

**EXECUTIVE SUMMARY:
HIGHLIGHTS, RECOMMENDATIONS AND CONCLUSIONS**

As it approaches its 10th anniversary, the Baskin School of Engineering has achieved many significant milestones. The School's reputation and visibility has continued to rise regionally, nationally and internationally. This is evident by the recognition of its faculty and increased corporate support. Faculty recognition over the past five years include:

- David Haussler received Carnegie Mellon's Dickson Prize and was also named Scientist of the Year by "R&D Magazine";
- Benjamin Friedlander received the IEEE Third Millennium Medal;
- Darrell Long was appointed to the Kumar Malavalli Endowed Chair in Storage Systems. Funds from the endowed chair provide support for research, graduate students, and other activities of the Storage Systems Research Center (SSRC), a leading center for research on data storage and storage systems;
- J.J. Garcia-Luna-Aceves received a long-term multidisciplinary research program grant from the Office of Naval Research for research on Dynamic Ad-hoc Wireless Networking (DAWN). UCSC will be the lead campus on the research with Maryland, MIT, UCB, UCLA, UICI and Stanford universities;
- Charles McDowell was named Carnegie Scholar by the Carnegie Foundation for the Advancement of Teaching;
- Darrell Long, together with Scott Brandt, Ethan Miller, Alkis Polyzotis, and Gabriel Elkaim, and Carlos Maltzahn, forged a significant agreement with Los Alamos National Laboratory to establish a new collaborative institute for research and education in the area of scientific data management, called The Institute for Scalable Scientific Data Management (ISSDM);
- Ali Shakouri received a long-term multimillion dollar grant from the Office of Naval Research to establish the Thermionic Energy Conversion (TEC) Center, a collaborative project in which UCSC is the lead institution involving researchers at Harvard, UC Berkeley, UCSB, MIT, Purdue and North Carolina State;
- SOE faculty received numerous awards and recognition including:
 - Named IEEE Fellows: Patrick Mantey, Darrell Long, and J.J. Garcia-Luna-Aceves;
 - Named ACM Fellows: Steve Kang, Ira Pohl, and Phokion Kolaitis;
 - Named American Association for the Advancement of Science Fellows: Marc Mangel, David Hausler, Michael Isaacson, others;
 - Sloan Foundation Fellow: Todd Lowe, others; and
 - Eleven SOE faculty have received NSF CAREER awards.
- David Draper was elected President of the International Society of Bayesian Analysis;
- Steve Kang received the Van Valkenburg Award and appointed to a blue-ribbon panel on nanotechnology; and
- Michael Isaacson was elected to the Executive Board of the Engineering Research Council of the ASEE.

Other milestones achieved in the past five years include:

- Full ABET accreditation of both Computer Engineering and Electrical Engineering;
- Launching initial UCSC academic degree programs in Silicon Valley;
- Establishment of the NSF funded multimillion dollar Developing Effective Engineering Pathways (DEEP) program, which provides Community College students with academic support and enrichment opportunities to create a successful transition to the university and an educational plan leading to a career in engineering;
- Completion of the award-winning, 90,000 square foot Engineering 2 Building, constructed adjacent to the existing Baskin Engineering Building to support the rapid expansion of the school's programs; and
- Extramural gifts and awards increased from \$14.1 million to \$38.9 million.

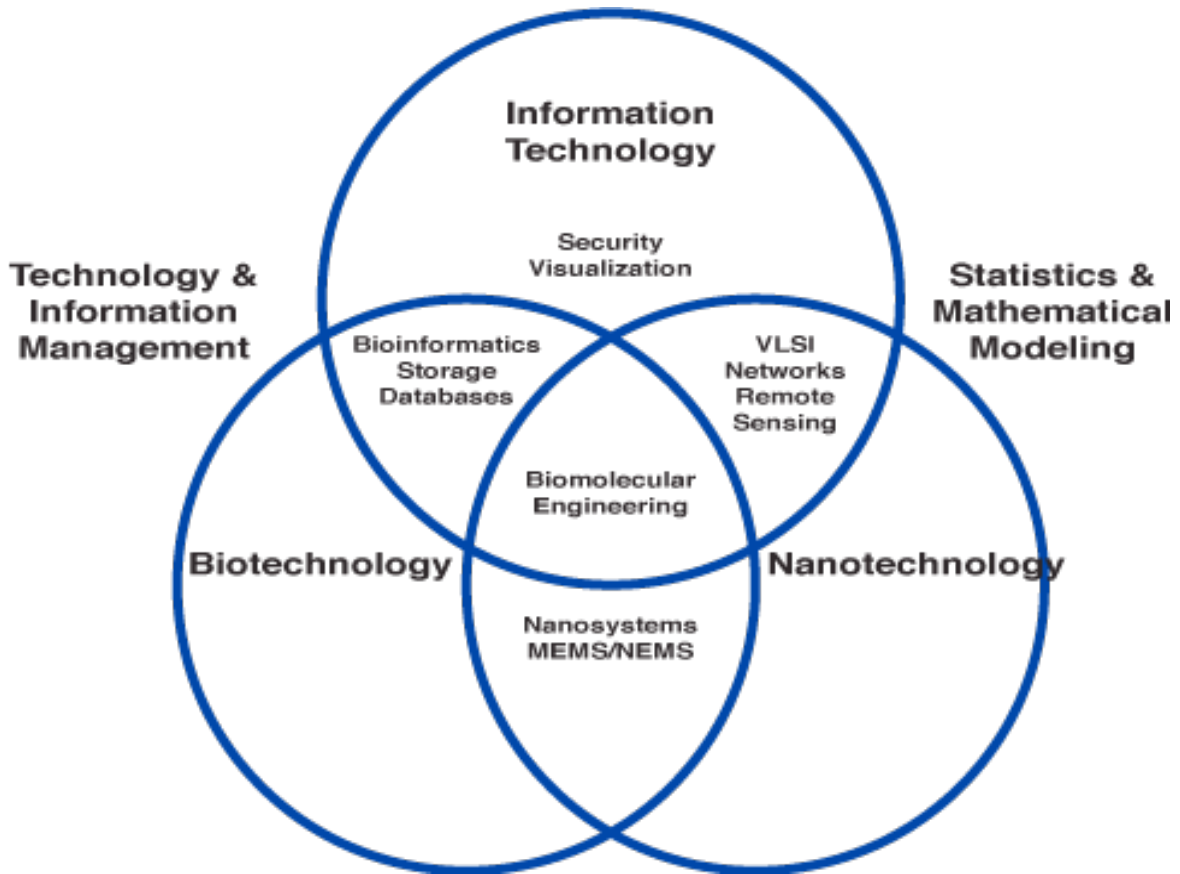
The School now has 80.2 faculty FTE, approximately 2.5 times the faculty size in 1997, when the School was formed. By 2010-11, faculty FTE will increase to 114.1, an increase of slightly over 40% over the five-year period. Also by 2010-11, the School plans to have a total of 1,921 FTE students, including 1,042 undergraduate majors and 500 graduate students. During this rapid period of growth, we anticipate increasing our budgeted student-faculty workload ratio from 14.4 to between 15 and 17.

