Microcomputer Software
Life-Cycle Cost Analysis of the Creation, Storage and Dissemination of a Digitized Document Collection

CITRIS / iNIST / UCSC Jack Baskin School of Engineering

The **Center for Information Technology Research in the Interest of Society** (**CITRIS**) is a California Institute for Science and Innovation (CISI). This CISI is one of four created by Gov. Gray Davis and the California Legislature and located on UC campuses, as part of the state's FY 2001-02 budget. The CISI are a billion-dollar, multidisciplinary effort to focus resources and expertise from the public and private sectors simultaneously on research areas critical to sustaining California's economic growth and its competitiveness in the global marketplace. UC Berkeley is the lead campus in CITRIS, with partner UC campuses: Santa Cruz, Davis and Merced. CITRIS will sponsor and house collaborative, information technology focused research to provide solutions to grand-challenge social and commercial problems affecting the quality of life of individuals and organizations.

The CITRIS research plan is designed to evolve over time, but will initially emphasize highly distributed, reliable, and secure information systems, referred to as Societal-scale Information Systems (SISs). Based upon its research results, CITRIS will design and demonstrate SISs for a range of applications including distributed "Smart Classrooms" (for enhanced education and training), "Smart Buildings" (that monitor and optimize environments for their inhabitants), Urban SISs (sensors installed throughout the civil infrastructure that provide data for transportation management, disaster response, seismic planning, and environmental monitoring), and Medical Networks (that monitor and treat individual patients). These applications have a number of shared requirements that lead to significant research challenges. An SIS must easily integrate devices, from tiny sensors and actuators to widely-dispersed supercomputers; must connect devices by short-range wireless networks as well as by high-bandwidth, long-haul optical backbones; must be secure, reliable, and high-performance even when parts are down, disconnected, under repair or under attack; must configure, install, diagnose, maintain, and improve itself; and must allow vast quantities of data to be easily and reliably accessed, manipulated, disseminated, and used by those who depend upon it. These challenges are motivating an entirely new approach to software design, system architecture, integrated microelectronic sensors and actuators, and human-computer interaction, including policy and organizational factors. The initial CITRIS research agenda includes the mathematical foundations, hardware and software architecture, and components common to all SISs, coupled with economic, policy, and sociological studies of the role and impact of SISs on society.

At UC Santa Cruz, participation in CITRIS is managed through the iNIST (Institute forNetworking, Information Systems and Technologies) in the Jack Baskin School of Engineering. The scope of research in the centers comprising iNIST has a very close match to those of CITRIS. CITRIS funds will add essential research space to the new engineering building at Santa Cruz.

Included in the "driving applications" of CITRIS are "Environmental Monitoring" and "Disaster Response". At UCSC, the work in REINAS (P. Mantey, D. Long, A. Pang, JJ Garcia-Luna et al.) emphasizes a real-time database systems for capturing and managing real-time measurement data from sensor networks, and visualization / decision support tools for use with this data (see http://csl.cse.ucsc.edu/projects/reinas//). This REINAS work was cited in the CITRIS proposal as "a prototype SIS" and follow-on work from

REINAS at UCSC is expected to continue under CITRIS and iNIST in creation of SISs for these driving applications.

Another driving application of CITRIS is the use of information technology for enhanced education and training, including new approaches to distance learning, to address the State's educational needs. At UCSC, we have already made a "virtual extension" of our campus to Silicon Valley, delivering a focused MS program in Computer Engineering in the area of Network Engineering, via a synchronous remote classroom. From this beginning, and via CITRIS partnerships and funding, potential expansion includes support for asynchronous learning, offering of other graduate degrees, and bringing community college students into engineering classes of UC. Of particular interest are the technologies to support options in synchronous, asynchronous and quasi-synchronous learning with a range of internet connections. A companion area of research of interest to UCSC faculty (Garcia-Luna, Tao, Mantey, Manduchi, Obraczka) is "telecollaboration" to enable effective collaborative work to be accomplished over the Internet. This is of great interest to industry in Silicon Valley, as they need add to their workforce in technical areas, but many will not move to the area for reasons of housing, transportation, etc. Telecommuting with today's technology is not a satisfactory solution for those whose work involves close collaboration with colleagues.

