

The Henry Samueli School of Engineering Strategic Plan

1. General Planning Horizon and Assumptions

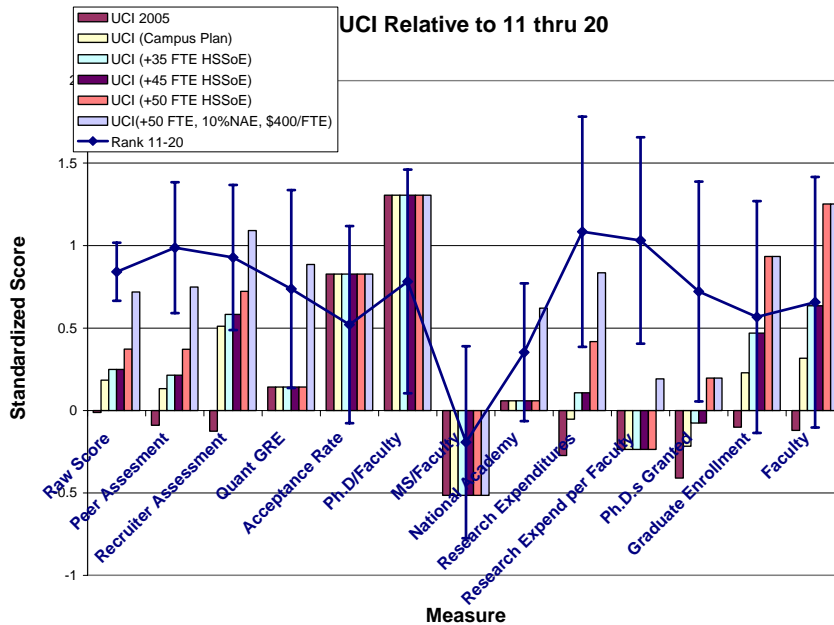
Nominally, the growth plan for UCI would call for the following increases for the HSSoE by the year 2015: 1) approximately 25 new faculty FTE, 2) an increase of 500 in undergraduate enrollment to a total of approximately 2,580, and 3) an increase of 657 in graduate enrollment to a total of approximately 1,340.

Although there is projected a 96% increase in graduate enrollment campuswide, growth in such enrollment within the HSSoE will undoubtedly be constrained by the limits of a sustainable graduate student to faculty ratio. The current ratios across the major UC campuses (UCB, UCLA, UCSB, UCSD, and UCI) are relatively constant at about 4.75 Ph.D. Students per faculty and 2.25 M.S. students per faculty, or about 7 graduate students per faculty. This indicates that the nominal campus goals for growth in graduate enrollment are not realistic for the HSSoE. This is a result of the HSSoE already having achieved the campuswide goal of graduate student to total student ratio of 0.25—the actual underlying goal driving the targeted 96% increase in enrollment for the campus.

Our strategic plan is predicated on a goal of achieving a “top twenty” ranking in the US News annual ranking of the nation’s engineering schools by 2015. Based on our analysis, it would appear that the minimum requirements to achieve the goal of a top twenty ranking are:

- 50 additional Faculty FTE,
- approximate doubling of the percentage of NAE members (from 5.8% to 10%),
- approximate doubling in research expenditures per faculty (from \$200,000 to \$400,000)
- raising the mean HSSoE student GRE score to the UC (UCB, UCLA, UCSB, UCSD) average of 766.

The following figure presents an estimate of the expected movement in the HSSoE rankings under scenarios in which the faculty FTE growth is 25 (Campus Plan under “across-the-board” assumption), 35, 45, and 50. For comparison purposes, the current (2005) conditions are also displayed, as are the current criteria levels associated with breaking into the “top twenty” designation (where the solid line represents the mean score for schools ranked 11-20, and the error bars represent one standard deviation from the mean). In estimating the projected HSSoE values for the objective measures used in the rankings, current relationships per faculty FTE have been maintained. In estimating the projected values in the two subjective measures (i.e., peer and recruiter assessments of quality), regression models based on US News data were used.¹ As can be seen, with these increases, the HSSoE would be expected to be solidly within the 11-21 grouping.



Based on these projections, a realistic goal for the HSSoE to be ranked in the top twenty schools of engineering (or, at least, to be in the “same league” as such institutions as Cornell University, UCSD, University of Texas, Texas A&M, UCLA,

¹ Details of the analysis leading these conclusions can be found in the HSSoE Vision Report.

University of Maryland, University of Wisconsin, Princeton University, Penn State University, Columbia University) can be achieved by 2015.

The expected composition and characteristics of the 2015 HSSoE would be the following:

- Faculty Size: 150 FTE (15 NAE members)
- Graduate Enrollment: 1,050 (715 Ph.D. + 335 M.S.)
- Undergraduate Enrollment: 3,150
- Annual Research Expenditures: \$60,000,000
- Annual Ph.D. Production: 82

