# Charting the Course IV

## - 2007-2010 and Beyond -

Jacobs School of Engineering
University of California, San Diego


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UCSD Jacobs | School of Engineering

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# 1. Introduction

The National Academy of Sciences, National Academy of Engineering, and Institute of Medicine focused in 2006 the Nation's attention on energizing and employing America for a brighter economic future in their landmark publication *Rising Above the Gathering Storm*. The 'gathering storm' addressed by the National Academies is simply the fact that the United States as a Nation cannot generate sufficient internal talent to fill the number of high technology jobs needed to keep the US in a leadership role in Science and Technology. In particular, other countries and regions around the world produce this talent in large numbers and under much more favorable economic conditions. More than 40% (and increasing) of all university entrants in Asia are studying engineering and technology, compared to less than 5% (and declining) here in the U.S. Thus, while the challenge of rising above the gathering storm by the National Academies addressed both education and industry, it is a particular challenge for U.S. engineering schools to provide the talent pipeline that will keep the U.S. on the forefront of innovation and technology leadership. And the simple question needs to be asked: *"What is the role of a leading engineering research school is in this global competition?"*

> *"The new competitors, China and India, are unlike any competitors we have seen in our lifetime, because they can bring limitless demographics and a strong technical underpinning."*
>
> **Jeffrey Immelt, CEO, General Electric 2006**

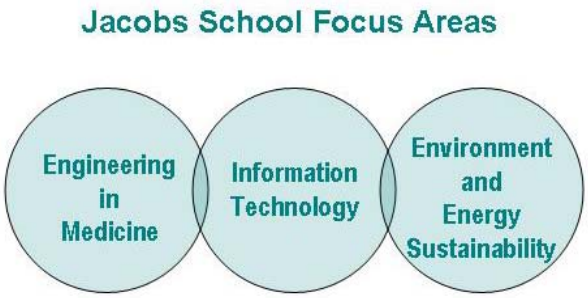
The Jacobs School of Engineering at the University of California, San Diego, has risen over the past decade in the national rankings (*U.S. News* annual graduate program survey) from a place in the mid-40's to number 11. With more than $800k/faculty in annual research expenditures, the Jacobs School has consistently placed in the top three of major research engineering schools in the U.S. over the past years. As one of the top research engineering schools, it is important for the Jacobs School to clearly define our contributions to 'rising above the gathering storm'. For a leading research university and for a leading research engineering school it is not sufficient to drive innovation by just developing new intellectual property, but it is also important to market and translate the research findings for the benefit of society. Similarly, it is not sufficient just to educate large numbers of engineering graduates, but rather to educate graduates with a broad and balanced education who have the depth and flexibility to compete globally for the best technology jobs and provide engineering leadership. The CEO of Northrop Grumman, Ron Sugar, defined the role of the research university as *"providing the human and the intellectual capital,"* namely both human and intellectual resources that are highly marketable and competitive (West Coast Competitiveness Summit of the Task Force on the Future of American Innovation, August 2006, San Diego). It is the role of the leading research engineering schools to establish this talent pipeline that will lead to continued innovation and technology leadership.

Charting the Course IV outlines the vision and implementation plan to firmly establish and sustain the Jacobs School as one of the leading research engineering schools. First and foremost, for the Jacobs School to continue on the forefront of research and innovation, we must be in a position to compete with the other top engineering schools in the country, both in terms of our research contributions and of our education programs.

# 2. The Vision

Only the very best and recognized leading research programs will attract the best and brightest faculty and students. More and more, the exciting research areas are on the interface between traditional academic disciplines. UC San Diego, and with it the Jacobs School, are well positioned to fully exploit engineering and technology to advance developments in other disciplines. In particular, the Jacobs School needs to leverage UCSD's strengths in the School of Medicine (incl. pharmacy) and in the Scripps Institution of Oceanography, and provide the technological underpinning to jointly advance science and technology in these fields.

Our role as human and intellectual capital provider must directly support our regional and state-wide industry. Historically, the strength of engineering at UCSD has been in the applied sciences, in particular information science and materials science. These strengths helped catalyze the rapid development of San Diego as an incubator and industry leader in communication technology and biotechnology. Our continued contributions in these areas are critical to our role as the region's only research engineering school. In addition, our state-wide economy, and indeed our nation, will be challenged by ever-increasing energy demands coupled with the need to sustain the integrity of our environment. We can and must apply our strengths in energy and combustion, nanotechnology, genomics and materials to develop new energy technologies, improve energy efficiency, and advance energy storage and distribution. Based on this regional context, our vision for engineering at UC San Diego is to have a clear focus in these three distinct areas: (1) *Information Technology*; (2) *Engineering in Medicine;* and (3) *Environment and Energy Sustainability*. The declared goal of the Jacobs School is to be the recognized research and education leader in these key economic areas.




***Information Technology***

The pervasive nature of information technology as a key societal driver was outlined in the Jacobs School's Charting the Course III, and the last three years have seen significant progress in engineering contributions towards this goal. New research initiatives in networked systems, information theory, algorithmic systems biology, and temporal learning have all resulted in engineering-led campus-wide centers/institutes that advance our science and technology base. With great support from some of our larger ORUs, such as the San Diego Supercomputer Center (SDSC) and the California Institute for Telecommunications and Information Technology (Calit2), new multi-disciplinary information technology-based research efforts continue to emerge and will define UC San Diego's contributions to the American Competitiveness Initiative. Engineering at UC San Diego will continue to drive the development of information theory and its applications, and we expect to strengthen this information technology leadership role and expand it to other academic disciplines.

***Engineering in Medicine***

With the concentration of health science research institutes in San Diego, the recent statewide regenerative medicine initiative, and UCSD's strength in Medicine, it is no surprise that biotechnology and bioengineering take on special importance in the region. The Jacobs School is the only research engineering school that can directly support these regional activities with technology innovations. Through collaborations with these leading institutions and the Jacobs School, we can and will have a much broader national and international impact. Currently we have research collaborations with the health sciences in all of our 5 engineering departments, and the proposed 6$^{th}$ engineering department in Nano Engineering has bio-materials as one of its areas of emphasis. To provide a forum for these joint developments between Engineering and Medicine, the EngMed (Engineering in Medicine) Initiative was launched, which will facilitate the interaction between researchers, clinicians, and the biotech industry, through affinity groups and targeted collaborative research. Where '*Engineering Innovation Fuels the Power of Academic Medicine*' is not just a combination of the slogans for the Jacobs School and the School of Medicine, but the true inspiration for significant advances in health care.

***Environment and Energy Sustainability***

The prudent management of our natural and built environments is of paramount importance to maintaining a sustainable economy. Indeed our nation's security, and with it global security, depends on the availability of reliable energy sources. The federal, state, and industry importance given to renewable energy technologies requires innovative engineering solutions ranging from the design of new and renewable fuel sources, to the efficient conversion of fuels to transportation fuels or electricity, to the management of the entire energy cycle through feedback controlled systems. To accomplish this with full respect of our natural resources requires an in-depth understanding of the complex interaction between our natural and man-made environments. The targeted combination of existing research capacities at UC San Diego will allow us to take on an international leadership role in defining sustainable energy and environment solutions. Similarly, sustainability and safety issues pertain to our built environment. Protecting critical facilities from natural and man-made hazards, and extending the functional service life of our civil infrastructure, requires health monitoring and management solutions--an area where the Jacobs School has unsurpassed facilities and expertise.