In the areas of " Engineering Systems Technology" at UCSC there are many areas of research that are relevant to the themes of CITRIS. Some examples are:

1. Networking, including wireless networks, network routing, sensor networks, etc., and including the work of Garcia-Luna, Obraczka, and the network performance and high-speed switching work of Varma.

2. Communications systems, including the opto-electronics work of Gu and Pedrotti, and the signal processing work of Friedlander, Milanfar, et al.

3. Packaging, including design of multi-chip modules and systems, which is especially relevant to sensors and other devices that may be on a person, in an instrument package on a building etc. The work, of Dai, Fang, Kang, Pedrotti, Chan and Shakouri, covers design, packaging, cooling, and interconnections (RF and optical).

4. Storage and management of data, including multimedia data and sensor measurement Data, as well as research related to new storage technologies and storage architectures, as done in the Center for Storage Systems and Databases of iNIST (Long et al.)

5. Visualization of data, especially measurement data, and support for decision-making. Pang and Lohda at UCSC are experts in this, and in the area called "visualization of uncertainty". Their work in haptic devices, sonification, and other user interfaces is very relevant to CITRIS applications.

11/30/2001

The Center for Biomolecular Science and Engineering Long Range Plan

UCSC Jack Baskin School of Engineering

December 10, 2001

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Introduction

The Center for Biomolecular Science and Engineering (CBSE) is a Focused Research Activity (FRA) housed within the Baskin School of Engineering and spanning to two other divisions: the Division of Natural Sciences, and the Division of Social Sciences. The CBSE currently has 43 faculty members from nine departments: Computer Science (4), Computer Engineering (4), Applied Mathematics and Statistics (2), Molecular, Cell and Developmental Biology (14), Chemistry and Biochemistry (12), Environmental Toxicology (4), Environmental Studies (1), Community Studies (1), and Physics (1). CBSE members are listed at http://www.cse.ucsc.edu/centers/cbe/faculty.html. The CBSE home page is http://www.cse.ucsc.edu/centers/cbe/.

The CBSE, directed by CS Professor and Howard Hughes Medical Institute (HHMI) investigator David Haussler, first took shape in 1999 and became an official FRA early in 2001. The CBSE is poised to become an Organized Research Unit (ORU) with submittal of a formal proposal in 2002. The interdisciplinary research and faculty recruitment efforts of the CBSE have paved the road for the creation of a new Biomolecular Engineering department in the School of Engineering, and it has worked diligently to establish new interdisciplinary academic programs.

This document is being developed in conjunction with the long term planning for the Baskin School of Engineering, to provide an outlook through 2011.

Mission Statement

The mission of the CBSE is to foster interdivisional interactions through joint research projects, coordinated faculty hiring, and helping to develop joint academic programs and courses aimed at a better understanding of biology and human health. These efforts are unified by the common theme across the divisions of approaching problems in biology and medicine through the study of human and model organism genomes. The DNA blueprints encoding life are amenable to intense study by both computational and experimental approaches, and will be best understood when these complementary approaches are coordinated to tackle specific problems. Such coordination is a primary goal of the CBSE. Specific functions of the CBSE are to:

- Facilitate interdisciplinary research that supports the study of genomic information and structural biology, including the development of new methods and technologies to decipher the structure and function of human and model organism genomes, and to understand their roles in human health and disease.

- Create a stimulating research environment for training graduate, undergraduate and postdoctoral students in interdisciplinary fields of study that are critical to biomedicine in the post-genomic era.

- Seek extramural funds in support of our research and teaching missions.

- Disseminate our research results through interdisciplinary publications, conferences, and the internet.

- To support a core of instrumental and computational facilities.

- To cultivate and maintain productive relationships and collaborations with high-tech and biotechnology industries and with other research institutions.

1. Academic Program Goals and Strategies

As an ORU, the CBSE will not offer academic programs, although it has played major roles in the administration, advising and general support of the computational biology graduate students that are currently part of the Computer Science graduate program, and in the development of new undergraduate and graduate programs in Bioinformatics. Much of the administrative work associated with developing the new programs and establishing a new Biomolecular Engineering Department that will eventually offer those programs is being carried out by the CBSE.