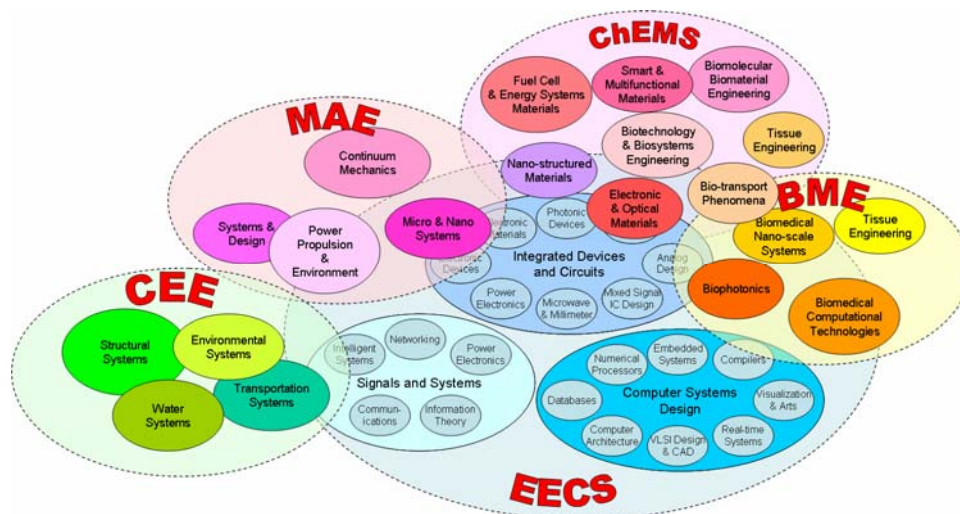
2. Mission and Structure

The HSSoE is organized into five departments: Department of Biomedical Engineering, Department of Chemical Engineering and Materials Science, Department of Civil and Environmental Engineering, Department of Electrical Engineering and Computer Science, and Department of Mechanical and Aerospace Engineering. The academic mission of The Henry Samueli School of Engineering is to provide a stimulating academic environment for individuals interested in the application of science and the development of new technologies for the benefit of society, and to provide a supportive environment for each program to meet its unique objectives.

The School offers undergraduate majors in Aerospace Engineering (AE), Biomedical Engineering (BME), Biomedical Engineering: Premedical (BMEP), Chemical Engineering (ChE), Civil Engineering (CE), Computer Engineering (CpE), Computer Science and Engineering (CSE, a joint program with the Donald Bren School of Information and Computer Sciences), Electrical Engineering (EE), Engineering (a general program, GE), Environmental Engineering (EnE), Materials Science Engineering (MSE), and Mechanical Engineering (ME). The majors in Aerospace, Chemical, Civil, Computer, Electrical, Environmental, and Mechanical Engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

3. Research Agenda

During the past decade, the HSSoE has made significant progress in establishing the school as a leader in the application of advanced technologies to the solution of modern engineering problems. Our growth has been focused in areas not common to the vast majority of engineering programs that populate the national scene—information technology, micro- and nano-technology, bio-informatics and biomedical engineering. The establishment of these programs, coupled with existing strengths in the application of novel technologies to the more traditional areas of engineering, has resulted in a school that is characterized by tightly-knit, overlapping research areas in high technology fields (see figure below) that place the HSSoE in an ideal position to address what we believe to be the most challenging engineering issues that will dominate the landscape in coming decades.



A key component in the overall strategy to accelerate the HSSoE into a position of national prominence will be its ability to identify and develop important research areas at the forefront of modern technology, and which can serve as the incubators for major, interdisciplinary, research centers. Below we present specific candidates for which there is evidence that the HSSoE is ideally suited to pursue.

Power and Energy Systems: A strong opportunity for program development in power generation and energy conversion now exists and the HSSOE should move swiftly to solidify and build upon the remarkable foundation that has already been established. The world community is recognizing the need to reform dramatically the energy infrastructure from fuels to energy conversion devices to energy utilization. There is now widespread acceptance that national GNP and average standard of living correlate with power generation, and that atmospheric quality (from urban air pollution to tropospheric acid rain and global climate change to stratospheric ozone depletion) is largely tied to energy conversion. With its emerging international reputation through faculty honors, faculty innovations, the National Fuel Cell Research Center, the Advanced Power and Energy Program, combustion research, miniaturization and portable-power research, and research on the air quality impacts of energy conversion, the school is uniquely positioned to make further major advancements in its world-class academic program.

The power generation, conservation, and transmission aspects of this research will aim at developing the research environment, ability, and infrastructure needed to place us as leaders in this crucial field. Indeed, in order to conserve our energy resources, protect our environment, and simultaneously support the global economic growth, it is an urgent task to renovate our power grid so that it makes efficient use of energy sources, has better generation and transmission efficiency, and is highly secure and reliable. A particularly promising area of research to be conducted is related to biofuels. The National Resources Defense Council argues that “aggressive action to develop biofuels between now and 2015 would position America to produce, by 2050, the equivalent of more than three times as much oil as we currently import from the Persian Gulf. And if combined with better vehicle efficiency and smart-growth urban planning, biofuels could virtually eliminate our demand for gasoline by 2050.” Our vision also calls for the development of the power electronics area. We aim at solving modern grid issues to address distributed power generation, efficient power transmission, power quality control, and power system security. This research will develop advanced power electronic circuits to be installed in the power systems. These power electronic circuits can be wirelessly controlled to perform renewable energy generation, harmonic cancellation, voltage support, and power flow control. In the meantime the power system health condition is monitored by the wireless sensors and analyzed at the base station. In the event of earthquake, terrorist attack, or nature disaster, the power electronics circuits will quickly respond to redirect power, reconfigure the power network, and self-repair the power system. With the necessary power electronics installed in the grid, the new sensing/commutation/communication technologies developed in the last decade can be adopted to interface with the power electronics to realize fast, accurate, and fine control of the power grid. With the growing consensus that energy utilization and global warming are a perilous concern, and with California as the second largest state for power generation, we are uniquely positioned to be successful.