**Jacobs School Mission Statement**

*To educate tomorrows technology leaders*, to *conduct leading edge research and drive innovation*, and to *transfer our discoveries to ensure societal benefit.*

These overarching focus areas of *Information Technology*, *Engineering in Medicine*, and *Environment and Energy Sustainability*, are areas where UC San Diego has recognized leadership components and where concerted development and strategic investments will put us on top for years to come. The need and potential for human and intellectual capital development over the next decade is enormous, and the Jacobs School is ready to deliver with technology advancement and innovation across traditional disciplinary boundaries. Our mission remains unchanged, namely, to *educate tomorrows technology leaders*, to *conduct leading edge research and drive innovation*, and to *transfer our discoveries to ensure societal benefit*.

## 3. The Strategic Plan - *Where We Are and Where We Need to Go*

The Jacobs School is the largest engineering school in the UC System (Table 1), and is currently the home for five engineering departments as shown in Figure 1 (page 7). A sixth academic department in Nano Engineering has been proposed and is currently under review by the UC San Diego campus. Similar to the Bioengineering Department (est. 1994) and the Structural Engineering Department (est. 1999), the proposed Nano Engineering Department will be one of the first academic departments in this particular field. While other universities have established research centers in emerging disciplines, engineering at UC San Diego has in all three cases taken the lead in proposing and forming academic departments with the full compliment and balance of research and curricular development. It can be expected that, as with Bioengineering and Structural Engineering, other universities will eventually follow UC San Diego's lead in Nano Engineering. For the discussions in this document, Nano Engineering will be treated as a separate department since our purpose is to paint a picture of the future for the Jacobs School. However, it should be noted that at the time this plan was written, the Nano Engineering Department had not been formally approved by the campus. With the formation of this new department, the Jacobs School is uniquely positioned to provide the research innovations and the required work force to meet the current and future engineering challenges outlined in our vision statement, and to make the contributions requested from the new research university in *Rising Above the Gathering Storm.*

**Table 1. Engineering Student Body within the UC System**

UC Engineering Student Head Count Fall 2005

| Enrollment Fall 2005 | San Diego | Berkeley | Irvine | Davis | Los Angeles | Merced | Santa Barbara | Riverside | Santa Cruz |
|---|---|---|---|---|---|---|---|---|---|
| Undergraduate | 3,942 | 3,065 | 3,004 | 2,941 | 2,272 | 98 | 1,445 | 1,267 | 327 |
| Graduate | 1,105 | 1,763 | 957 | 874 | 1,278 | 0 | 660 | 291 | 253 |
| Student Total | 5,047 | 4,828 | 3,961 | 3,815 | 3,550 | 98 | 2,105 | 1,558 | 580 |

Data source

UCOP report (p. 15, table 4):

http://www.ucop.edu/ucophome/uwnews/stat/statsum/fall2005/statsumm2005.pdf

Engineering is made up of "Computer and Information Sciences" and "Engineering" categories.

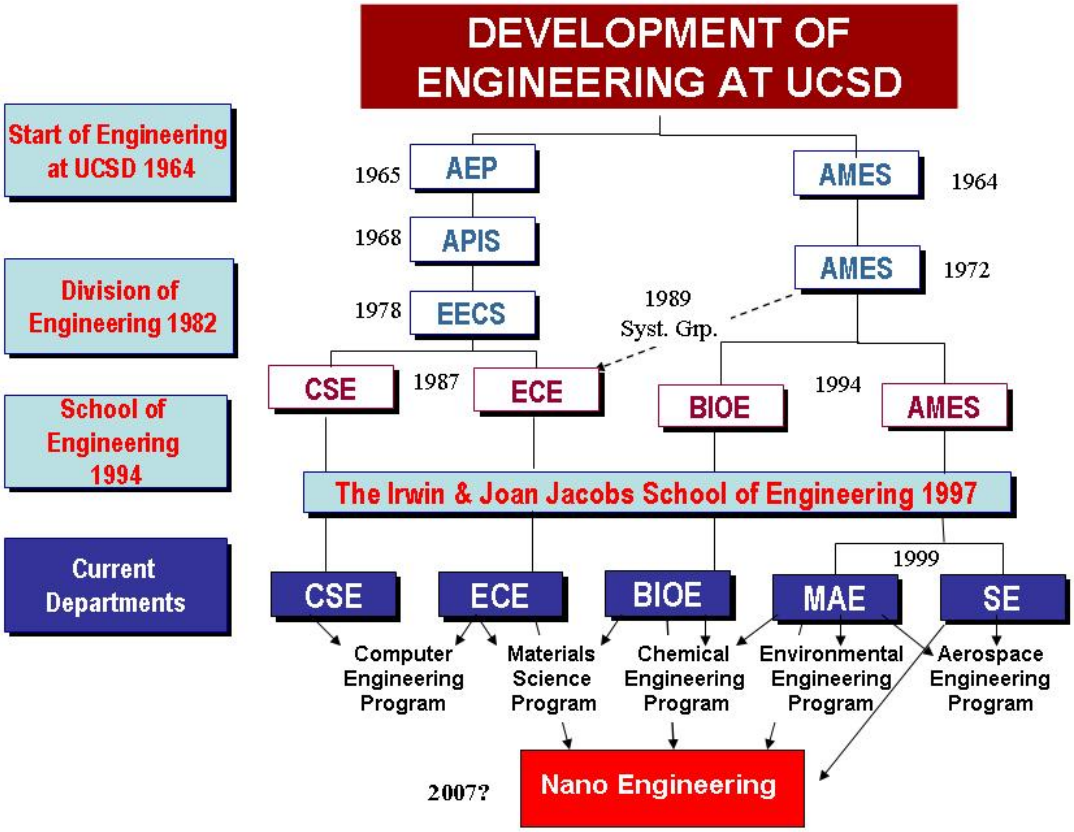



**Figure 1. Development of the Jacobs School**

# Schools of Engineering

THE TOP SCHOOLS

| Rank/School | Overall score | Peer assessment score (5.0 highest) | Recruiter assessment score (5.0 highest) | '05 average quantitative GRE score | '05 accept-ance rate | '05 Ph.D. students/ faculty | '05 faculty membership in National Academy of Engineering | '05 engineering school research expenditures (in millions) | '05 research expenditures per faculty member (in thousands) | Ph.D.'s granted '2004-2005 | '05 total graduate engineering enrollment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Massachusetts Institute of Technology | 100 | 4.9 | 4.8 | 775 | 25.4% | 4.4 | 13.2% | $224.8 | $622.7 | 273 | 2,717 |
| 2. Stanford University (CA) | 95 | 4.9 | 4.6 | 778 | 35.8% | 5.1 | 14.8% | $142.7 | $689.3 | 260 | 3,218 |
| 3. University of California–Berkeley | 86 | 4.8 | 4.6 | 773 | 17.5% | 4.5 | 21.0% | $118.0 | $477.8 | 201 | 1,694 |
| 4. Georgia Institute of Technology | 85 | 4.5 | 4.3 | 760 | 33.8% | 4.1 | 5.0% | $202.2 | $426.6 | 275 | 3,685 |
| 5. University of Illinois–Urbana-Champaign | 82 | 4.5 | 4.3 | 773 | 19.9% | 4.1 | 2.2% | $195.8 | $473.0 | 220 | 2,507 |
| 6. Purdue University–West Lafayette (IN) | 80 | 4.2 | 4.1 | 751 | 36.5% | 4.0 | 5.1% | $211.6 | $676.0 | 183 | 2,273 |
| University of Michigan–Ann Arbor | 80 | 4.5 | 4.1 | 770 | 42.3% | 4.4 | 4.0% | $157.4 | $507.6 | 226 | 2,390 |
| 8. Carnegie Mellon University (PA) | 78 | 4.3 | 4.3 | 772 | 24.8% | 4.4 | 8.6% | $142.3 | $711.7 | 136 | 1,570 |
| 9. University of Southern California (Viterbi) | 76 | 3.7 | 3.6 | 749 | 48.5% | 5.7 | 14.1% | $157.4 | $965.4 | 91 | 3,560 |
| 10. California Institute of Technology | 75 | 4.7 | 4.6 | 790 | 10.9% | 5.3 | 10.1% | $51.2 | $538.5 | 74 | 577 |
| 11. Cornell University (NY) | 73 | 4.3 | 4.3 | 760 | 22.4% | 4.2 | 8.7% | $112.2 | $544.8 | 116 | 1,234 |
| University of California–San Diego (Jacobs) | 73 | 3.8 | 3.9 | 764 | 21.8% | 4.9 | 11.0% | $128.8 | $805.2 | 68 | 1,147 |
| 13. University of Texas–Austin | 69 | 4.2 | 4.1 | 760 | 28.6% | 3.7 | 8.8% | $106.9 | $464.6 | 143 | 2,059 |
| 14. Texas A&M University–College Station (Look) | 68 | 3.7 | 3.7 | 740 | 44.4% | 3.0 | 3.5% | $179.0 | $675.4 | 148 | 2,187 |
| 15. University of California–Los Angeles (Samueli) | 66 | 3.7 | 3.8 | 766 | 34.6% | 5.2 | 11.4% | $88.3 | $605.1 | 137 | 1,256 |
| University of Maryland–College Park (Clark) | 66 | 3.6 | 3.7 | 760 | 24.0% | 4.5 | 5.3% | $145.3 | $637.1 | 149 | 1,943 |