1.1 Internships and Co-op Programs

The CBSE conducted a survey in which biotechnology industry leaders were provided a draft of the graduate program proposal, and asked to comment on their interest in an associated internship program. The majority expressed a strong interest in participating in such a program. This has resulted in an optional industry internship program being planned for the MS and PhD programs in Bioinformatics, and being considered for the BS program. These internships will contribute substantially to the recruitment of high quality students, provide a practical dimension to their academic experience, enhance their preparation for professional careers, and assist them significantly in securing a first position following graduation. The CBSE will help coordinate the internship program until a BME department staffperson is dedicated to such duties.

1.2 Promotion of Diversity

The CBSE values the excellence achieved through diversity in the academic environment, and strives to create such an environment through targeted outreach to women and minorities during faculty, staff and student recruitment campaigns.

1.3 Interdivisional and Intercampus Collaborations

As captured by the CBSE mission statement, interdivisional and intercampus collaborations are the primary focus of the CBSE. In February, 2000, the CBSE responded to a call from EVC Simpson for Initiative Funding Proposals with a joint proposal, from the School of Engineering and the Division of Natural Sciences, requesting support for the CBSE in the form of new, interdisciplinary faculty positions (to be distributed among participating departments), the approval of new academic programs, the formation of a new Biomolecular Engineering Department, and funding for equipment, laboratory and personnel. This proposal resulted in 4 new faculty FTE (2 each in Engineering and Natural Sciences) including upgrades, start-up, and associated academic support in 2000-01. The CBSE is continuing its work to establish new interdivisional academic programs (a proposal for a new graduate program in Bioinformatics will be submitted November, 2001) and recently completed a Biomolecular Engineering Department Long Range Plan that will serve as the springboard for development of a formal department proposal within the coming year.

The CBSE coordinates and obtains funding for large interdisciplinary, interdivisional research projects. Two of the current projects are The "Bioinformatics and Microarray Expression Analysis of Nervous System Function" and the "UCSC Center for Genomic Sciences". Funded by the Packard Foundation, the first project involves 5 faculty from Natural Sciences, 4 from Engineering, and students, post docs and staff from both divisions. The second project was established by funding from the National Human Genome Research Institute and involves 2 investigators from Engineering and 2 from Natural Sciences, 5 engineering staff positions, and 9 students from both divisions. The CBSE will continue to coordinate and obtain funding for such projects.

Individual CBSE faculty members have formed collaborations with CBSE faculty from other divisions and with faculty from other campuses. David Haussler, for instance, collaborates on a project with Chemistry faculty member David Deamer, and with MCD Biology faculty Manny Ares and Alan Zahler on other projects that have resulted in joint publications. Haussler and his team also collaborate with faculty at institutions worldwide on the Human Genome Project. CE faculty Kevin Karplus and Richard Hughey have also worked collaboratively on individual projects with members of the Chemistry faculty. Karplus has collaborated on projects with faculty from UCSF as well, resulting in two joint publications. Our most recent hire (resulting from the CBSE Initiative), Todd Lowe, is housed in Sinsheimer laboratories in part because of the high level of collaboration he plans to establish with MCD Biology faculty. From his graduate and postdoctoral work, Todd has close ties to faculty at several other institutions and is continuing these collaborations.

Intercampus collaborations are of vital importance to faculty of the CBSE in furthering their research and teaching goals, thus the CBSE identifies and facilitates such interactions. The CBSE coordinated UCSC's participation in a proposal to establish a California Institute of Science and Innovation (Cal ISI) entitled the "Institute for Biotechnology, Bioengineering, and Quantitative Biomedicine (QB3)", and wrote UCSC's contribution to the proposal. A cooperative effort between UCSF, UC Berkeley, UCSC and industry, QB3 has been chosen as one of the Governor's first Cal ISIs, thus establishing close research and educational ties between the three campuses. QB3 endeavors to harness the quantitative sciences to create fundamental new discoveries, new products, and new technologies for the benefit of human health. The CBSE is also coordinating the participation of UCSC in a proposal for a UC-wide Multi-Campus Research Unit (MRU) entitled the "Bioengineering Institute of California". This initiative, lead by Prof. Shu Chien of UCSD, involves all 10 UC campuses. The proposal is currently undergoing review at UCSD, the lead campus. UCSC was recently asked to host the next Steering Committee meeting in February 2002. CBSE members Kevin Karplus, Richard Hughey, and David Haussler, and SoE Dean Steve Kang are championing CBSE involvement in this MRU, as well as involvement of the future BME department. The CBSE hosted a visit by Prof. Chien on July 23, 2001 to discuss the goals of the MRU and the status of the proposal. The goals are as follows:

> Under the MRU, the campuses will establish a modern information infrastructure with facilities and staffing for broadband inter-campus transmission, thus forming a network for research and teaching system-wide. It will make possible the sharing of databases, broadcasting of teaching materials, tele-operation of specialized instruments, video conferencing, and telecommunication. It will provide seed funds for inter-campus collaboration for

high-risk, high payoff research, establish graduate student fellowships and facilitate intercampus joint training, hold system-wide Bioengineering Symposia, set up a Traveling Seminar Program, and attract the participation of large industrial companies to facilitate academia-industry collaboration and technology transfer. The MRU will establish state-of-the-art research core facilities for shared usage by the participating campuses. The activities of the MRU will synergize with other units in the UC system, including the four new California Institutes for Science and Innovation.

1.4 Faculty and Staff Resources

Faculty Resources

As an ORU, the CBSE will not hold faculty FTE positions, but the CBSE is playing an integral role in faculty planning for the new Biomolecular Engineering Department, and is highly involved in the recruiting and hiring process. BME faculty will be members of the CBSE, due to the nature of their research and teaching interests, and will have automatic colleagues in CBSE members from other departments and divisions. Details on the planned BME Department faculty can be found in the Biomolecular Engineering Department Long Range Plan dated December 10, 2001.

Staff Resources

Current CBSE staff positions, except for the Assistant Director, are funded from extramural sources. It is the CBSE's goal to become entirely self-sustaining by receiving a percentage of the indirect costs it generates to fund the Assistant Director position and future Budget Assistant and Web Designer positions. This is discussed further in section 3.2 under CBSE Budget.

The following table outlines current and future CBSE staff positions, with positions associated with QB3 building space broken out. Note that year of hire for staff associated with QB3 space is based on estimated occupancy of the buildings, and may not exactly match hiring patterns.

CBSE Staff	**FTE**	**Year of Hire**	**Funding Source**
Assistant Director	1	2000	SOE
Admin. Assistant	1	2000	HHMI
Technical Staff	2	00/01	HHMI
Research/Tech Staff	12	01/02	Sloan (1); NCI (3); NHGRI (8)
Budget Assistant	1	03/04	unknown
Web Designer/Tech Staff	1	03/04	unknown
Postdoctoral Fellow	(1)	00-02	FSU
Postdoctoral Fellows	3	01/02	HHMI
Subtotal	**21**		
CBSE/QB3 Staff (location)			

QB3 Visiting Res/Adj. Prof.(PSB*)	3	03/04	extramural
QB3 Technical Staff (PSB)	2	03/04	“
QB3 Postdoctoral Fellows (PSB)	3	03/04	“
QB3 Director/Adj. Prof. (E2*)	1	04/05	“
QB3 Assistant Director (E2)	1	04/05	“
QB3 Admin. Assistant (E2)	1	04/05	“
QB3 Business Mngr (E2)	1	04/05	“
QB3 Technical Staff (E2)	1	04/05	“
Visiting Res/Adj. Prof. (E2)	5	04/05	“
Postdoctoral Fellows (E2)	12	04/05	“
Subtotal	**30**		

* PSB = Physical Sciences Building; E2 = Engineering 2 building

2. Research Program Goals and Strategies

2.1 Target Areas of Research Excellence

The CBSE promotes the target areas of research excellence put forth in the Biomolecular Engineering Department Long Range Plan:

- Bioinformatics/Computational Biology
- Computational/Experimental Systems Biology
- Technology Development
- Proteomics/Protein Engineering (a potential 4th focus area)

Highlighted below are some of the current areas of research supported by the CBSE.