Sustainable Natural and Built Environmental Systems: Sustainability will be fundamental to the study and practice of engineering in the 21st century. In simple terms, sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs. As an organizing concept, sustainability includes questions of energy use and emissions, global and local environmental impacts, systems analysis, planning and public policy, land use and urban design, economics and finance.

This research area will strategically choose subject matters for research to solve specific problems involving interactions between the built and the natural environment—the development of next generation technologies for civil infrastructure systems and their impacts on the built environment interacting with the natural environment. The constructed facilities are supported by an important subset of the built environment consisting of lifelines such as power and water supply, wastewater treatment facilities, and transportation networks. Equally important are the human networks for education, medical care, legal, financial and other societal activities. Together, the built environment provides the space and mechanism in which we live and interact with the natural environment which includes some devastating extreme meteorological and seismic events.

We will focus our research efforts on the three most prominent systems that constitute the built environment—structural systems, water systems, and transportation systems. In the area of structural systems, we will concentrate our research on the innovation of advanced technologies and analysis for civil infrastructure systems and their impacts on the built environment interacting with the natural environment. Our focus in the water systems area will be on infrastructure systems used to protect and/or deliver fresh and marine water resources for municipal, agricultural, industrial, environmental, and recreational uses. Emphasis will be placed on water systems in arid to semi-arid hydrologic zones, where limited fresh water supplies are a chief factor affecting economic sustainability. In transportation, the search for and investigation of sustainable transportation solutions will therefore permeate transportation research for many decades to come. We will develop research surrounding issues related to future transportation vehicles, systems, and fuels from both a LCA (Life Cycle Analysis) perspective (energy efficiency, environmental impacts, economics, sustainability) and social behavior perspective with the goal of identifying scenarios that are likely to be successful (or perhaps necessary) to meet the growing reality of constrained energy resources, traffic congestion, and environmental impacts.

Biomaterials, Nano-biotechnology and Biomedical Systems: This thrust area aims at capitalizing on a number of advances both in the field of Biomaterials, by conducting research in the middle-ground between the basic sciences and clinical

applications—specifically, in the fields of synthesis and characterization, interfacial engineering, and biotransport engineering—and in the field of nanotechnology, by putting together a number of crucial enabling technologies, creating entirely new application domains.

The US is estimated to spend approximately \$1.3B in nanotechnology R & D in 2007. Europe and Japan are spending R & D dollars at a similar level. With the emergence of nano-bio technology as a rapidly growing field of research, there is a burning need to develop an entirely new set of tools to understand, measure, and quantify the nanoscale in biology.

In a complementary activity, we will expand the Micro/Nano Fluidics Fundamentals Focus Center (MF3). The Center's research will focus on the exploration and advancement of fluidic surface and interface analyses and chemistries, design and modeling methods, and the development of economical and modular components, as well as analyze the establishment of standard fabrication and packaging processes. Advancements made in these areas may lead to bioanalytical microsystems for drug discovery, in-situ health monitoring, and electronics cooling.

This thrust will be complemented by establishment of the Edwards Center for Cardiovascular Technology, creating a research program aimed at developing new technologies to treat cardiovascular disease. This new interdisciplinary center will be the cornerstone of our efforts in cardiovascular engineering. We are currently negotiating the naming gift from Edwards Lifesciences and hope to make a formal announcement in the Spring, 2007.

Advanced Manufacturing Systems: Lester C. Thurow, former Dean of MIT's Sloan School of Management, foresees a historic movement in wealth away from nations with natural resources and capital towards those nations emphasizing brainpower and imagination, invention and the organization of new manufacturing technologies. The world is at a crossroads in the area of high tech manufacturing. Manufacturing jobs in the US, over the last 25 years, have been steadily lost to Japan, Korea and Taiwan. To stanch the hollowing out of the manufacturing base in developed nations, the governments of many countries have made substantial investments in the miniaturization of new products (MEMS and NEMS), the miniaturization and automation of manufacturing tools (Desk Top Factory or DTF), and the development of new electronic manufacturing technology.

The current nanotechnology and energy craze in the US will not amount to much, unless we regain an edge in manufacturing what we invent. For example, one of the reasons fuel cells is not a reality yet is the lack of inexpensive manufacturing processes; likewise, nanotechnology's main challenge is manufacturability. ICs, MEMS lithography-based machining and non-lithography based micromachining will continue to enrich the nations that invest in it most heavily. In the IC area, which is based on traditional photolithography and where the US still leads, we are already working in the nanodomain with quantum physics becoming a required tool in the manufacturing toolbox.

During recent years, a significant number of HSSoE faculty have been added in the MEMS and NEMS area; research in these areas are among the most highly funded efforts in HSSoE today and constitute one of the more popular directions for our graduate students. We are in an excellent position to expand this activity because UCI is located in one of the largest manufacturing bases in the world—southern California. Also, the INRF has reached a level of prominence and now acts as a catalyst for bringing together the required interdisciplinary efforts in novel manufacturing techniques.

The HSSoE is in an advantageous position to take a leadership role in novel manufacturing through faculty additions and the development of new courses. The fundamental background in which this novel manufacturing effort could be grounded ranges from quantum mechanics and reliability to courses on machining mechanics, scaling of actuators, machines and machine tools. With the presence of the Fuel Cell Center on campus, a very good application area of our manufacturing effort could be in manufacturing of novel energy devices.

Communication, Information and Mobility Systems: Increasingly, the fabric upon which society is built, and the backbone for both its social as well as economical interaction, is provided by its communications and transportation networks and the attendant computation systems upon which they are based. In this research, we focus on crucial aspects of these systems, designed to unleash their full potential.