**Figure 2. 2006 *US News* Research Engineering School Rankings**

For the Jacobs School to establish a firm foothold in the top ten research engineering schools (Figure 2), we must address three key parameters: (a) student and faculty numbers; (b) annual research expenditures; and (c) external recognition by peers and industry partners. Before comparisons in these three general categories are made, it is important to establish where we currently are and where we need to be at steady state in order to be competitive. Table 2 provides these statistics for the Jacobs School overall and for the six engineering academic departments. For the faculty numbers, both permanent and temporary are considered, and partial FTE numbers indicate joint appointments with only a portion allocated to engineering. Projected steady state numbers come directly from and are consistent with the Charting the Course IV documents provided by the six engineering departments (attached).

Table 2 shows that while undergraduate student enrollment is expected to increase by almost 20%, graduate student enrollment and faculty should see a > 33% increase to stay competitive with our comparison institutions.

**Table 2: Jacobs School of Engineering Faculty FTE and Student Enrollment**

| | | Jacobs Total | BENG | CSE | ECE | MAE | NE* | SE |
|---|---|---|---|---|---|---|---|---|
| **Faculty FTE** | | | | | | | | |
| Fall 2006 | Perm | 168.64 | 14.23 | 45.67 | 49.74 | 33.00 | 8.00 | 18.00 |
| | Temp | 8.31 | 1.06 | 2.50 | 0.00 | 4.15 | 0.00 | 0.60 |
| | Total | 176.95 | 15.29 | 48.17 | 49.74 | 37.15 | 8.00 | 18.60 |
| Steady State | Perm | 236.00 | 30.00 | 53.00 | 60.00 | 47.00 | 20.00 | 26.00 |
| | Temp | 10.00 | 1.00 | 2.50 | 1.50 | 2.00 | 2.00 | 1.00 |
| | Total | 246.00 | 31.00 | 55.50 | 61.50 | 49.00 | 22.00 | 27.00 |
| **Undergraduate Enrollment** | | | | | | | | |
| Fall 2006 | | 3820 | 879 | 682 | 567 | 1068 | 157 | 467 |
| Steady State | | 4580 | 800 | 950 | 1030 | 950 | 400 | 450 |
| **Graduate Enrollment** | | | | | | | | |
| Fall 2006 | | 1195 | 198 | 293 | 388 | 165 | 65 | 86 |
| Steady State | | 1670 | 270 | 330 | 470 | 270 | 120 | 210 |
| **Total Enrollment** | | | | | | | | |
| Fall 2006 | | 5015 | 1077 | 975 | 955 | 1233 | 222 | 553 |
| Steady State | | 6250 | 1070 | 1280 | 1500 | 1220 | 520 | 660 |

**Data Sources**

Faculty FTE: Report to the University-Wide Council on Engineering Education--UCEE 2006

Underlying data is from campus permanent budget database.

Enrollment: Registrar 3rd week enrollment reports

http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,18398,00.html

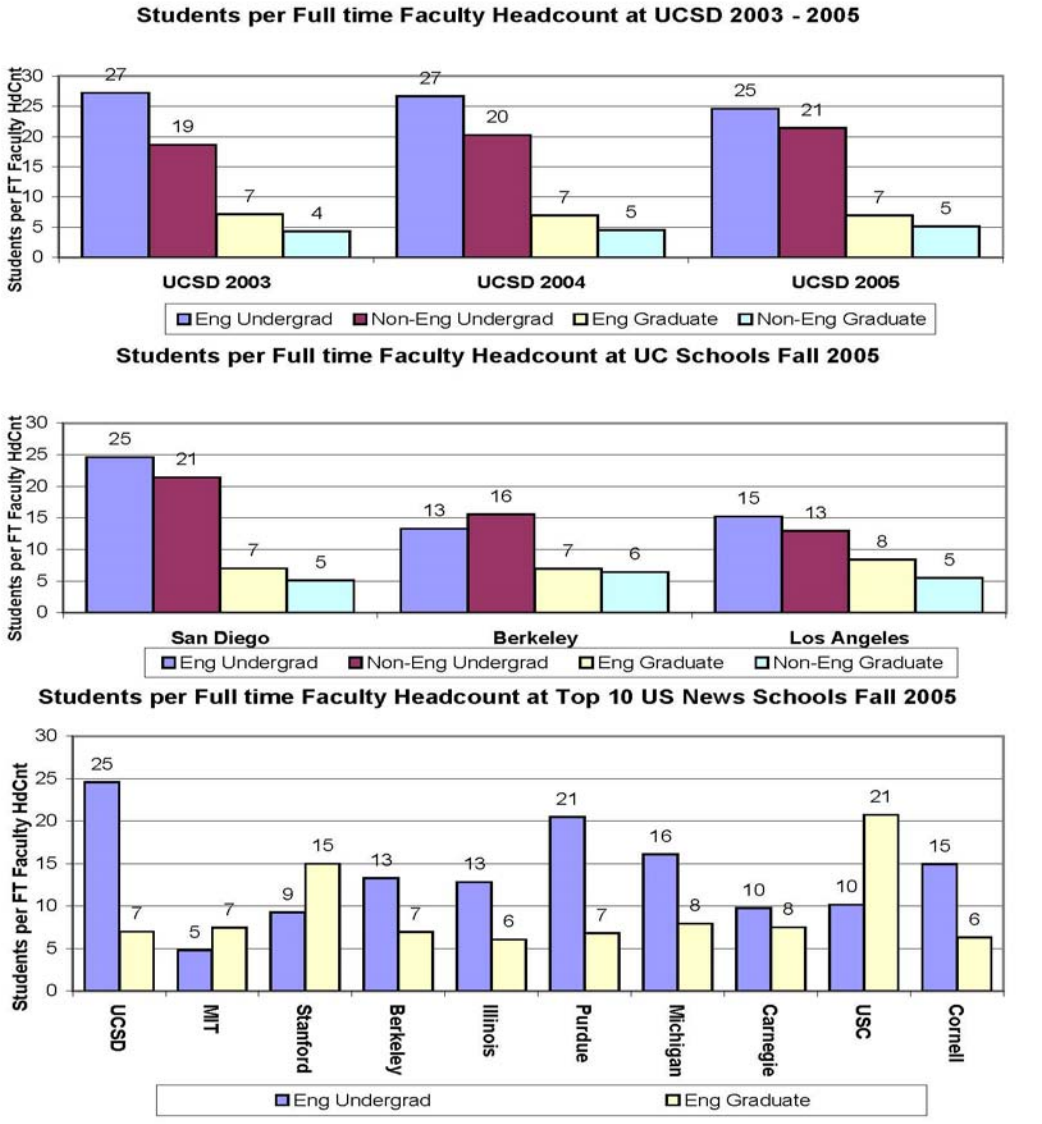
* Notes on Fall 06 NanoEngineering data:

1) the faculty are the FTE planned, per the department proposal, to transfer to the new department

2) the student data reflects a shift of the Chemical Engineering and Materials Science Program from MAE to NE

### *a) Comparison of Student and Faculty Numbers*

Figure 3 shows student to faculty ratios for UG and G student bodies. The UCSD comparison shows Engineering student/faculty ratios are improving slowly, but are still very high compared to the rest of the campus population. The high UG student/faculty ratios in the Jacobs School are particularly evident in direct comparison to the ratios at Berkeley and UCLA, which are off by almost a factor of 2, a situation that needs to be remedied if we truly want to be the top engineering school in the UC System. Similar discrepancies can be found in direct comparison with the nation's top ten engineering schools.




**Source:** Engineering and campus enrollment obtained from ASEE annual survey www.asee.org.
Eng and campus faculty are Full-time Teaching Tenure / Tenure Track faculty hdcnt as reported to US News www.usnews.com
Georgia Inst of Tech (rank 4) is excluded because it is very large, and is also a technical rather than comprehensive university.
Calif Inst of Tech (rank 10) is excluded because it is very small.

T:\Resource Administration\Schoolwide\Charting the Course Reports\2006 Working\Section3Charts.xls

**Figure 3. Comparison of Student/Faculty Ratios**

Only an aggressive strategic plan of increasing our faculty numbers will allow us to penetrate the top 10 elite. It is of interest to note here that Purdue, shown second highest in UG student/faculty ratio after the Jacobs School in this 05 data, hired 60 new engineering faculty over the past two years in order to stay competitive. Needless to say, we are far behind and have a lot of catching up to do! The proposed faculty growth (see Table 2, pg. 8) is essential for us to be even remotely competitive with our peer institutions, and needs to occur over this next 3-year planning period, or we stand to lose our current #11 ranking.

### *b) Annual Research Expenditures*

Our relatively high ranking despite the large discrepancy in student/faculty ratios is largely due to the fact that we have a very high research volume, commensurate with a top research engineering school. The Jacobs School ranks consistently among the top three in terms of annual research expenditures/faculty (Figure 2, pg. 7). Figure 2 also shows that the overall absolute research expenditures at the Jacobs School are higher than that of Berkeley or UCLA, commensurate with our goal to be the top research engineering school in the UC System. The vision, focus and strategic investments in the above outlined multi-disciplinary research areas can be expected to increase our research volume and should allow us to compete favorably with the other top 10 schools.

### *c) Recognition by Peers and Recruiters*

From Figure 2 it is clear that we are also lagging behind our competition when it comes to the external recognition of our programs. While these two reputation rankings have slowly increased over the past years, it should be recognized that UC San Diego is a relatively young academic institution, and external recognition is always a high inertia subject that will take time to adjust. However, we can and need to do more to disseminate our contributions to research and education and to lead the way with targeted external relations efforts with our alumni, corporate partners, and academic peers. The external recognition is directly tied to the quality of faculty and students we are able to attract, the impact of our faculty research, and the quality and marketability of our alumni (human capital). Our diligent pursuit of excellence, following the principle that 'second best is not good enough' in all areas of research, teaching, and service, will help us in reaching the top 10.

In order to reach our top 10 goal, we need to lead with new ideas and with wisely managed investments. We must define the research engineering school of the 21$^{st}$ century with a clear focus on innovation, globalization, and flexibility to not just adjust to but lead our rapidly changing technology-driven society. The strategic plan to accomplish this both in education and research is outlined below.

# 4. The Strategic Plan - *Education*

The goal for the Jacobs School is to provide our students with the best possible training in engineering and the basic sciences, and to equip them with additional attributes and values that will enhance their degrees and allow them to compete and excel. These attributes include flexibility, creativity, teamwork, ethics, and communication, as well as a broad understanding across disciplines, and greater awareness of our increasingly global society.

## 4.1 Team Engineering

In support of the above outlined goal, the Jacobs School has made team engineering and multi-disciplinary real-world experiences its central education theme, from K-12 through graduate education.

### 4.1.1 COSMOS: Multidisciplinary Summer Program for High School Students

The California State Summer School for Mathematics and Science (COSMOS) is a 4-week residential summer program open to entering ninth through exiting twelfth-grade high school students with demonstrated interest and achievement in math and science. This intensive experience is multi-disciplinary and team-based, and is intended to encourage the most promising young minds to continue their interest in these fields. Modules range from Media Computing to Earthquakes in Action. The program is close to steady-state in its current level of funding, and we plan to continue the program at the annual level of 150 students, given adequate external and state support.

### 4.1.2 Undergraduate Team Engineering Initiative Components

Educating tomorrow's technology leaders is embedded into the mission of the Jacobs School of Engineering. Our Team Engineering programs give our undergraduate students real-world, client-driven experience, and enable them to develop the leadership and communication skills sought by today's employers and needed to excel in a global society. We outline existing and proposed programs and their expansion plans.

### 4.1.3 Summer Team Internship Program

One of the first of its kind in the country, our signature industry Team Internship Program (TIP) sends multidisciplinary teams of students to our industry partners for 10+ weeks during the summer to address engineering projects devised by our corporate partners. Initiated in 2004 with 5 industry partners, the program expanded to 50 students in 18 teams with 14 companies in 2006, including one international team. The feedback from students and companies has been tremendous, and many students are offered permanent positions after graduation. Student feedback emphasizes the benefit of multidisciplinary teams in that students proclaim that they learn so much from each other, and the corporate feedback attests to the qualification of our students, their problem solving and communication skills, as well as their drive to succeed and complete their projects on time and on budget. Furthermore, the team based approach requires much less corporate supervision and guidance compared to individual summer interns. The

student demand for TIP participation is high (in 2006 we had over 300 students for 50 spaces). Our goal is to essentially double the number of teams each summer for the next three to four years, based on student and industry demand. To address the need for globalization of our education program, special emphasis will be placed on the development of TIP opportunities abroad.

### 4.1.4 Teams In Engineering Service (TIES) Academic Program

Our academic team engineering effort is embodied in our Teams in Engineering Service (TIES) program. Initiated in 2004, TIES ensures students gain practical experience while serving their community. Multi-disciplinary student teams design, build, and deploy technology solutions for San Diego non-profit organizations, and student interns for each team continue the interaction with the community client over the summer. Projects have ranged from a solar-powered water quality monitoring system for the Lakeside River Park Conservancy, to digital patient recording keeping systems for St. Paul's Senior Homes and adapted toys for United Cerebral Palsy.