Human Genome Project

The Human Genome Project, initiated in 1990, is a publicly funded, international collaboration to fully sequence a reference human genome. Prof. David Haussler leads a team of students and technical staff in generating up to date assemblies of the human genome sequence for the Human Genome Project. They have created and maintain a web browser that displays the genome sequence aligned and annotated with additional data, including information on human genes and their variation in the population, the RNA and protein products they make, their locations in the genetic and cytogenetic maps of inherited human diseases, their patterns of expression, their relation to corresponding genes from other species, and many other kinds of information. The UCSC Human Genome web pages receive over 30,000 requests per day and transmit an average of 8.4 gigabytes of data on a daily basis.

Mammalian Gene Collection

The Mammalian Gene Collection (MGC), is an NIH-sponsored project to generate a complete set of full-length sequences and cDNA clones of expressed genes for human and mouse—a “gold standard set of mammalian genes”. Professor Haussler and a team of UCSC researchers have been contracted to provide informatics expertise for this project. Their goal is to create a coordinated, linked web interface between the assembled human genome sequence and sequences of proposed full length cDNAs and other supporting evidence for gene structure, and to develop new algorithms to integrate this data to identify full length genes and all of the alternately expressed forms of these genes.

Gene Splicing

One gene can generate multiple forms of protein products through a process called alternative splicing, in which pieces of the intermediate molecule in protein production, mRNA, are spliced together in different combinations. Manny Ares and Alan Zahler of MCD Biology study several aspects of splicing, including: the development of microarray technology methods to identify all of the alternative spliced forms of genes of interest, correlation of aberrantly-spliced genes with disease, and identification of the genomic sequence and protein products responsible for the regulation of splicing. Jim Kent, working with Zahler, developed a program for identifying alternatively spliced genes in the roundworm *C. elegans*; further development of this program by Kent led to the UCSC Human Genome Browser. Computational approaches are coupled with the laboratory work of Ares and Zahler to identify and validate alternate splice forms of genes.

Molecular Nanopore Technology

Chemistry faculty member David Deamer, Haussler’s HHMI Research Specialist Mark Akeson and their team have developed a nanopore constructed of a biological molecule that is able to discriminate between different DNA sequences as they pass through the pore. Haussler and graduate student Stephen Winters-Hilt are developing a machine learning algorithm capable of idenitfying single DNA base pairs in real time. This device, when fully developed, should have many possible uses such as DNA fingerprinting, detection of disease genes, and pathogen identification.

Bioinformatic and Microarray Expression Analysis of Nervous System Function

The purpose of this project is to develop and use gene expression microarrays and computational analysis of gene sequences and expression patterns to find and classify all genes important to nervous system development and function in *C. elegans*. The project represents an interdisciplinary research effort among scientists in the departments of Computer Science (David Haussler), Computer Engineering (Richard Hughey and Kevin Karplus), Applied Mathematics and Statistics (Hongyun Wang), Chemistry and Biochemistry Anthony Fink), and MCD Biology (Manny Ares, Andrew Chisholm, Yishi Jin, and Alan Zahler).

The UCSC Kestrel Server: Remote Parallel Processing and Computational Biology

CE Prof. and Chair Richard Hughey's research group, in collaboration with Prof. Karplus, built the UCSC Kestrel parallel processor, a programmable VLSI co-processor that performs sequence comparison and hidden Markov model searching 20 to 35 times faster than high speed workstations.

The Sequence Alignment and Modeling System (SAM)

SAM is a collection of flexible software tools for creating, refining, and using linear hidden Markov models for biological sequence analysis. SAM was developed by Profs. Karplus and Hughey, in collaboration with Prof. Haussler and Dr. Anders Krogh of the Technical University of Denmark. Version 3.2 is the third version of SAM since its initial release in October 1999. It has been commercially licensed to several companies.