Our research into Ubiquitous Secure Computation Systems is a ground-breaking effort at harnessing the tremendous power of digital data. It will have profound implications at all levels of the design not only of computer systems, but also of any engineering project. The overall philosophy of this research will be to focus on application areas and system building, and to emphasize all software aspects of the Computer design process. The system design process will be an intimately integrated mix of hardware and software systems, thereby confirming the intimate relationship of this domain to all other aspects of our school.

Our immensely powerful, highly interconnected society offers the promise of heretofore unimaginable empowerment to the individual; the same technology brings with it incalculable risks of crime, terrorism, loss of privacy, and potential for government abuse of individual rights. Beyond "human-made" misuses, over-reliance on digital technology may prove equally disastrous, owing to the very power it bestows upon us. The technological giant we have been building has clay feet and has ignored fundamental issues of designing for error tolerance. This research effort will bear on multiple levels of the

design of interconnected systems from the lowest electronic design to computer architecture, middleware, software, and applications, with a strong emphasis placed on telecommunications and networking which are obviously at the core of these technologies. At the same time, we will research the design of intelligent searches that rely upon universal translation systems, allowing a formal representation (and hence storing) of the whole knowledge of mankind, inherently allowing searching through it, processing it, and visualizing it. This is one of the most significant frontiers of the computing field and it will simultaneously require the interaction between many specialties of computer systems design as well as application areas.

In the design of new transportation systems, and particularly in cost-effectively improving the performance of existing systems, it is now clear that the use of advanced information technologies will play a critical role. This role needs to be investigated and defined. Our research in Intelligent Transportation Systems and Telematics will concentrate at the interface of technologies and concepts emerging from fields such as microelectronics, automated control, networking and communications, computer science, materials science, operations research, and the social sciences, and the problems faced in achieving improvements in the real-time performance capabilities of transportation/activity engineering systems.

Life Chip Technology Research Initiative: Life Chips are micro- and nano-scale devices that hybridize technologies developed by engineers and biologists to help solve fundamental problems in the life sciences. Life Chips technology involves both the research/development of biochip technology and its application to biological systems on the sub-cellular, cellular, tissue, and organ levels.

The LifeChip Technology effort lies at the intersection of biomedical engineering, device and material design, biology, to name just a few. It draws upon our existing expertise in device design and will reach critical mass with the addition of several FTEs. LifeChips is the study and development of micro- and nano-scale technologies, systems and devices that combines methods developed by life scientists and technologists to help solve fundamental problems in the life sciences and in engineering. As the name suggests, it also represents the merging of two major industries, the microelectronic chip industry with the life science industry.

LifeChips has emerged from a growing research paradigm that combines technology development with the study of life science and medicine at microscopic and smaller size scales. Since the 1990's, governments and industries in the United States, Asia and Europe have initiated major efforts to bring microtechnology and nanotechnology to biology and medicine under such labels as "bioMEMS", "nanomedicine" and "nano-bio." Other initiatives seek to use lifebased materials for non-biological applications, such as the use of DNA for transistors. Additionally, high throughput biology products that utilize semiconductor chip technologies, such as lab-on-a-chip, DNA microarrays and protein microarrays, have seen considerable commercial success. These events have driven the need for collaborations among researchers from traditionally different backgrounds and cultures, namely life scientists (biologists, medical researchers) and technologists (physical scientists, engineers). The LifeChips theme encompasses these research topics, as well as the interdisciplinary collaborative efforts themselves.

The properties of biochips and the sophistication of ancillary technologies needed to generate, interface with, and deliver them, suggests that life chips will find roles in multiple analytical, diagnostic, and therapeutic systems of the 21st century. The ability to design, build, and miniaturize them will require a concerted interdisciplinary effort. It is not only a micro/nano fabrication chip technology for enabling life science research but also the research of life's remarkable technology, developed over three billion years of evolution.

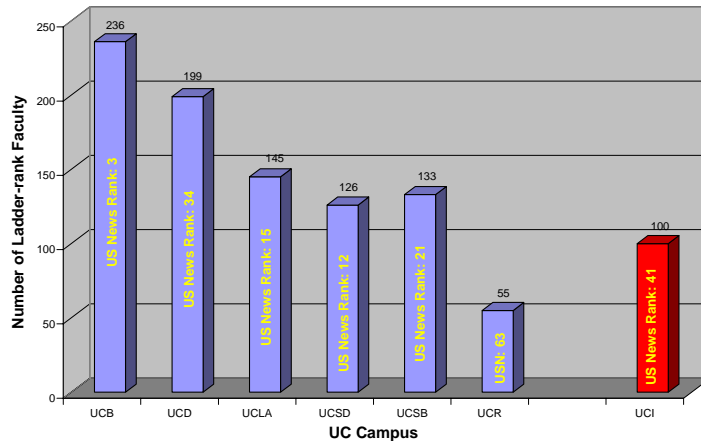
With the addition of high quality faculty members possessing expertise in the proposed emerging areas, the Life Chips research program can become one of the top ranked programs in the nation. Our new program of Life Chips research and teaching will serve as a model for other universities, leading to hiring of our graduate students and post-docs as faculty in other universities. A strong life sciences/engineering program can have many benefits and spin-offs on campus units, including several departments within engineering, and within the sciences and medicines. Many synergies can develop with an enhanced Life Chips technology activity. The program's broader impact will be development of a generation of engineers and scientists who will develop new nanotechnologies inspired by the "technology of life" and invent Life Chips to address fundamental problems in life-sciences.