*"The engineering, communication, project planning, and teamwork skills that are employed during a TIES project prepares one more for industry than any other opportunity in college. … the bottom line is the stuff learned through TIES really matters."*
**Chris Lee, former TIES student**

TIES provides a service-learning framework for faculty, staff, visiting lecturers, and alumni at the Jacobs School, and supports the Sixth College Practicum requirement. TIES has expanded from 80 students per year, 2 community clients, and 3 faculty advisors in 2004; to its current 11 teams, enrolling over 200 students per year working for 9 community organizations, mentored by 10 faculty advisors. In addition, through our TIES prerequisite course ENG 100, we are developing new shorter-term projects in which class teams work with 8 non-profits each quarter to assess their needs and propose a design to solve a particular need.

The TIES program is also a tool to foster student diversity and support transfer students. The percentage of women engineering students registered for TIES from Fall 2004 – Spring 2006, (average 27%) surpassed the female engineering enrollment (22%) in the Jacobs School of Engineering. A strong connection between technical knowledge and community also draws underrepresented minorities to the program (Fall 2004 – Spring 2006, average 11.4%). Transfer students find TIES to be a welcoming environment and socially relevant program, and on average from Fall 2005 to Spring 2006, 45% of TIES students were also transfer students.

*"Technology is something we aspire to in the non-profit world. However, it is difficult to acquire the funds to access the resources, initiative, and involvement of innovative people."*
**Cheryl Wilson, CEO, St. Paul's Senior Homes, TIES client since 2004**

We plan to fully integrate TIES into the Jacobs School and with other service learning initiatives at UCSD. In addition, we seek to expand the program so that at least 20% of our student body takes part in TIES. In order to fulfill these goals, additional external corporate and internal institutional support is needed.

## 4.2 Proposed Integrative Engineering Major

The Jacobs School has recently proposed a new Integrative Engineering major in order to directly attract students whose interests lie at the border of engineering and other disciplines, or across engineering fields of study. This major will provide students the flexibility to pursue interests outside of currently available engineering programs, and give them the broader range of skills and knowledge needed. Its aim is to provide career preparation for professions requiring an engineering background, but not professional engineers. Examples include CEO in a technical company, technology attorney, engineering marketing and sales, and engineering management. The academic unit of this major is the Jacobs School with oversight by an interdisciplinary faculty committee representing each engineering department. Our Engineering Student Services team in the Jacobs School will provide additional advising for this major, as well as the affiliated Engineering departments.

In addition to fulfilling a critical need in our engineering education, the Integrative Engineering major will compliment our proposed per-major admissions plan, in accordance with the implementation of proposed campus-wide UCSD Enrollment Management principles. The Integrative Engineering major will be open to any student who is admitted to UCSD and is interested in pursuing an engineering major. It will serve the purpose of a pre-engineering major with the flexibility to transfer into any one of the traditional majors as long as certain criteria are satisfied. For this Integrative Engineering major, no per-major admissions plan is sought, which will leave engineering in full compliance with the UCSD admissions policy. While no additional resources are needed at this time in support of this major, we expect that in the future, new courses will be developed in leadership, innovation, and information technology, and that additional faculty, lecturers, and staff will be needed in their support.

### 4.2.1 Information Technology General Courses

The plan for the Jacobs School is to expand our curricula in the general area of information technology. It is envisioned that the CSE and ECE departments, in close collaboration with Calit2 and SDSC, will expand and develop course offerings in sensors and sensor networks, Internet engineering, gaming and graphics, networked systems, etc., that are of interest as general education courses to all students at UCSD. There is no reason why the attribute of IT proficiency should be limited to Jacobs School graduates and not extended to all UCSD students.

### 4.2.2 Leadership Development

The Jacobs School recognizes the need and demand for leadership training, both in the technical domain and on the interface with management. The attributes of leadership, innovation, and continued learning are emphasized in special graduate courses in entrepreneurism through our von Liebig Center. A select group of undergraduates have shown great interest in these courses, and we expect to develop undergraduate versions through our von Liebig Center as part of our proposed Integrative Engineering major. These courses will compliment undergraduate courses developed by the Rady School in preparation for a management career.

### 4.3 Multi-Disciplinary Graduate Education Initiatives

As a leading research engineering school, graduate education is the cornerstone of our teaching and research efforts. While the emphasis is on our Ph.D. program to accomplish our research mission, the Jacobs School also needs to be relevant to our industry stakeholders by providing the qualified post graduate workforce and relevant continuing education opportunities. Our goal is to provide: Master of Engineering programs in all engineering departments; a new Master of Advanced Studies in Engineering Systems for the Enterprise; and targeted degree programs in support of the national laboratories affiliated with the University of California to develop the U.S. workforce critical to national security.

#### 4.3.1 Engineering Institute with Los Alamos National Laboratory

We are continuing to support and expand the Engineering Institute, a multidisciplinary, research-based joint education initiative with Los Alamos National Laboratory (LANL). The Institute aims to attract, educate and retain a technical workforce relevant to the Lab's mission of enhancing global security; and to advance research for management of critical infrastructure in the civil and defense sectors. This unique partnership between LANL and the Jacobs School has served as a model for the development of three additional Institutes at Los Alamos, and continues to provide a prototype for UC-Laboratory collaborations. Through this program we offer a unique multi-disciplinary graduate program in structural health monitoring which is one of the first of its kind. Courses are jointly taught by UCSD engineering faculty and Los Alamos senior scientists, and are open to both UCSD graduate students and Laboratory employees. As part of this research-focused education program, students work on real-world projects at the Laboratory that provides for collaborative research between UCSD faculty and students and Los Alamos scientists. This partnership leverages UCSD's strengths in large-scale structural testing, high performance computing and simulation, and sensor and sensor networks with Los Alamos' expertise in damage prognosis, modeling and characterization.

Similar to the Engineering Institute with Los Alamos, we are currently discussing education and research partnerships with Lawrence Livermore National Laboratory in the areas of high performance computing and high energy density areas.

#### 4.3.2 M. Eng. Degree Expansion

To meet the demand from students and industry, the Jacobs School of Engineering proposes to offer a Master of Engineering (M.Eng) degree in addition to the existing Master of Science (M.S.) degree in all engineering departments with consistent requirements. The B.S. degree programs in engineering have relied on maintaining a careful balance of fundamentals in physical and/or biological science together with engineering design-oriented courses that emphasize integration of these domains. The success of our undergraduate curricula is evidenced by the fact that seven of our undergraduate programs are accredited by the Accreditation Board of Engineering and Technology (ABET). However, these undergraduate degree programs are unable to provide the opportunity for more in-depth training in an elective sub-specialty area.

Many students who wish to pursue an engineering business career, desire a broad combination of technical in-depth training and management-related courses. In addition, working engineers often need to retrain or update their knowledge in a specific specialty by taking advanced classes.

The rapidly growing demand by students for this kind of training is being stimulated by fundamental industrial developments not only in the computing, communications, and biotechnology fields, but also in mechanical, aerospace, and construction fields. The training needed for professional careers in these industries is well suited to the Master's degree format, but is not provided effectively by the strict course requirements and thesis or examination option of the existing M.S. degree programs.

For the above reasons, the Jacobs School of Engineering proposes to offer an M.Eng. degree with consistent degree requirements in all engineering departments. At present this degree is offered by our Electrical and Computer Engineering (since 1998) and Bioengineering (since 1999) departments. The M.Eng. degree is a terminal professional degree based on advanced coursework with a capstone requirement. A full-time student can complete the M.Eng. program in one academic year (4 courses per quarter), or students may work on the program part time concurrent with outside employment. The course requirement is more flexible than that of M.S., allowing students to take courses in economics, finance, management, and accounting from the Rady School of Management and the Graduate School of International Relations and Pacific Studies. The students are strongly encouraged to take two quarters of industry-sponsored projects or design projects, especially if they do not have prior industry experience.