2.2 Participation in QB^3, a California Institute for Science and Innovation

As mentioned above, the CBSE worked with UCSF and UC Berkeley to propose the Institute for Biotechnology, Bioengineering, and Quantitative Biomedicine (QB3), and has since coordinated UCSC's participation in the Institute, along with UCSC personnel in Planning and Budget, and Capital Planning and Space Management. Current major efforts of the CBSE for QB3 include coordinating internal research groups in the areas of Structural and Chemical Biology, Experimental Genomics/Proteomics Biochemistry, Bioinformatics and Computational Chemistry, and Bioengineering and Biotechnology. The CBSE is also acting as primary consultant in the design of QB3-funded space in the new Physical Sciences Building (PSB) and the new Engineering Building (E2).

2.3 Silicon Valley Center

Joint ventures with industry such as QB^3 may serve as the primary vehicle for a CBSE/Biomolecular Engineering research presence at SVC. If appropriate laboratory space is available, certain research projects involving industry partners and QB3 students and faculty may be housed there, as a central location between the three UC campuses and the biotech industry. A SVC location may also be convenient for partnerships with companies outside of the Bay Area, thus allowing collaborations that may not otherwise have been possible. The SVC may be particularly appropriate for projects involving new product development and testing activities (as opposed to basic research), which may not be allowed on certain tax-exempt financed QB3 spaces on campus (which are constrained by IRS rules on private business use).

2.4 Industry, Government Laboratory Relationships and Support

The CBSE will facilitate research collaborations and student internships with industry and government labs where related research is taking place. One example is with Lawrence Berkeley National Labs, where a project to create a computer model of how cells work is being conducted (led by Berkeley Professor Adam Arkin). The CBSE will also foster relationships by inviting industry and government lab researchers to participate in our seminar series and as guest lecturers in classes.

3. Capital and Resource Development

3.1 Instructional and Research Space

The following table outlines the projected need for administrative, technical, research, and scholarly activity space associated with the CBSE and QB3. This plan excludes the HHMI office and research space of Prof. Haussler, which is listed with the BME Department space needs in the BME Long Range Plan. Since Prof. Haussler is Director of the CBSE, his office space is written in italics here to indicate it will probably be co-located with CBSE administrative staff. The future location of the CBSE administrative office is not certain, although the current plan is to occupy a suite of offices in PSB (approx. 1312 asf) that would house the Director, Assistant Director, Admin. Assistant/Reception area, Budget Assistant, one technical staffperson and a visiting researcher/adjunct faculty affiliated with QB3. The two CBSE systems administrators should remain in Baskin Engineering due to the need to be close to the machine room housing the CBSE's "kilocluster." The twelve CBSE research/technical staff could be housed in additional space in PSB, in offices designated for QB3 (possibly two per office), since the work of these personnel will contribute to UCSC's QB3 research. If this were to happen, QB3 staffing listed below would need to be adjusted accordingly. This would consolidate most CBSE staff to PSB and locate all QB3 personnel to just two buildings, PSB and E2. The CBSE would also consider an eventual move back to Baskin Engineering, should appropriate renovations, creating space comparable to PSB, take place. The advantage of such a move would be to locate Prof. Haussler and his staff closer to the HHMI student, postdoc, and machine room space, and would place the CBSE centrally between the QB3 operations in PSB and E2, and the BME Department.

Type of Space	**FTE**	**ASF/FTE**	**Total ASF (location)**
*CBSE Director**	*1*	*200*	*200 (PSB or BE**)*
CBSE Assistant Director	1	140	140 (PSB or BE)
CBSE Admin. Assistant/ Reception/Service Area	1	350	350 (PSB or BE)
CBSE Budget Assistant	1	120	120 (PSB or BE)
CBSE Tech Staff - Webmaster	1	120	120 (PSB or BE)
CBSE Tech Staff – Systems Admin	2	150	300 (BE)
CBSE Research/Tech Staff	12	75 - 140	900-1,680 (PSB or BE)
CBSE Subtotal	**18**		**1,930 - 2,710**
QB3 Visiting Res/Adj. Prof.	3	140	420 (PSB)
QB3 Research/Tech Staff	2	75 - 140	150 - 280 (PSB)
QB3 Postdoctoral (PD)Fellows	3	75 - 140	225 – 420 (PSB)
QB3 Comp Biology Lab Space	1	1543	1,543 (PSB)
QB3 Conf/Seminar Room	1	685	685 (PSB)
QB3 Director/Adj. Prof.	1	200	200 (E2**)
QB3 Assistant Director	1	135	135 (E2)
QB3 Admin. Assistant/	1	300	300 (E2)