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 with **FIRST-rate** faculty, who are *Frontier Impacting* through excellence in *Research, Service* and *Teaching*.

To achieve this goal, the School must continue to recruit excellent and visionary faculty and staff in the face of the enormous challenges in addressing the high cost of living and offering competitive salaries and start-up packages. We plan to continue 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 success in our three target areas of excellence: biotechnology, information technology, and nanotechnology.

A. AREAS OF EXCELLENCE

The Baskin School of Engineering will continue to focus on building and promoting 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.



Biotechnology

With the establishment of the Department of Biomolecular Engineering, research in biotechnology has rapidly advanced. Under the leadership of David Haussler, the School has established an international reputation for its bioinformatics research. This recognition has resulted in Dr. 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. Building upon an established program in bioinformatics and the Center for Biomolecular Science and Engineering (CBSE), and the SOE participation in the NSF funded Engineering Research Center in Biomimetic Electronic Systems (BMES), a partnership between USC, CalTech and UCSC, the School plans to continue development in this area by creating an undergraduate program in Bioengineering and undergraduate and graduate programs in Biomolecular Engineering.

Information Technology

Information technology has been the focus of the School's founding programs—Computer Science and Computer Engineering—along with Technology and Information Management (TIM) 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 the Center for Information Technology Research in the Interest of Society (CITRIS) continues to provide exciting opportunities in IT research and education programs in close collaboration with UC Berkeley, UC

Davis and UC Merced, and California's IT industry. The Baskin School is the lead institution in a multimillion dollar, multiuniversity consortium funded by the Department of Defense to study Dynamic Ad-hoc Wireless Networks (DAWN) for development of technology for complex wireless networks that can be set up in rapidly changing emergency environments. In addition, a new Institute for Scalable Data Management (ISSDM) has just been set up between the SOE at UCSC and Los Alamos National Laboratory which will be a multimillion dollar multiyear effort supported by the DOE.

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 to decrease feature size in electronic and photonic devices will enable a plethora of new devices for diagnostics and computing to be developed. Such shrinking will enable nanoelectromechanical systems (NEMS) that will further enhance the advantages of the current microelectromechanical systems (MEMS) used in a variety of applications from communications to medicine. This is an area our School is building. It is an area that cannot be overlooked in modern engineering disciplines. The Electrical Engineering Department already has begun to develop a strong research program in this area, but except for molecular beam epitaxy (MBE) instrumentation within the EE department, there is little materials processing, fabrication and deposition equipment for fabricating novel material devices on campus. We are actively seeking to develop the infrastructure for materials processing and characterization needs. At present we have four faculty members in EE actively working in this important area and in the coming year, the EE Department will search for a tenured faculty member in nanotechnology and device materials. A member of the physics department is on that search committee. Concurrently, the Physics Department plans to hire a tenure track faculty member in condensed matter physics and a member of the EE department is on that committee. These two hires, plus additional collaboration between the departments of physics, chemistry, EE and Molecular and Developmental Biology will accelerate UCSC's program development in this area with the aim of being able to put together a successful proposal to create an NSF funded Materials Science and engineering Center at UCSC. The School of Engineering and the Physical and Biological Sciences Division have been approached by National Laboratories for future research collaboration in this important area. Furthermore, EE faculty will play a key role in the development of the Bio-Info-Nano Research and Development Institute being planned at NASA-Ames Research Park.

B. RESEARCH EXCELLENCE BY DEPARTMENT

In order to establish the three Areas of Excellence, we plan to strengthen interdepartmental research collaborations by focusing on the following areas of research.