### 4.3.3 Proposed Graduate Program in Engineering Systems

The Jacobs School of Engineering, in collaboration with the Rady School of Management, proposes to expand upon its executive education offerings to create a new interdisciplinary program leading to a Master of Advanced Studies in Architecture-based Enterprise Systems Engineering (MAESE). The goal of the program is to educate professional students in the processes, structures, and formal methods through which enterprise systems are architected, integrated and made interoperable. The program aims to bridge the *gulf* between *management* and *engineering* communities through increased understanding and communication such that the enterprise can find timely, innovative, and effective solutions to the problems of dealing with the dynamic and complex global environment. A possible extension of this initiative could be a two-year MBA/M.Eng. degree program offered jointly by the Jacobs School and Rady School.

### 4.3.4 Engineering and Medicine Initiative

Similar multi-disciplinary education opportunities exist to develop human resources in direct support of the technology advances that will enhance our health and quality of life. Already, Bioengineering is the home of a designated pre-med UG major, and the department's innovative Biotechnology degree program is ABET-accredited. The campus is successfully collaborating in our highly-ranked Bioinformatics program, and we foresee future such multi-disciplinary education programs focused on the needs of the health sciences and biotechnology industries.

### 4.3.5 Proposed Nano Engineering Department Course Offerings

By definition, new multi-disciplinary education initiatives cannot be developed in isolation, but require multi-departmental and multi-divisional, campus-wide input and support. Similar to other campus-wide education initiatives in Environmental Systems and Bioinformatics, new campus-wide educational initiatives in Information Technology and Nanotechnology should be considered and supported to keep UCSD at the forefront of defining the 21st Century University. The Jacobs School of Engineering will play a leading role in these developments. These new multi-disciplinary education programs also offer unique opportunities to be embedded into core curricula for our colleges and for new educational emphases in the Rady School of Management and SIO. These multi-disciplinary education initiatives are considered essential components of a modern and leading engineering school, but they will only be successful if they are embraced by the entire campus and go well beyond engineering. This is the challenge and opportunity for UCSD to provide leadership and resources to take full advantage of the remaining growth and expansion period for our campus.

### 4.3.6 Joint Doctoral Program with San Diego State University

We are proposing a major expansion of the existing SDSU/UCSD Joint Doctoral Program in Engineering Sciences (Applied Mechanics) which was initially approved in 1988, and initiated in 1990 to include ECE, BE and SE. This expansion is informed by a detailed review of the current program conducted by a committee of faculty with representatives from both institutions and proposes a strategic partnership between SDSU and UCSD that allows both institutions to better serve the educational needs of the region and the state. The program should better integrate both universities, enrich their relationships to the local community, facilitate exchange and collaboration among faculty, leverage resources, and increase the production of doctoral graduates. Broadening the scope of the joint-doctoral program between the Jacobs School of Engineering at UCSD and the College of Engineering at SDSU will strengthen a mutually advantageous partnership in several ways, including increasing collaborative partnerships that bring together complementary skills and expertise of faculty and students to tackle complex and challenging research and engineering problems; increasing the impact of research efforts through sharing and leveraging of resources and facilities of the two partnering institutions; broadening opportunities for student and faculty interaction that can improve diversity of future engineering workforce; expanding opportunities to develop partnerships with industry and outreach to local communities.

# 5. The Strategic Plan - *Multi-Disciplinary Research*

Research in the Jacobs School is leading in many areas and all of our academic departments and units are nationally and internationally recognized. It can be expected that this broad research excellence will continue and add to the stature of the Jacobs School. However, to truly be recognized as one of the premier research engineering schools, we must be able to clearly identify research areas where we are or can be in the top five worldwide. Furthermore, these leadership areas need to be relevant to society and to our industrial partners, and thus by definition need to be research areas of tomorrow and not of yesterday. Engineering has to play a more dominant role in our technology driven society and engineering innovations in fields and disciplines important to society will lead the way. It is therefore not coincidental that the burning societal issues of healthcare, energy, and the environment, are the focus areas where, driven by information technology, the biggest advances and breakthroughs are expected from engineering collaborations with traditional disciplines. The exciting technological innovations will come from multi-disciplinary research, conducted by teams of researchers and engineers (not by individuals), with a clear understanding of the enterprise and systems architecture, and a direct connection to societal acceptance and applicability.

Based on the existing strengths of individual research disciplines at UC San Diego and on the regional setting, healthcare and environmental issues are predestined to be advanced. It is therefore important for the Jacobs School to clearly define the engineering contributions and participation in areas where UC San Diego as an institution will have a major impact.

***Engineering in Medicine***

In the general area of *Engineering in Medicine,* several specific topical foci can be defined where UC San Diego will lead, namely (a) *regenerative medicine,* (b) *systems biology,* (c) *medical devices,* (d) *nanotechnology for cancer therapy,* (e) nano-biomaterials, and (f) *information technology enabled medicine* (tele-medicine, imaging, visualization), just to mention a few. The Bioengineering Department in the Jacobs School has historically taken the lead on this critical interaction with Medicine, and the recently launched EngMed (Engineering in Medicine) Initiative will strengthen and facilitate this interaction across disciplines. While still in the formation stages, this EngMed Initiative has already found great reception and resonance with our industry partners and other local health science research institutes, and has already seen participation from all of our six academic departments. Strategic resources in this multi-disciplinary field can be expected to yield exciting results and breakthrough innovations.

***Environment and Energy Sustainability***

As a leading engineering research school, we are challenged to address the questions of (a) how do we develop a sustainable energy model, (b) how can we develop and maintain our physical environment in an economic and sustainable way, and (c) how can both of the above be accomplished without irreparable harm to the natural environment? With the Scripps Institution of Oceanography (SIO) providing leadership in the monitoring, modeling, and management of our natural environment, engineering participation and contributions to (a) sensors and sensor networks, (b) embedded systems, (c) data storage and management, and (d) visualization and modeling, among others, can again lead to great progress. Such innovation needs to be strategically supported with resources and infrastructure. Both Calit2 and SDSC are prime examples of the great value core facilities and trained technical support staff can bring to enhance and enable this multi-disciplinary research.

Energy is directly tied to our natural environment in terms of energy production, and to our physical environment in terms of energy consumption and preservation. The recent bio-fuel initiatives are prime examples as to the nature of multi-disciplinary research needed to move towards renewable and sustainable energy sources. Engineering contributions range from the genomic modeling of bio fuel sources, to the generation of bio-fuels and their efficient conversion to either transportation fuels or electricity. Bio-fuels alone cannot be the answer to energy independence. Other renewable energy technologies, such as photo-voltaic, wind, and wave action electricity generation require focused engineering attention. At the same time, societal issues such as distributed energy co-generation, renewed interest in nuclear energy, and carbon generation issues need to be addressed from the technology and policy perspectives. Finally, concerted efforts need to be directed to energy conservation in our man-made environment, through energy efficient and smart (sensor and actuator equipped) buildings, hybrid vehicles, energy efficient and sustainable manufacturing processes, and recyclable materials.

Similarly, engineering solutions are required, to monitor the health of our man-made environment, to extend the service life of our structures and products, and to efficiently manage our structures in light of natural and man-made hazards.

Engineering solutions are needed to rehabilitate aged or damaged structures and to assess historic and preservation aspects. Architectural historic preservation is becoming more and more an important societal issue with high demand for the preservation of historic monuments, archaeological sites, buildings, and works of art. Non-destructive investigation and visualization tools need to be developed and applied in a domain or discipline specific fashion, based on the multi-disciplinary team research approach.