Reception/Service Area			
QB3 Business Mngr	1	135	135 (E2)
QB3 Technical Staff	1	135	135 (E2)
QB3 Visiting Res/Adj. Prof.	5	135	675 (E2)
QB3 Postdoctoral Fellow Offices	5	135	675 (E2)
QB3 Comp Bio Lab-4 grads, 1 PD	1	600	600 (E2)
QB3 Comp Bio Lab-4 grads, 2 PDs	1	800	800 (E2)
QB3 Comp Bio Lab-6 grads, 4 PDs	1	1,200	1,200 (E2)
QB3 Scholarly Activity Space	1	540	540 (E2)
QB3 Videoconference/Classroom	1	920	920 (E2)
Subtotal	**30**		**9,338 – 9,663**

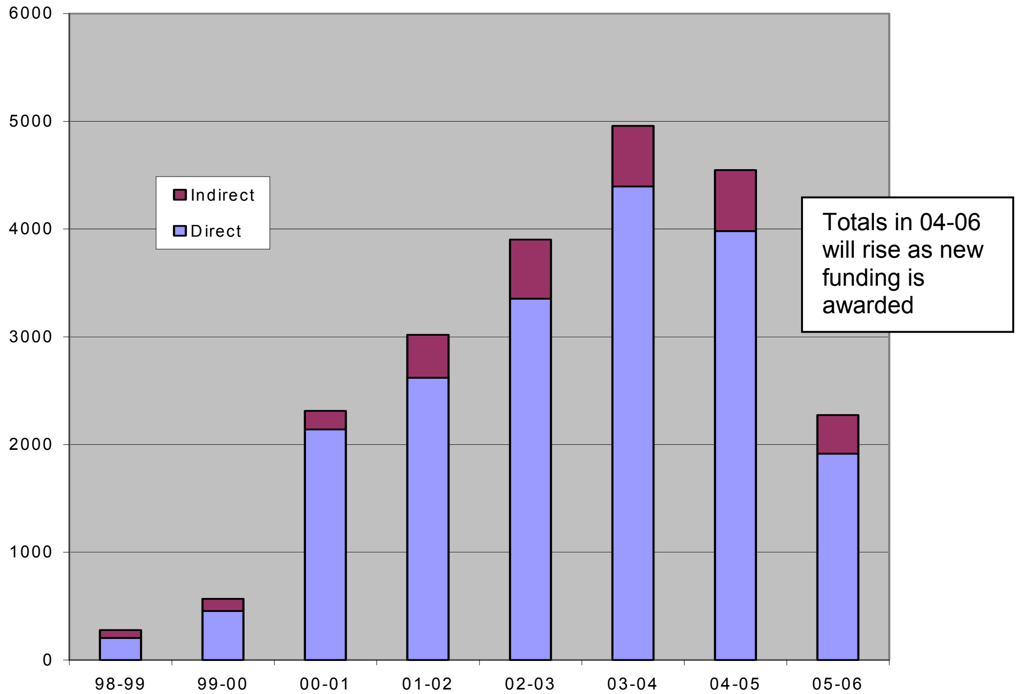
*CBSE Director Office also listed in BME Department plan as HHMI Investigator office at 150 asf, and is included in the total count for BME Department space. The Director office listed here is not included in the total asf.
** PSB = Physical Sciences Building; BE = Baskin EngineeringE2 = Engineering 2 building