	AMS	BME	CE	CS	EE	TIM
Autonomous Systems: Control Theory/Algorithms and Physical Systems	X		X		X	
Assistive Technologies and Biomedical Devices			X		X	
Bayesian Statistics and Applied Mathematical Modeling	X	X		X		X
Bioinformatics and Biomolecular Engineering		X	X	X	X	
Communications, Signal and Image Processing	X		X		X	
Computer Systems, Storage and Architecture			X	X	X	
Formal Methods and Security			X	X		
Graphics & Visualization, Computer Game, Computer Vision, Human Computer Interface			X	X		X
Machine Learning and Artificial Intelligence	X	X	X	X		X
Networks			X		X	X
Optoelectronics and Optical Systems			X	X	X	
Remote Sensing and Environmental Technology	X		X		X	
Software Engineering and Databases			X	X		X
Technology and Information Management			X	X		X
VLSI, Nanosystems, and Materials		X	X		X	

AMS – Applied Mathematics and Statistics

BME – Biomolecular Engineering

CE – Computer Engineering

CS – Computer Science

EE – Electrical Engineering

TIM – Technology and Information Management

C. ACADEMIC PROGRAMS
(Summary of Initiatives from Section 1)

During the past five years, the School of Engineering has introduced the following new programs:

- Bioinformatics: Minor, BS, MS and PhD;
- Computer Engineering: MS with emphasis in Network Engineering;
- Electrical Engineering: MS and PhD;
- Statistics: Minor; and
- Computer Technology: Minor

By 2010-11, the School will have a comprehensive set of engineering degree programs that cover biotechnology (BT), information technology (IT), and nanotechnology (NT) disciplines. At the end of the next few years, SOE is considering phasing out the dual degree program as the SOE approaches its full complement of faculty.

Below is a comprehensive look at the School of Engineering’s existing and planned programs:

	CURRENT	PROPOSAL UNDER REVIEW	PLANNED
Applied Mathematics			BS, MS, PhD
Autonomous Systems			MS, PhD
Bioengineering			BS
Biomolecular Engineering			MS, PhD
Bioinformatics	Minor, BS, MS, PhD		
Computational Biology with MCD			BS
Computer Science: Computer Game Design with F&DM		BS	
Computer Engineering*	Minor, BS, BS/MS, MS, PhD		
Computer Science	Minor, BA, BS, MS, PhD		
Dual Degree Engineering Program**	BA, BS		
Electrical Engineering	BS, MS, PhD		MEng
Statistics and Stochastic Modeling	Minor	MS, PhD	
Software Engineering			MS
Technology and Information Management	BS	MS, PhD	

* Includes MS with emphasis on Network Engineering and Computer Technology minor.

** With BA awarded by UCSC and BS awarded by the College of Engineering at UC Berkeley (to be phased out as the SOE reaches its full complement of faculty).

The Baskin School of Engineering will have introduced ten new programs by 2010. The campus's commitment to the School has enabled our rapid growth in both program quality and size, and we ask campus administration 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 world-class School of Engineering.

We should note that as the SOE continues to grow, some of the programs in CE and EE will begin to have a mechanical engineering flavor, particularly in the areas of Micro-Electro-Mechanical-Systems (MEMS), autonomous systems, renewable energy resources and in some instances in bioengineering. Since the number of faculty allocated to the SOE does not allow the development of a new department in Mechanical Engineering, we anticipate being able to develop mechanical engineering-like research and instructional programs within existing departments by planning concentrations and minors in those areas.

D. INTERDISCIPLINARY COLLABORATION

The School of Engineering is committed to building interdisciplinary programs between our departments and across divisional boundaries, linking to other divisions and colleges at UCSC and UCSC Extension. We envision campus-wide benefits as academic and research program collaborations grow.

In particular, we plan to develop and offer new degree programs at both the undergraduate and graduate levels in collaboration with the divisions of Physical and Biological Sciences, Social Sciences, Humanities, and Arts. Examples include:

- Applied Mathematics and Statistics is considering a proposal for a new undergraduate major and minor in **Applied Mathematics**, a joint degree program with Mathematics;
- Biomolecular Engineering will propose a new graduate program in **Biomolecular Engineering**, in collaboration with Molecular, Cell and Developmental (MCD) Biology, Chemistry, and Biochemistry;
- Applied Mathematics and Statistics, Computer Engineering and Electrical Engineering will propose a joint graduate program in **Autonomous Systems**;
- A new program track in **Computational Biology** will be developed in collaboration with MCD Biology and Biomolecular Engineering;
- Biomolecular Engineering, Computer Engineering, Electrical Engineering and MCD Biology departments are planning to create a new undergraduate program in **Bioengineering**, with the goal of eventually developing a graduate program in this area;
- Computer Science will propose a new undergraduate program, **Computer Game Design**, in collaboration with Film and Digital Media and Mathematics Departments;

- Computer Science is considering proposing a graduate program in **Software Engineering**. Such a program could be related to faculty in Technology and Information Management and Computer Engineering, and could be a key initiative in the Silicon Valley Center;
- Electrical Engineering is planning a project-oriented **Masters of Engineering (MEng)** degree program, which fits in well with the new Technology and Information Management program and the possibility of a UCSC School of Management, centered at the Silicon Valley Center; and
- Technology and Information Management will launch a new graduate program, **Technology and Information Management**, in collaboration with Computer Science, Economics and Psychology.

The School of Engineering will also pursue the development of a certificate program related to the Technology and Information Management Program with UCSC Extension, and short courses based on faculty areas of expertise, depending on appropriate opportunities and mutual interest.