Resultant HSSoE Strategic Research Growth Pattern

A graphic illustration of the HSSoE strategic plan for growth in the research areas outlined above is shown in the figure below, which overlays each of the targeted areas for development relative to the existing areas of research strength. As can be seen, the planned growth both builds on our existing strengths, while extending the frontier those strengths toward areas of emerging national importance.

Broadly speaking, the research agenda of the school covers the spectrum of modern technological research impacting both physical and biological systems, ranging from emergent micro/nano-scale technologies to large scale systems, while providing bridging technologies to virtually all other UCI schools.

Faculty Size of UC Schools of Engineering (excluding CS)



In fact, in nearly every case, engineering departments within the HSSoE have fewer faculty than our higher-ranked sister counterparts—the lone exceptions being the EE department at UC Davis, and the Bioengineering departments at UC Berkeley, UCLA, and UCSD.²

The current faculty of the HSSoE comprise a very distinguished group of scholars. Counted among them are 9 members of the National Academy of Engineering (including 3 emeriti and adjunct faculty), 5 Distinguished Professors (including 3 adjunct faculty), 1 Chancellor’s Professor, and 5 Chaired Professors. A more general, objective, indication of the quality of our faculty can be found in the Faculty Scholarly Productivity Index™ (FSP Index)—a method for evaluating doctoral programs at research universities. The FSP Index measures the annual productivity of faculty on several factors including: publications (books and journal articles), citations of journal publications, federal research funding, and awards and honors.

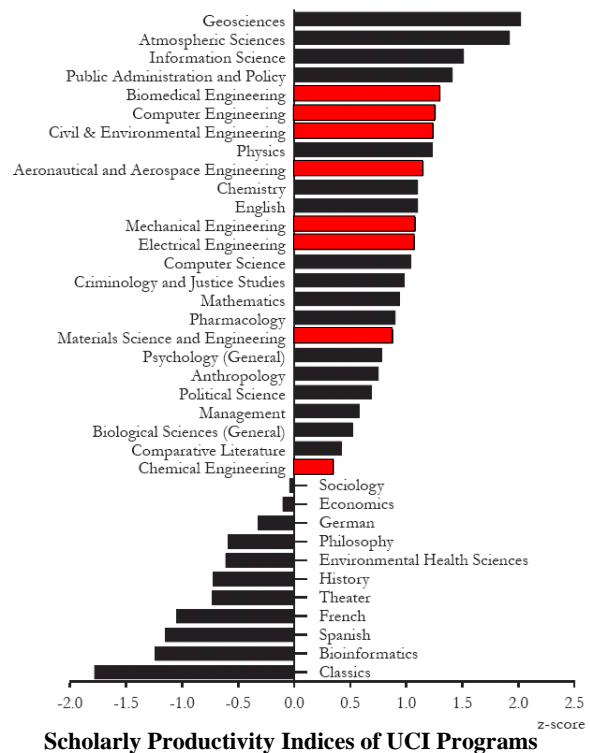
An objective, standardized, measure of the quality of our faculty is provided by the 2005 Faculty Scholarly Productivity Index, by Academic Analytics, a company owned partially by the State University of New York at Stony Brook, that ranks 7,294 individual doctoral programs in 104 disciplines at 354 institutions.

The index examines faculty members who are listed on a Ph.D. program’s Web sites; the total number of faculty members rated by the index is 177,816. The productivity of each named faculty member is measured on such factors as the number of books and journal articles published as well as citations of journal articles; federal-grant dollars awarded; and honors and awards. The faculty’s scholarly productivity in each program is expressed as a z-score, a statistical measure that reveals how far and in what direction a value is from the national mean..

As can be seen by the figure below which details the results of this index for UCI academic programs, not only do all of the HSSoE departments score significantly above the national means for their respective disciplines on this index (all but one score at or better than one standard deviation above the mean, or better than about 85% of national programs), but they are also ranked among the top programs at UCI—comprising four of the top ten rated programs at UCI, and six of the top fifteen.

4.5 Recruitment Strategy to Achieve Faculty Diversity

As noted in the May 2006 Report of the UC President’s Task Force on Faculty Diversity, and shown in the figure below, the demographic profile of minority representation in the UC faculty has changed only slightly; the exception to this general trend is a



² Here, it is noted that while the Bioengineering departments at UC Berkeley, UCLA, and UCSD are somewhat similar to the BME department at UCI, they differ significantly in scope.

gradual increase in the percentage of Asian faculty, but that growth being confined principally to engineering. Similarly, the steady growth in women faculty has been concentrated in fields outside of engineering, and still lags by a substantial margin their representation in the general population. These latter two points are evident in UC Systemwide data for engineering ladder-rank faculty composition for the year 2004, which show that Asian faculty representation among engineering fields is more than double that overall, while the percentage of women faculty in engineering is almost three times lower than the UC Systemwide average; percentages of African American and Chicano/Latino faculty in engineering are slightly below the UC Systemwide average, a somewhat misleading statistic in that these minorities are concentrated in certain fields (humanities and social studies), with over one quarter in the subfields of education, languages, and ethnic studies. Representation of minorities and women among the UCI HSSoE faculty roughly parallels that of UC Systemwide.