3.2 Extramural Research Funding

Most of the major funding agencies (including the NIH and its constituent branches, the NSF, and the DOE) and private foundations (such as HHMI and the Packard, Sloan, Whitaker, and Keck Foundations) allocate substantial portions of their budget to research awards in areas relevant to the CBSE (such as bioinformatics, proteomics, and various types of technology development). The CBSE faculty are strong candidates for such awards, and individually and through collaborative projects organized by the CBSE, have had extraordinary success in obtaining extramural funds. Current CBSE funds are allocated to space renovation and the creation of new space, equipment purchases, undergraduate and graduate student support, postdoctoral fellows, technical and administrative staffing, general operating expenses, travel, publications, and other expenses. The building of UCSC's "Kilocluster", a series of over 1000 interconnected processors working in parallel to perform computations for the bioinformatics work of the CBSE, including the Human Genome Project assemblies and annotations, was funded by contributions from HHMI and QB3. NHGRI and NCI funds will contribute to its upkeep and improvements.

The following chart shows the annual funding awarded through grants to Prof. Haussler and his research team, and through project grants awarded to Haussler and Co-PIs Karplus, Hughey (CE) and members of Natural Sciences faculty (all members of CBSE). This chart does not include individual awards to faculty other than Haussler, and only shows awarded funding, not projected.

Annual Funding In-Hand for Prof. Haussler and CBSE Multi-PI Projects (in $1000s)



Considering CBSE faculty as a whole, approximately 74% (or 32 faculty) have active extramural research funding according to *Banner* summary reports generated by the Office of Sponsored Projects on 11/5/01. The current year funding for these 32 faculty totals approximately **$15,220,000**, of which approximately 19%, or **$2,891,800** represents indirect costs.

CBSE Budget

As mentioned in section 1.4 under Staff Resources, the CBSE's goal is to become entirely self-sustaining by recovering a percentage of the indirect costs it generates. The CBSE is currently very close to being self-sustained, in that all staff except the Assistant Director and two future positions (a budget assistant and a web designer) are funded from extramural sources. Most staffing, operating costs, equipment, infrastructure needs, travel, and miscellaneous other expenses are funded from extramural sources. The CBSE proposes to recover a sufficient percentage of the indirect costs it generates to fund the salaries and benefits associated with these three positions. The projected total costs for these positions are summarized in the table below:

	02/03	**03/04**	**04/05**	**05/06**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**
Salary totals	64.0	157.2	165.1	173.3	182.0	191.1	200.6	210.7	221.2
Benefits (23%)	14.7	36.2	38.0	39.9	41.9	43.9	46.1	48.5	50.9
TOTAL	**78.7**	**193.4**	**203.0**	**213.2**	**223.8**	**235.0**	**246.8**	**259.1**	**272.1**

Further analysis is needed to establish which awards will be included in the indirect cost calculations for this purpose. In general, we would expect to include only awards that were obtained through CBSE coordination or other assistance, and that are agreed to be "CBSE" awards by all PIs involved. Similarly, further analysis is needed to determine the appropriate percentage of indirect costs needed.

3.3 Private Funds Development

The CBSE will work closely with SoE and campus Development personnel to take part in appropriate fund-raising opportunities. We are pleased that SoE has recently hired a new Director of Development, and look forward to assisting him. Many potential donors have an interest in the Human Genome Project and the development of new technologies to advance medical research and human health. The CBSE has engaged in several activities to reach out to such donors, including maintaining a web page and press packet, giving tours of our facilities, and talks at key events. With additional staffing, we hope to increase and professionalize these activities. The proposed Web Designer position will be key for this effort.

4. Summary

The CBSE has been highly active in stimulating collaborative research, obtaining extramural funds, and contributing to the growth and raising the profile of the Baskin School of Engineering and the UCSC campus. Outcomes of the CBSE's efforts include: four new faculty FTE in interdisciplinary research; multiple cross-divisional and intercampus research projects; recognition that UCSC plays a key role in the Human Genome Project; the building of a 1000 CPU "Kilocluster" compute farm; a direct CBSE annual income increasing from approximately $3 million in 2001-02 to close to $5 million in 2003-04; proposed new academic programs in Bioinformatics; a proposed new Biomolecular Engineering Department; and the creation of new and upgraded space on campus through $4 million of QB3 funds. The CBSE is almost entirely self-funded, with the exception of three positions, and hopes to obtain funds for those positions through a recovery of a percentage of the indirect costs it generates.