E. SCHOOL-WIDE INITIATIVES (Summary of initiatives from Section 2)

In addition to our plans for new academic and research programs, the Baskin School of Engineering plans to engage in several new initiatives that contribute to the goals of the School and the campus as a whole.

1. Building Interdisciplinary Collaborations with Other Divisions

Interdisciplinary collaboration between the SOE departments and with other UCSC divisions has the advantage of broadening and strengthening SOE's programs and research. The SOE will pursue new opportunities for interdisciplinary collaboration by:

- Sharing courses between departments and across divisions that complement and support existing courses and programs;
- Creating new courses that span disciplines, such as technology and information management, statistics and stochastic modeling, computer game design, autonomous systems, and biomolecular engineering; and
- Joint appointments of faculty.

To improve the ability of all UCSC divisions to increase their interdisciplinary collaborations, we recommend that central administration look at the following:

- Provide support to interdepartmental and interdivisional joint faculty appointments by contributing 1/3 of the cost of the position (with the other 2/3 being split between the two hiring departments);
- Provide adequate contiguous space to include the wet lab space for Biomolecular Engineering;
- Coordinate hiring faculty searches across divisions; and
- Current campus policy and procedures make it difficult for departments to receive enrollment credit for courses they develop to support other departments with large enrollments and students with widely diverse educational needs.

2. International Programs

The growing global nature of the world will increasingly impact every aspect of our professional and personal lives. The Baskin School of Engineering strives to be a school that is representative of the international world in which our students will live their lives. We accomplish this by reaching out to international students, creating learning opportunities that integrate topics of globalization into appropriate SOE programs and courses at both the undergraduate and graduate level, and by conducting research that is relevant and valuable worldwide. In just a few short years, SOE has built collaborative relationships with higher education institutions and industrial organizations throughout the Pacific Rim, including Korea, Japan, Taiwan, China, Malaysia, India, and Singapore. And, we have just initiated a collaboration with EPFL in Switzerland.

3. Improving Enrollments

Over the next five years, the SOE plans to increase enrollments and budgeted faculty workload ratio from 14.4 to between 15 and 17. This will be accomplished in the following ways:

- Develop new and attractive programs, which will bring students to UCSC in greater numbers. Examples of such programs include the Applied Mathematics, Autonomous Systems, Bioengineering, Biomolecular Engineering, Computational Biology, Computer Game Design, Software Engineering, Statistics and Stochastic Modeling, Technology and Information Management and a project-oriented Master's of Engineering in Electrical Engineering;
- Develop a university honors program in engineering;
- Increase fellowship funds by actively seeking externally funded graduate training grants to enable the SOE to increase its number of talented graduate students which will enable the SOE to offer multiyear GSR's and fellowships. This will make us more competitive with competing institutions. Towards this end, the SOE will hire a grants writing coordinator to assist the faculty in putting together large scale, multi-investigator research and training grants, and we will work across divisional boundaries to create interdisciplinary efforts;
- Establish the plan for providing adequate space including the wet lab space for the Biomolecular Engineering Department. The program cannot be successful without adequate resources, including a wet lab and contiguous office space for its faculty;
- Develop new undergraduate courses that will appeal to a broad spectrum of UCSC students, such as courses on how to better understand and use computers, information and technology, and nanotechnology. For example, we have just initiated a new course in renewable energy resources. Some of these courses will function well as general education courses to increase the technological literacy of the UCSC student population. Others will enable students who are trying to decide on a career direction to know if engineering is the right choice for them;
- Work to increase retention of undergraduate students; and

- With programs such as DEEP, increase the number of university college transfer students.

We note that as a program focused jointly on graduate and undergraduate education, any unadjusted summation of enrollments will necessarily put the SOE at a disadvantage because of the instructional intensity of graduate education.

4. Diversity Promotion

The Baskin School remains committed to continuing its 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.

The School promotes diversity primarily through student outreach to underrepresented groups. Specific examples of such efforts and past accomplishments include:

- Appointed a SOE faculty member to be director of student outreach for the School. This is a new position;
- Created a permanent staff position in undergraduate affairs to handle student outreach;
- Strengthen ties with other educational institutions to reach underrepresented groups through programs such as the NSF-funded Developing Effective Engineering Pathways (DEEP) Program;
- Create the "Welcoming Diversity Project" which seeks to: (1) increase student retention in computing during the first two years of University education, (2) understand the issues at UCSC that lead to a lack of retention, and (3) begin increasing the pipeline by exposing students at local K-12 schools to computing and woman computer science and engineering students. With the aid of a Campus Diversity Grant in 2005, we established eWomen, a support community for female graduate students and faculty, now funded in part by Google. We will work to ensure the continuing success of this new organization;
- The planned Bioengineering BS program is expected to increase the number of women, underrepresented ethnic/racial minorities, and disabled students attending UCSC and pursuing engineering majors; and
- Working with the Division of Physical and Biological Sciences, create the right climate at UCSC to successfully put in a bid to the National Conference of Black Physics Students to hold their annual meeting at UCSC sometime in 2009-2010. This conference generally has between 150-200 attendees and is supported by industry and national laboratories as a way to actively recruit students from underrepresented groups to pursue graduate studies in physical sciences and engineering.