Our goal in achieving faculty diversity is to adopt a focused effort in directions that will have a high probability of success in achieving tangible results. The national trend of Ph.D. awards in engineering to minorities and women indicate that such awards to three groups of the pool of minority candidates potentially eligible for appointment to engineering faculty positions—Native American, African American, and Latino/Chicano—have remained both very small and relatively constant over the past decade. Conversely, engineering Ph.D awards to Asians (a group already well-represented among engineering faculty) have declined significantly, while Ph.D awards to women in engineering have experienced significant, steady, growth—the only underrepresented minority in engineering to exhibit this characteristic.

The under representation of women faculty in engineering is particularly perplexing in that, among the sciences and engineering, engineering remains at the very bottom of the scientific fields in the inclusion of women among ladder-rank faculty.

With the increasing entrance of women in advanced degree programs in engineering, the opportunity is ripe for us to structure a recruiting strategy designed to significantly increase the representation of women among the HSSoE faculty ranks. Based on historical trends, it can be projected that, by a decade from present, women Ph.Ds in engineering will account for over 25% of the degrees granted—engineering Ph.Ds to women over the next decade will number more than those produced in the previous three decades!

The UCI HSSoE is in a very favorable position to attract significant numbers of women to ladder-rank faculty positions. First, all of the engineering fields represented by the academic departments in the HSSoE represent areas in which the relative size of the current pool of women applicants is greater than the UC Systemwide average representation for women faculty in engineering.³ Second, in academic areas represented in two of the four HSSoE departments for which national data are available (ChEMS and CEE) the production of Ph.Ds to women exceeds the national average across all engineering fields—an indication that the pool of women candidates in these fields is particularly rich. Third, as a school, the HSSoE is already above both the UC and national averages in terms of representation of women among its faculty; this core group can serve as a catalyst to attract additional faculty.

Finally, there is a swelling of young women scholars in engineering. Because of the growth anticipated for UCI, few, if any, engineering programs in the country can be expected to grow as rapidly as the UCI HSSoE over the next decade. The rising percentage of Ph.D awards to women in engineering coupled with the pool of promotable junior faculty offer an opportunity for UCI to lead the nation in pushing women faculty representation in engineering toward the pace reflected by the trends in PhD awards—UCI can lead, as others catch up.

Implementation of the strategy to substantially increase women faculty in the HSSoE is relatively straightforward. As noted above, the academic areas featured by the HSSoE are well-subscribed to by women pursuing advanced degrees in engineering—we will not have to alter our growth plans relative to our academic goals in order to achieve the complementary goal of increased presence of women faculty. Rather, we will implement a “dynamic” priority list of recruiting that will advance those positions in our priority list where we identify outstanding women candidates.

5. Educational Programs

The School offers M.S. and Ph.D. degrees in Biomedical Engineering; Chemical and Biochemical Engineering; Civil Engineering; Electrical and Computer Engineering, with concentrations in Computer Graphics and Visualization, Computer Networks and Distributed Computing, Computer Systems and Software, and Electrical Engineering; Engineering, with concentrations in Arts Computation Engineering, Environmental Engineering, Materials Science and Engineering, and Protein Engineering Science; Materials Science and Engineering; and Mechanical and Aerospace Engineering.

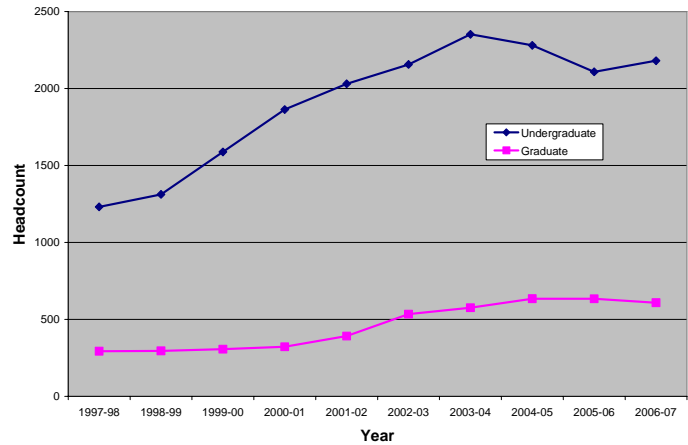
³ We note that, because it such a new field, national statistics are not yet available for Biomedical Engineering (BME); however, we further note that other medical-related fields have generally shown a higher percentage of women than traditional engineering fields.

The modest steady growth in faculty in the HSSoE has been accompanied by corresponding growth in the numbers of students enrolled in its academic programs. In recent years, there has been a healthy shift toward graduate enrollment that has resulted in a graduate student to total student ratio (currently, 25%) that is consistent with our being a major research university. At the same time, the total student to faculty ratio has been remarkably stable over the past several years, at a value in the neighborhood of 30:1.

Undergraduate enrollment has demonstrated steady growth in all of the areas covered by the departments in the HSSoE, with one exception being the unprecedented growth (and the subsequent precipitous drop) in enrollment in the computer engineering field—this phenomenon is the well-documented national “dot.com” bubble burst. Graduate enrollment in each of the departments also show steady, stable, increase, again accounting for the anomaly presented by the electrical engineering subfield of computer engineering.

Interestingly, despite the bubble of computer engineering, overall growth in both the undergraduate and graduate engineering programs of the HSSoE has been remarkably stable.