***Information Technology***

It is no surprise that one of the Jacobs School traditional strengths, namely *Information Technology* is the driver and catalyst for many of the outlined multi-disciplinary activities that will take the Jacobs School and UC San Diego to the next level of innovation and technology leadership. Over the years we have developed a great framework and leadership for multi-disciplinary research at UC San Diego through organized research units and research centers/institutes. While the efficient administration of smaller ORUs on campus needs to be revisited, there is no question concerning their effectiveness to facilitate multi-disciplinary team based research and to provide efficient interfaces to our industry partners. In particular the value provide by our larger ORUs such as SDSC and Calit2 with core facilities and domain experts that can assist our researchers with utilization of the latest information technology are invaluable assets that need to be enhanced and strengthened to maximize the intellectual and human capital development at UC San Diego and in the Jacobs School.

## 5.1 Multi-Disciplinary Joint Appointments

As expected with our three general focus areas being I*nformation Technology*, *Engineering in Medicine*, and En*vironment and Energy Sustainability*, the opportunities for multi-disciplinary joint appointments are significant. The departments have recognized at least 22 faculty recruitments that could present significant multi-disciplinary opportunities, including 11 cross academic affairs opportunities, 9 with the School of Medicine, and 2 with SIO. Engineering in Medicine is the dominate theme behind many of these opportunities, but there is significant attention to Environment and Energy as well. The nature of these appointments could range from joint recruitments resulting in full appointments in a given department, to cluster hiring across departments, to split appointments between departments.

# 6. Diversity

Excellence and diversity remain fundamental goals of the Jacobs School of Engineering. Diversity can foster new ways to innovate and integrate science and technology for society, and thus is the basis for excellence in engineering. Considering the demographics of the state of California, and the strong need for engineers as described in *Rising Above the Gathering Storm*, diversity in the engineering workforce is critical. However, the diversity of our technical workforce is not reflective of the diversity of our society, and the Jacobs School is aware that greater efforts to change are needed. This will require focused strategies to increase diversity and excellence at all levels (faculty, staff and students). The Jacobs School leadership is committed to helping to make this transition to a much more diverse engineering work force.

## 6.1 Faculty

Both women and several ethnic groups are underrepresented in the faculty, as shown below. These numbers have been of considerable concern to the Jacobs School leadership, and have resulted in several efforts.

| **Eng Faculty Fall 2006** | | **Total** | Men | | Women | | Ethnicity | | | | | | | | New Faculty Appts. 06-07 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | | Total | | Detailed Count by Ethnicity (#, %) | | | | | | | | Total | Women | | Minorities | |
| | | | # | % | # | % | White | | Afr. Amer. | | Hispanic | | Asian | | | # | % | # | % |
| **Jacobs School of Engineering** | | | | | | | | | | | | | | | | | | | |
| | Subtotal | 173 | 157 | 91% | 16 | 9% | 115 | 66% | 0 | 0% | 7 | 4% | 51 | 29% | 8 | 1 | 13% | 0 | 0% |

Source: UCSD employee database, count of teaching tenure faculty paid on engineering distributions 10/1/06-12/31/06.
New teaching tenure faculty counts are for AY2006-07 including mid-year hires.

The Jacobs School continues to work toward a broadly attractive and supportive culture, and continues its commitment to broad faculty searches. Since academic year 2004-05, the following language is now included in every faculty recruiting advertisement:

1. Exceptional candidates in all areas will be given serious consideration.

2. Applicants are asked to include a personal statement summarizing teaching experience and interests, leadership efforts and contributions to diversity.

Consistent with this, 1-2 FTEs are reserved each year and are filled at the Dean's discretion to enable successful departmental hires of exceptional candidates in broader technical areas at all levels. Together, these policy changes have been successful in increasing gender representation. After a decade of no female faculty recruits and 72 male faculty recruits, in 2004-05 the Jacobs school hired two women faculty out of eight total recruits. This success has continued in 2005-06 with two academic appointments to women out of 9 total recruits: 1 Lecturer PSOE, and 1 ladder rank faculty. Language similar to ours inviting (but not requiring) a personal statement regarding contributions to diversity has now been adopted by general campus in an effort to increase the pool.

While the Jacobs School has moved in a positive direction towards increased faculty diversity, much more is needed. We believe that faculty training in better recruiting practices is essential. In particular, we believe the development of a small number of respected senior faculty recruiting advisors, trained to work closely with recruiting committees, is the single most crucial step in expanding faculty diversity at UCSD. While the Chief Diversity Officer Jorge Huerta and Academic Affirmative Action Director Jon Welch hold annual meetings with faculty in each department, Huerta and Welch simply don't have the time to work closely with each individual search committee. We propose to work with general campus on a *pilot program for training such faculty Diversity Advocates* in the Jacobs School.

It is a particularly opportune time to start this pilot program, since we can build on the NSF ADVANCE PAID grant that UCSD is participating in to train and grow the initial group of Diversity Advocates. We propose additional monthly meetings of Advocates to provide a forum to share best practices and brainstorm solutions. It is also proposed that departments with an active Diversity Advocate will receive a course relief buyout in support of their divisional activities. Diversity Advocates are modeled after UC Irvine's Equity Advisors, but differ in that they are focused specifically on recruiting, whereas Equity Advisors also consider mentoring and equity issues.

Each Diversity Advocate will report to and work closely with the Deans, and advise the Deans on search approvals. They will also monitor progress towards diversity goals and recommend outstanding efforts for divisional and campus rewards. Finally, the Diversity Advocates could provide advice to CAP on initial appointment levels and salaries. The Diversity Advocates pilot program, if successful, would become a model for general campus.

The Jacobs School plans are part of a larger campus effort to enrich campus diversity at UCSD. The Jacobs School took the lead in creating and expanding the Women's Leadership Alliance, a group of senior women campus leaders. The group, now a subgroup of the Chancellor's Committee on the Status of Women (CSW), promotes leadership, professional development, recognition, and networking among its members. The group has recently proposed a Leadership Academy to provide professional development and promote leadership among UCSD women faculty. The group is also exploring joint activities with UCSD ATHENA.

### 6.2 Students

Diversity of our student body is also not reflective of our society, and at each step of the educational pipeline, diversity is lost. To remedy this, a multi-pronged approach is needed at every level of the pipeline.

At the middle school level, Associate Dean Ferrante, along with Professor Steve Buckley and TIES Program Director Dr. Silvia Mah, received funding for a new three-year, $1.2 million National Science Foundation grant as part of their Information Technology Experiences for Students and Teachers (ITEST) award program. As a result, the Jacobs School is launching an environmental education initiative for middle school girls to engender excitement about science, and eventually, careers in engineering. The UCSD team, along with the San Diego Supercomputer Center, will help San Diego county students, (including those at Preuss and

Gompers middle schools), monitor the air quality, solar radiation, and other environmental factors surrounding their own schools. Using the environmental research concepts and techniques, the UCSD team will also create a multi-player online science challenge game. The game will be designed specifically to attract and interest 12-15 year-old girls in science and engineering.

At the high school level, the Jacobs School initiated COSMOS (Math, Science, and Technology Summer Program) at UCSD in 2004. The annual 4 week residential session is designed to give talented high school students a taste of college and university-level academics through team projects, and attract them to careers in science and engineering. COSMOS includes needs-based scholarships and concerted recruiting efforts to attract a diverse group of students each year.