Although still relatively young, the School's original departments have a strong history of faculty diversity, particularly with regard to women and Asians and that trend continues as we have grown and added new departments and disciplines. The School of

Engineering has been committed to continued good faith efforts to recruit, develop, promote, and retain the highest quality faculty for the School and to provide the campus with a faculty consistent with the ethnic and gender diversity of available Ph.D.'s to serve our student population. We recognize that the diversity of our faculty applicant pools is ultimately a factor of the diversity of engineering graduates. As such, the school has a strong history of providing co-curricular and outreach efforts in support of recruiting, retaining, and ensuring the success of a diverse student population

Finally, it should also be noted that the School is sometimes at a disadvantage in its efforts to recruit underrepresented faculty due to resource constraints and the extreme competition from the other research universities.

5. Summer Session

The Baskin School will participate in year-round operations with a proper allocation of the State budget. At the Silicon Valley Center, we will be able to 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. With adequate resources for staff and faculty compensation, a full-fledged summer session will be a major asset to the campus.

6. 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 UC's initiative for the "10 Plus 10 Program" with China 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 established MOUs for potential collaboration and exchange programs with Hokkaido Information University (HIU), Yonsei University, Korea Telecom (KT) and Seoul National University, and has received students from those institutions. The President of National ChiaoTung University, Taiwan and his various deans visited UCSC for future collaborations. So did directors and several professors of IIT, India. In October 2005, an international forum was held in Sapporo, Japan among HIU, Nanjing University, China and UCSC to discuss the matters related to IT education and research. In two years, UCSC plans to host this meeting on our campus.

6. 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 accessible to students and professionals who live and work in Silicon Valley; and
2. Increase UCSC's visibility and impact in Silicon Valley.

The Technology and Information Management and Network Engineering programs have been high priorities for the School 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. In AY 2006-07 we plan to move our MS in network engineering program to SVC, contingent upon the availability of the program space. We have also offered our first set of courses in Technology and Information Management. In fall 2007, we will launch a new graduate program in Technology and Information Management at SVC. And, we are developing plans to offer courses and projects in our proposed MEng Program in EE at SVC.

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 and institutes (ITI, CBSE, CIMSS, SSRC, and ISSDM) 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. Furthermore, SOE faculty are playing key roles in the initial stages of planning for an Air Traffic Management Institute located at the SVC that will be a partnership between UCSC, UC Berkeley and NASA-Ames.

F. RESEARCH INITIATIVES

(Summary of initiatives from Section 3)

The School's reputation will be based on our excellence in research. In addition to particular areas of research excellence, the Baskin 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 continue the expansion and support of focused research centers, such as the existing Center for Biomolecular Science and Engineering, the Information and Technology Institute, and the proposed Center for Innovative Materials, Sensors and Systems which will evolve around interdisciplinary science and engineering. Each activity encompasses a set of collaborative and interdisciplinary research centers founded on our current and planned areas of excellence.

Center for Biomolecular Science and Engineering (CBSE)

The Center for Biomolecular Science and Engineering (CBSE) is directed by Biomolecular Engineering Professor and Howard Hughes Medical Institute (HHMI) investigator David Haussler. The CBSE fosters interdisciplinary research and academic programs, explores new biological and biomedical questions resulting from genome sequencing and advances in biomolecular science, and blends cutting-edge computational approaches with new research in biology, chemistry, and engineering. It serves as an umbrella organization to promote the exploration of new biological and biomedical questions resulting from genome sequencing and advances in biomolecular science. CBSE affiliates blend cutting-edge computational approaches with new research in biology, chemistry, and engineering. The center's 62 faculty affiliates come from 12 departments spanning the School of Engineering, the Division of Physical and Biological Science, and the Division of Social Sciences.

Information and Technology Institute (ITI)

ITI is a Focused Research Activity (FRA) and is operationally within the Baskin School of Engineering. Via its research centers, ITI focuses research in an inter-related set of areas of interest to faculty in Computer Science, Computer Engineering, and Electrical Engineering (as well as some from Physics, Chemistry, and Applied Mathematics). Areas of emphasis include:

- Design and development of complex networked systems and software technologies;
- Storage systems and databases;
- Multimedia systems and applications in education and business management;
- Communications;
- Opto-electronics (including nanotechnology devices);
- VLSI design, packaging, testing;
- Sensors, sensor systems and Internet appliances;
- Visualization and computer graphics;
- Knowledge management / data mining; and
- Decision support tools.

For ITI, advanced "Internet" applications provide the impetus and focus that bring together the components of research related to the rapidly expanding world of networks, distributed computing, "smart" sensors and internet appliances. As electronics and packaging developments lead to low cost and powerful sensors resulting in a broad array of instruments, these become Internet devices, bringing a significant increase in the data captured, transmitted, stored, managed, and displayed. ITI also promotes research in applications of the emerging capabilities of the Internet to such exciting areas as distance education and telecollaboration, environmental monitoring, and resource management.

Center for Innovative Materials, Sensors and Systems (CIMSS) - Proposed

A third Focused Research Activity 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 research centers in the School, the Division of Physical and Biological Sciences and also potentially with NASA-Ames, national laboratories and the Monterey Bay Aquarium Research Institute (MBARI) among others. Biomaterials will be critically important, not only for biomolecular and biomedical engineering but also for sustainable technology and systems development and intelligent biosensory development.. This center would be consistent with the university initiative to establish a coordinated effort between the SOE and the Division of Physical and Biological Sciences to develop a materials science and engineering core. Sustainable technology will enable product and services that are ecologically balanced, environmentally sound and socially responsible to ensure mankind's future. The Center will provide excellent research collaboration among researchers and graduate students in biomolecular engineering, computer engineering, electrical engineering, physics, biology, chemistry, environmental toxicology, and earth sciences, and ocean sciences.