HSSoE Total Graduate and Undergraduate Enrollment Trends



Capitalizing on National Graduate Enrollment Trends

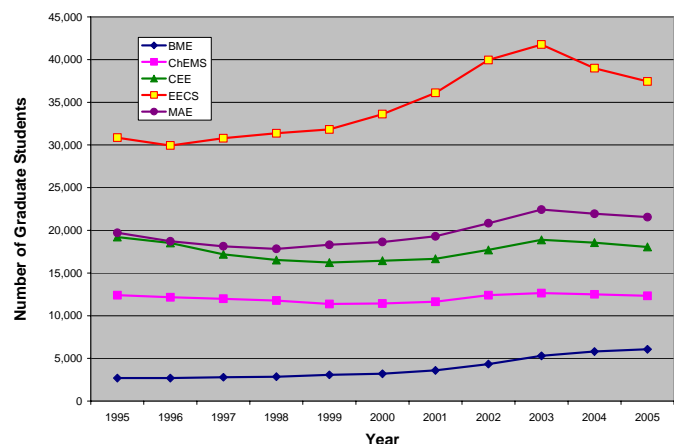
Graduate enrollment in science and engineering has historically had significant representation from international students—enrollment of foreign students in graduate science and engineering fields increased by 41% over the 10-year period beginning in 1995. Although there has been a slight decline in foreign student enrollment beginning in 2004, this decrease has been more than offset by the increase of enrollment of U.S. citizens and permanent residents—enrollment of U.S. citizens and permanent residents was the highest ever (339,550) in 2005. Indeed, graduate enrollment in science and engineering has been remarkably stable; this despite significant increases in the cost to foreign nationals of attending graduate school in the United States.

Within engineering itself, full-time enrollment in graduate programs has also been relatively stable, with the slight decreases in foreign enrollments being offset by increases in domestic enrollments. This has brought the national average to an approximate balance between domestic and foreign students. Moreover, surveys evidence that approximately 40% of foreign advanced degree engineering graduates remain in the US workforce after graduation.

As seen in the figure, national engineering graduate enrollment trends in the five graduate program areas covered within the HSSoE have also remained stable over the years. It is anticipated that, with recent changes in fee structures for foreign applicants (e.g., the remission of non-resident tuition for Ph.D candidates), the HSSoE will be in an advantageous position relative to the recruitment of increasing numbers of outstanding graduate students from the pool of foreign applicants. This, coupled with the increasing national stature of our school, should lead to substantial growth in the engineering graduate program at UCI.

Moreover, the School is in an ideal position to tap into the growing numbers of Latino/Hispanic students attending graduate engineering schools. The September issue of **Hispanic Business Magazine** features its 2006 Diversity Report with lists of the Top 10 Graduate Schools for Hispanics in the fields of law, business, engineering and medicine—The Henry Samueli School of Engineering is ranked #5 in engineering in the nation in this regard.

Engineering Graduate Enrollment Trends



The Henry Samueli School of Engineering is ranked #5 in engineering in the nation in this regard.

6. Feasibility of Achieving Goals

Based on an analysis of criteria for a “top twenty” ranking, we presented a series characteristics that would need to achieve the goal for the HSSoE to be ranked in the top twenty schools of engineering by 2015. Here we analyze whether or not, in addition to the allocation of approximately 50 faculty FTE to the school, we are positioned to realize each of the necessary characteristics.

Target of Approximately Ten Percent (15) of Faculty NAE Members

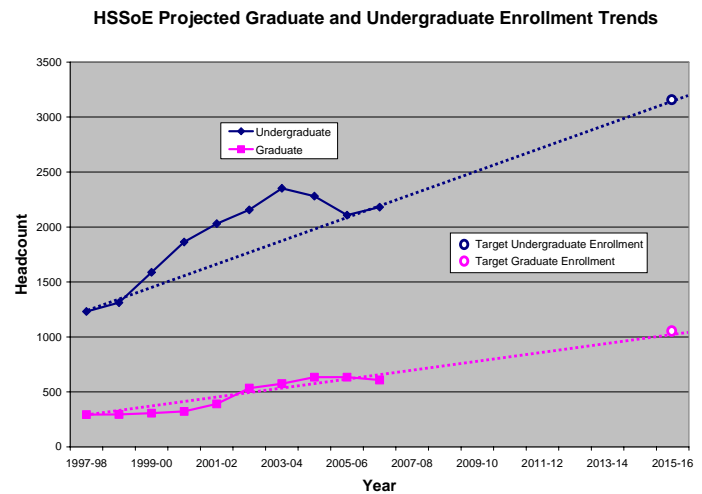
As already stated, the current faculty of the HSSoE comprise a very distinguished group of scholars. Counted among them are 9 members of the National Academy of Engineering, 5 Distinguished Professors, 1 Chancellor’s Professor, and 5 Chaired Professors. Assuming that even a few of those already holding distinguished and/or chaired positions, but not yet elected to the NAE, achieve election during the next ten-year period, this target is nominally achievable through a recruitment strategy that includes a historical percentage of senior appointments.

Undergraduate and Graduate Enrollment Targets

A simple linear projection of graduate and under graduate enrollment trends indicates that that student demand is sufficient to reach target values.

The capacity of the faculty to accommodate graduate student demand is dictated by “sustainable” graduate student to faculty ratios among respected research institutions. As stated previously, the current such ratios across the major UC campuses (UCB, UCLA, UCSB, UCSD, and UCI) are relatively constant at about 4.75 Ph.D. Students per faculty and 2.25 M.S. students per faculty, or about 7 graduate students per faculty. The current graduate student to faculty ratio in the HSSoE is about at this average.

Projecting a faculty size of 150 FTE translates to a capacity for 1,050 graduate students, distributed as 715 Ph.D. and 335 M.S. students, as targeted.