Additional new opportunities for interdisciplinary focused research centers include:

The Engineering Research Center for Biomimetic Electronic Systems (BMES) is part of a multimillion dollar NSF funded Engineering Research Center consisting of USC, CalTech and UCSC. The UCSC portion of this center emphasizes the development of the low power, mixed signal electronics necessary for development of biomimetic prosthetic devices for vision, memory and muscle function.

Dynamic Ad-hoc Wireless Networks (DAWN) is a collaborative effort to develop the technology for complex wireless communication networks that can be set up in rapidly changing environments such as battlefields and emergency situations. The Baskin School of Engineering will head a multidisciplinary team of scientists at seven major universities. The project also includes researchers at UC Berkeley, UCLA, Stanford University, Massachusetts Institute of Technology (MIT), the University of Maryland, and the University of Illinois at Urbana-Champaign (UIUC). It is funded by a five-year grant from the U.S. Department of Defense that will provide an average of \$1 million per year spread among the seven institutions.

Institute for Scalable Scientific Data Management (ISSDM) will address looming issues of data storage and management for projects that involve large-scale simulation and computing. The University of California, Santa Cruz and Los Alamos National Laboratory have agreed to establish a new collaborative institute for research and education in the area of scientific data management. The institute will be a multimillion dollar per year, multi-year DOE funded effort and will provide opportunities for UCSC graduate students to gain specialized experience and expertise in scientific data management by working on large-scale computing projects at Los Alamos. In addition, the students who take advantage of these opportunities will provide a pool of potential employees for the laboratory with skills in key areas of computer science and data management where the lab foresees significant staff needs in the future.

Research Institute in Applied Mathematics and Statistics (RIAMS) – Proposed

RIAMS will enable UCSC to bring together a sufficiently large critical mass of researchers in Applied Math and Statistics required to tackle large, difficult and important collaborative problems in fields such as astronomy/astrophysics, computational genomics, environmetrics, mathematical biology and robotics. As the west coast center of excellence in these highly important research areas, RIAMS will greatly increase UCSC's visibility in the mathematics sciences.

Storage Systems Research Center (SSRC) is composed of faculty from the Computer Science, Computer Engineering, and Electrical Engineering departments. SSRC research focuses on caching, storage systems hierarchies, large-scale distributed storage systems, security, and performance.

Thermionic Energy Conversion (TEC) Center is a collaborative and multidisciplinary project involving researchers at seven major universities working to develop new technology for direct conversion of heat to electricity. The research team is comprised of experts in mechanical engineering, electrical engineering, materials science, and physics. With UCSC as the lead institution, the TEC Center also includes researchers from UC Berkeley, UC Santa Barbara, Harvard University, Massachusetts Institute of Technology, Purdue University and North Carolina State University. It is funded by a five-year, \$6M grant from the Office of Naval Research.

**G. ADMINISTRATION CHALLENGES
(Summary of initiatives from Section 5)**

The Baskin School of Engineering has undergone rapid growth during the first few years of its existence, and this pace is projected to continue. As the first professional school at UCSC, the operations of the Baskin School have resembled a start-up business with both the campus and the School evolving and learning together in a grand experiment to create a unique 21st century engineering environment for teaching and research. The leadership role of the Baskin School on behalf of the campus in helping to plan and implement academic programs at the Silicon Valley Center while developing essential industrial partnerships throughout the Silicon Valley, has added further complexity to the broad task of establishing a professional school.

The Baskin School continues to take the lead on a variety of interdivisional collaborations in both academic and research programs. In particular, we plan to develop and offer degree programs at both the undergraduate and graduate levels, with collaboration between other departments in School of Engineering, and with the Physical and Biological Sciences, Social Sciences, Humanities, and Arts divisions. As with our successful initiatives in the Silicon Valley, the Baskin School seeks broad-based collaborations and connections to enhance both instruction and research programs, as 21st Century engineering must be intellectually and professionally diverse to be relevant and effective.

Examples of interdivisional collaborations include:

- Joint Applied Mathematics degree programs with Mathematics;
- A proposed collaboration with Biology, Chemistry and Physics to develop a research emphasis in Bio-Materials;
- Collaboration with MCD Biology, Chemistry and Biochemistry on a new Bio-Molecular Engineering program;
- Collaboration with MCD Biology on a new Computational Biology program track;
- Collaboration with MCD Biology on a planned new Bio-Engineering program;
- Collaboration with Film and Digital Media, and Mathematics, on a new Computer Game Design program; and
- Collaboration with Economics and Psychology on development of a new Technology and Information Management program.

As the Baskin School has quickly evolved and grown, operational resources have often lagged behind academic program development and implementation—the faculty have been recruited and hired even though essential administrative and research infrastructure was not in place. In planning for continued expansion of the schools instruction and research programs through 2011, a major challenge is to sustain the necessary infrastructure to ensure success. More resources will be needed on a regular basis.

Key elements in this process include sufficient resources in four areas:

1. Adequate and appropriate space;
2. Faculty salaries, start-up and housing assistance;
3. Staffing and operational support; and
4. Technology investment.

Adequate and Appropriate Space

The Baskin School will continue to need additional space as programs expand. The severe space shortage that restricted SOE growth was partially alleviated by completion of the new E2 building in 2004. However, with faculty expected to increase over 40% in the next five years, space shortages will again be problematic without careful planning and allocation of campus resources.