Extramural Expenditures Target

Our plan to achieve a top 20 national ranking is predicated, among other goals, upon an approximate doubling of extramural research expenditures per faculty FTE to about \$400,000 per faculty annually. It is reasonable to question whether or not this specific goal is achievable under the current structure of the School. For example, using the current (and projected) graduate student to faculty ratio of 7, and assuming an “average” professor as being at the top of the Associate professor salary scale, the maximum annual expenditures on contract and grant activities related to personnel costs per faculty is about \$340,000—this figure includes both direct and indirect costs, assuming 3-months summer salary for the professor and full academic year GSR and 3-months full-time support for 7 graduate students. Although there are likely to be other direct costs associated with our contract and grant activities (e.g., equipment, supplies, travel), the “cap” placed on personnel expenditures greatly limits our ability, under the current structure, to achieve the schoolwide goal of \$400,000 per faculty FTE, and suggests that we will need to examine ways to expand our “capacity” for expenditures. One obvious example of how this could be achieved would be to follow the lead of many of our competitors in establishing research centers staffed by professional researchers/adjunct faculty/faculty-in-residence who are not constrained to charge only their summer months to extramural contract and grant activity. The research areas targeted for growth are natural incubators for attracting such centers. However, this would likely require a substantial investment by the campus in laboratory facilities that would ensure the competitiveness of these centers for securing a steady stream of extramural funding.

Annual Ph.D.s Granted Target

Trends in annual production of both M.S. and Ph.D. awards in the HSSoE indicate that annual Ph.D. production has been about 0.4 Ph.D./faculty/year—the average over the past eight-year period is 0.42. Maintaining this average would translate into an annual Ph.D. award production of about 63 Ph.D.s by 2015 with 150 FTE, which is short of the specified target of 82. To achieve this target, HSSoE faculty will need to achieve an average production of about 0.55 Ph.D.s awarded per faculty per year. We note that this target was reached (and exceeded) in the latest year for which complete data are available.

Growth: Presented below is a summary of planned faculty growth to achieve our research and educational goals.

Research Area		Growth Period			Total
		2007-09	2009-14	2014-16	
Power and Energy Systems	Alternative Fuels		1.0		1.0
	Chemical Processes	1.0	1.0		2.0
	Physical Processes		2.0		2.0
	Energy Systems	1.0	1.0		2.0
	Renewable Power Generation	1.0			1.0
	Power Electronics		1.0		1.0
	Biofuels Engineering	1.0			1.0
	Metabolic Pathway Engineering	1.0			1.0
	Systems Engineering of Alternative Energy		1.0		1.0
	Membrane and Interfacial Transport			1.0	1.0
Sustainable Nat & Built Env Sys	Air Quality (Regional/Meso Scale)	2.0			2.0
	Air Quality (Local Scale)			1.0	1.0
	Sustainable Transportation Systems	1.0			1.0
	Hydrometeorology & Water Resources Sys Engr	2.0	1.0		3.0
	Environmental Hydrology	1.0	1.0	1.0	3.0
	Structural & Geotechnical Systems	2.0	2.0		4.0
Biomats, Nano-biotech & Biomed Sys	Biomaterials/Polymers	1.0	1.0		2.0
	Interfacial Engineering of Biomaterials	1.0		1.0	2.0
	Transport Engineering of Biomaterials		1.0		1.0
	Nano-scale biotechnology	2.0			2.0
	Nano Biometrology	1.0			1.0
	Materials Characterization Instrumentation	1.0			1.0
	Cardiovascular Technology	2.0	2.0		4.0
	Cancer		1.0	2.0	3.0
	Ophthalmology			1.0	1.0
	Neuroengineering		1.0	0.5	1.5
Comm, Info & Mobility Systems	Cybersecurity	1.0			1.0
	Signal Processing	1.0			1.0
	Communications Systems	1.0	1.0		2.0
	Embedded Systems	1.0	1.0		2.0
	Networking	1.0			1.0
	Telematics			1.0	1.0
Adv Manufacturing Systems	Quantum Engineering	1.0			1.0
	Self Assembly Engineering	1.0			1.0
	Advanced Mechanical Manufacturing		1.0		1.0
	MEMS	1.0			1.0
	Nanotechnology		1.0		1.0
Computational Methods			1.0	1.0	2.0
Totals		29.0	22.0	9.5	60.5

As mentioned previously, the Life Chip technology research initiative is a broadly interdisciplinary effort that draws from a number of these strategic research thrusts. Shown below is a summary of the interactions of the various faculty positions with this initiative.

HSSoE Faculty FTE Growth Plan Relative to Life Chip Research Initiative

Research Area	Growth Period			Total
	2007-09	2009-14	2014-16	2007-16
Power and Energy Systems				
Biofuels Engineering	1.0			1.0
Metabolic Pathway Engineering	1.0			1.0
Membrane and Interfacial Transport			1.0	1.0
Biomaterials, Nano-biotechnology and Biomedical Systems				
Biomaterials/Polymers	1.0	1.0		2.0
Interfacial Engineering of Biomaterials	1.0		1.0	2.0
Transport Engineering of Biomaterials		1.0		1.0
Nano-bio Instrumentation	2.0			2.0
Nano Biometrology	1.0			1.0
Communication, Information and Mobility Systems				
Signal Processing	1.0			1.0
Embedded Systems		1.0	1.0	2.0
Advanced Manufacturing Systems				
Self Assembly Engineering		1.0		1.0
MEMS	1.0			1.0
Nanotechnology		1.0		1.0
Instrument Development for Materials Classification	1.0			1.0
Totals	10.0	5.0	3.0	18.0