The first space challenge will be to ensure that the campus proceeds with plans to relocate non-engineering services and programs out of the BE and E2 buildings to facilitate the growth of engineering programs. This includes campus services such as Financial Aid, Printing Services, and the Post Office, plus academic programs such as Mathematics and Economics. Provided sufficient resources, space currently used by these functions will then be available to help accommodate SOE program growth. This growth includes important technology and nanotechnology laboratory space for instruction and research used full-time by students and faculty.

The second space challenge is to provide resources to modify and sustain available space within the BE and E2 buildings appropriate to programmatic uses. Examples include funding renovations to create new laboratory space for BME, CE and EE, including wet laboratories, clean rooms, laser optic rooms, vibration sensitive facilities and locations for autonomous vehicle storage and development. Campus capital funding for Alterations 2 and 3 Projects within BE (to begin in 2006) will partially complete some laboratories, but the space will be insufficiently furnished to support faculty and student research without the allocation of further funding. Planned expansion of the BME Program will require additional wet laboratory spaces beyond what is available following these renovations, requiring either new space to be constructed or other existing space to be modified. Moreover, as other space within the BE building becomes available to SOE, it will require renovation to be appropriately suited to faculty and student needs for instruction and research. Significant resources will be required for all these types of space.

The third space challenge is to identify and implement solutions to allow for contiguous occupation of instruction, research and office space by faculty and academic programs. Under current campus planning, the BME Program will be spread across multiple buildings and facilities with offices in the new PSB building, partially completed wet laboratories in the BE building, some laboratories in the Sinsheimer building, and computational space in the BE and E2 buildings. In addition, campus plans to construct a Bio-Medical building which will include additional BME wet laboratories in yet another facility. SOE and the campus would be well served to begin long term capital planning for a separate Bioengineering Building properly designed and equipped to facilitate the future direction of instruction and research in this field.

Faculty Salaries, Start-up and Housing Assistance

Similar to other areas of the campus, the Baskin School faces major challenges in recruiting and retaining the highest quality faculty. The competitive problems associated with faculty salaries, housing costs, and start-up packages as outlined in our initial Academic Plan five years ago remain today.

The current engineering salary scale impairs our ability to make competitive offers to faculty candidates, particularly in technology related fields. Competition comes not just from other higher education institutions, but also from private industry. There are disadvantages as well simply from the cost of living in the Santa Cruz area and greater San Francisco Bay Area, which diminishes the real consuming value of salaries. SOE is further hampered by limited upgrade funds as the Baskin School has yet to reach a size or maturity that yields normal turnover savings sufficient to provide resources for upgrading faculty salaries. We need assistance from the campus to create resource flexibility that enables hiring the very best faculty at salaries competitive with those offered elsewhere.

Housing costs are an additional problem in attracting and retaining qualified faculty, especially at the tenured-track level where the vast majority of our hires are made. Again, Santa Cruz is part of a larger economic environment with some of the highest housing prices in the nation, so we are naturally disadvantaged compared to institutions

in other regions. For SOE to be successful in developing unique 21st Century engineering programs, new approaches must be identified to mitigate housing costs for faculty and enhance recruitment of top scholars from throughout the world.

Start-up funding continues to be an enormous challenge in successful faculty recruitment, as SOE offers are often not competitive with the resources provided by older and more established engineering schools. This affects particularly our ability to hire underrepresented minority faculty where there is extreme competition from other institutions. SOE has pursued extramural funding to help increase start-up packages, but additional campus resources are necessary as well. Unfortunately, limitations in start-up funding adversely impacts the quality of faculty recruitment, both in attracting and keeping the top candidates. This became most apparent recently with recruitment efforts in departments such as BME. Available wet laboratory space to be provided to faculty after completion of the Alterations 2/3 Project in the BE building will be incomplete and unfurnished—so further start-up funding will be necessary to make the labs operational. Recent BME faculty candidates reviewing the project plans for such space have turned down SOE offers because they view the incomplete laboratories as a lack of commitment by the campus administration to create and sustain successful programs.

Staffing and Operational Support

The statewide budget problems of recent years impacted creation of a sustainable staffing and operational infrastructure within the Baskin School. While faculty recruitment proceeded at a rapid pace and the school experienced growth, campus support funding allocations were decreased due to budget reductions. This especially disadvantaged a new professional school since core infrastructure was not sufficiently established. Some essential components of staffing support were created, while others, such as separate departmental staffing, were not. In reality, individual departments exist in terms of clusters of faculty and available academic degrees, but there are not physically separate and adequately staffed departmental offices within the Baskin School at this time.

As SOE continues to grow, staffing and operational support lags behind. Faculty often cannot rely on the extent of support services and resources available in other programs due to limited staff. The level of staff positions relative to faculty positions within SOE lags behind those evident within other engineering schools throughout the University of California. As a result, faculty often must function as their own administrative assistants which is not an efficient use of resources. Professional schools simply require a higher level of staffing and operational support than some other academic programs. For example, at UC Irvine, besides centralized staffing reporting to the Dean's Office, the engineering school strives to provide resources equivalent to one permanent staff FTE for every four ladder rank faculty FTE.

Recruitment and retention of qualified staff, especially in technology support areas, also presents a major challenge to SOE. The competitive climate fostered by proximity to Silicon Valley sometimes makes university staff salaries unattractive. Given that part of SOE's mission is to further expand the academic presence of UCSC within the Silicon

Valley, staff performance expectations, standards, and competitive pressures require the highest caliber of professional staff. Unfortunately, we are restricted by campus staff human resource practices that can impede using the job classification and salary levels necessary for success. This has been especially evident in frustrated efforts to hire permanent staff to support academic programs at the Silicon Valley Center.

SOE will require additional resources from the campus, extramural sources, and industry partners to build the necessary staffing and operational support levels as the school expands.

Technology Investment

The programmatic cornerstone of the Baskin School is technology. Our focus to create academic excellence exclusively in the fields in bio-technology, info-technology, and nano-technology sets SOE apart from the traditional patterns adopted by engineering schools established in the 20th Century. And this makes technology even more integral to our success. Technology is more than a tool used to complement and support instruction and research; it also is the primary object of much instruction and research.

In this regard, on-going investment in technology is essential, and the requirement to upgrade and expand technology for SOE programs is never-ending. One emerging demand is to enhance the provision of videoconferencing and distance learning capabilities between the main UCSC campus and the Silicon Valley Center to support new academic programs offered in both locations. Changes in the technology curriculum are creating demands for expanded instructional laboratory space and dedicated teaching and fabrication space, along with the equipment required for such facilities. Within the realm of computer resources for SOE faculty, students, and staff, there is demand for expanding and enhancing network infrastructure, wireless computing, virtual private networks, enterprise computing services, computational computing capacity, and an increased number of data centers.

SOE has been successful in generating extramural funding to help keep pace with some technology demands, but additional resources will continue to be necessary. A portion of these costs should be provided from campus resources as part of regular operations, but it is unclear how the dynamics and service levels for technology support will be realized given the recent ITS consolidation. Tradeoffs and priorities have not been identified as they relate to sustaining high quality support for academic based computing, although this is a goal shared by many. The ITS consolidation removes resources from academic divisions into a centralized operation, reducing flexibility for faculty to directly influence the allocation of technology resources. As the process to overcome this challenge is developed and implemented, SOE will still need resources to move forward to keep pace with technological advances and changes.

H. ACCOUNTABILITY

Our goal is to establish an internationally eminent and distinctive School of Engineering that provides significant impact to industry, academia, and society. Our target areas of excellence will promote active collaborations across departmental and divisional boundaries and achieve the School's reputation as one of the best nationally. We expect that the School's reputation will follow once our areas of excellence are well established. By the end of this decade, we expect that each of the SOE departments will be in the top 25 in the nation.

The Dean's Advisory Council (DAC) consistently recommends that the SOE aim at being the first in a small number of target areas. At the same time, DAC emphasizes the importance of providing broad basic education. This recommendation strongly supports our goal for building truly outstanding focused engineering programs with significant impact at UCSC. For strategic management of enrollment growth and promotion of excellence, each department will be asked annually to justify resources based on its research productivity, program strength and outcome assessment in addition to the enrollment count. The School of Engineering will 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, private foundations, industry and Federally supported research laboratories, such as Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Lawrence Berkeley Laboratory, and NASA Ames Research Center. Individual departments in the School have increased research funding on a yearly basis beyond that expected by the increase in the number of faculty. In this long term planning document, the School also presents a timeline for program development.

Despite our ambitious and concerted best efforts, our goals cannot be achieved in the absence of proper resource allocations, such as faculty and staff recruitment, adequate space provision and infrastructure support for both research and instructional activities. 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.

I. CONCLUSIONS/RECOMMENDATIONS

In the next five years, the Baskin School of Engineering can fully achieve the vision for the school that was first articulated in the 2001-2011 Long Range Plan. The revised long-range plan details the pathway that will enable the SOE to become preeminent in three areas of excellence: biotechnology (BT), information technology (IT), and nanotechnology (NT). The School will accomplish this by increasing and improving its leadership with interdisciplinary collaborations in both academic and research programs. In order to achieve its goals over the next five years, the Baskin School of Engineering will depend on the following additional support and resources from central administration:

- Free up space in the BE and E2 of non-engineering services and programs to provide sufficient resources to help accommodate SOE program growth;
- Provide resources to modify and sustain available space within the BE and E2 buildings appropriate to programmatic uses. Examples include funding renovations to create new laboratory space for BME, CE and EE, including wet laboratories, clean rooms, laser optic rooms, locations for autonomous vehicle storage and development, and vibration sensitive facilities;
- Assist to create resource flexibility that enables hiring the very best faculty at salaries equivalent to those offered elsewhere;
- Identify new approaches to mitigate housing costs for faculty and enhance recruitment of top scholars from throughout the world;
- Augment resources derived from SOE extramural sources and industry partners to build the necessary staffing and operational support levels as the school expands;
- Provide support to and incentives for interdepartmental and interdivisional joint faculty appointments, by supporting 1/3 of the cost of the position for a five year period, with the other 2/3 being split between the two hiring departments;
- Change existing policies and procedures for calculating teaching credits, such that departments with courses that have significant enrollments from other departments or divisions are appropriately rewarded, and acknowledge that more TA resources are needed in teaching laboratory courses than conventional classes;
- Provide enhanced teaching and research resources and facilities at the UCSC Silicon Valley Center (SVC), including videoconferencing and distance learning capabilities between campus, SVC and the SOE research and teaching partners; and
- Augment resources derived from SOE extramural sources and industry partners for investment in SOE technology equipment and related operational support. With the continued growth of the SOE will come the requirements for expanding and enhancing network infrastructure, wireless computing, virtual private networks, enterprise computing services, computational computing capacity, and increased number of data centers.