At the undergraduate level, the Jacobs School has continued to develop its focus on team engineering and real world experience, with the goal of attracting a larger and more diverse group of students who become technology leaders. The Jacobs School also works closely with our student run organizations and supports existing programs on campus that reach out to diverse populations, such as our National Society of Black Engineers, the Society of Hispanic Professional Engineers, and the Society of Women Engineers. Many of our student groups, such as Tau Beta Pi, conduct outreach activities, and such activities are vital to increasing the pipeline to engineering. To the extent that funding allows, we support and augment these activities by participation from our Engineering Student Services.

In addition, in 2004 we initiated the **T**eams **I**n **E**ngineering **S**ervice (TIES) program which partners multi-disciplinary teams of undergraduate students and non-profit organizations in the local community. TIES provides a unique way for students to learn how technology can truly benefit society, an issue often of importance to women and minority students. TIES attracts a high percentage of female participants who want to apply their engineering skills towards a worthy cause. The additional benefits for students in TIES include improved communication, organizational, and leadership skills, ethics training and responsibility, as well as customer and community awareness.

At the graduate level, the Jacobs School aims to build a sense of community and to foster leadership. In 2003 the school initiated the Woolley Leadership award as a supplementary fellowship to foster community and leadership in our Engineering graduate students. The Jacobs School has awarded this fellowship annually to a graduate student selected for their demonstrated leadership and record of notable academic achievement. Past recipients of this award include Maria De Gador Canton, Alejandro Hevia, Adam Conway, Robbie Saperstein, Barath Raghavan, and Sourobh Raychaudhuri. A reception in honor of the awardee(s), each who give a short talk on his or her accomplishments, is held in fall quarter. All Engineering graduate students and faculty invited to attend.

The Jacobs School also took the lead on bringing MentorNet, an e-mentoring program for undergraduate, graduate students and postdoctoral scholars in science and engineering, to UCSD in 2006. MentorNet has been very successful at attracting women to its programs, which match students with potential mentors ranging from technical professionals in industry to universities and government labs.

### 6.3 Staff

Underutilization occurs when fewer women or people of color are employed in a particular job group than would reasonably be expected by their availability in the job market. During the last 10 years, the UCSD workforce has become steadily more diverse, just as the community around us has become more diverse. The UCSD Diversity Council, established in 1998, advises the Chancellor on diversity with particular reference to institutional access and representation, campus climate and intergroup relations, education, scholarship, and institutional transformation.

The relationships among UCSD staff, faculty, and students are the University's most important resource in promoting and sustaining diversity. All employees are encouraged to:

- Promote inclusiveness
- Value differences
- Avoid actions or behaviors that offend, demean, or exclude

The Jacobs School is a place that provides work opportunities for a diverse group of people. In comparison to all of Academic Affairs statistics, we are higher in our Asian and African American population categories, equal American Indian population category, slightly lower in our Hispanic population category. The male/female ratio is 46% to 54% respectively and in comparison to Academic Affairs the ratio is 42% to 58% respectively.

The Jacobs School is committed to continue increasing our diverse work force, which will be supported by the following plan of action:

1. Review all staff applicant pools to maximize the number of interviewed applicants from underutilized population categories.
2. Provide informational sessions for supervisors and managers on the Equal Opportunity/Staff Affirmative Action current report – Completion by July, 2007.
3. Provide a EO\SAA Report Summary Fact Sheet to new employees – continuous.
4. Review attendance of the Campus Diversity training by SOE managers and supervisors. Require those people who have not attended to participate in one of the sessions held by Staff Education. – Completion by December, 2007.

### 6.4 Departmental Diversity Award

Jacobs School is also considering the establishment of an award to recognize diversity efforts in departments. This idea was discussed at the Jacobs School faculty retreat in 2006, and will be further developed by conducting focus groups of faculty, students and staff.

### 6.5 Women In Engineering Web Page

The Jacobs School has reorganized its public web pages, and has created a Women In Engineering page to enhance the community of women engineers at the school, as well as attract more women students and faculty. See http://www.jacobsschool.ucsd.edu/about/about_wie/.

## 7. Departmental Executive Summaries

## DEPARTMENT OF BIOENGINEERING
## Mission and Areas of Excellence

The mission of the Bioengineering Department at UCSD is:

> *To improve health and quality of life by applying engineering principles to scientific discovery and technology innovation; and to train future leaders in Bioengineering through inspiring education and dedicated mentorship.*

The field of Bioengineering is experiencing unprecedented and accelerating growth as the scope of the field continues to broaden, demand for undergraduate and graduate education rises, and biomedical science becomes more complex, more applied and more technology-driven. The field of regenerative medicine is one example where we find both the basic biological science community working on stem cells and developmental biology in La Jolla, and the clinical science community developing and testing new cell-based therapeutic strategies both looking to Bioengineering at UCSD to serve as a key bridge from discovery to translation.

The Bioengineering Department has established three areas of excellence during the last planning period that will continue to form the foundation for growth during Charting the Course IV. All fall within the overarching theme of **Integrative Bioengineering**. **Systems Biology** is focused on large-scale *functional* integration of biological components into networks responsible for the complex emergent dynamics of living systems. **Multi-Scale Bioengineering** is focused on measurement, analysis and manipulation across *physical scales* of biological organization to achieve *structural* integration from molecule to organism. **Regenerative Medicine** is the theme of our focus on integrating the biological and engineering sciences with *clinical medicine and healthcare*. It aims to use novel engineering approaches to develop therapeutic procedures for repairing and regenerating injured and diseased tissues and organs.

Within these three broad areas of excellence, we will place emphasis on recruitments at the *interfaces* (e.g. the systems biology of stem cells for discovery in regenerative medicine) and on those that align with *partners* and areas of expertise across campus and in the La Jolla Mesa. These include: the Cancer Center (nanotechnology), the Cardiology division (stem cells), the departments of Pharmacology (systems biology and human genomics), Neuroscience (multi-scale imaging and regenerative medicine), and Orthopedics (regenerative medicine/tissue engineering), Pediatrics (systems biology), Radiology (diagnostic and molecular imaging), Surgery (regenerative medicine and biomaterials), and Nano-Engineering (multi-scale bioengineering/regenerative medicine), the School of Pharmacy and Pharmaceutical Sciences (systems biology and stem cells), and the Division of Physical Sciences (multi-scale computational biology).

## DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
## Mission and Areas of Excellence

The mission of the Department of Computer Science and Engineering is:

> *To continue in our role as a world-class leader in computer science and engineering education and research, both by increasing our impact on industry and other universities and by collaborating with our fellow departments and divisions at UCSD.*

The department has strength in Artificial Intelligence, Bioinformatics, Systems and Networks, Embedded Systems, Architecture, Programming Languages/Software Systems, Database and Information Management, Graphics and Vision, Algorithms, Complexity and Cryptography, and High Performance Computing

Our ability to improve ourselves by large-scale growth is over. One way we see to improve is to develop a visionary collaborative project that spans more than one research group. Departments at other universities, such as UC Berkeley, MIT and CMU have all used this approach with good results; it has helping them in influencing industry, placing students, and attracting further research funds. For us to do this, we need to strengthen the core of our field: **Theory and Algorithms**. We wish to hire one or two faculty in this area, with a preference for at least one senior member. And, we need to ensure the rest of the groups are at full strength; the "rule of three" has not been met in four research areas: Bioinformatics, Graphics, Vision, and Embedded Systems. Given the severe programmatic demands and the rapid growth of interest in Bioinformatics, hiring someone in this area is a priority. Our **Graphics** group is relatively new with one associate and one brand-new assistant professor, and is fragile to one person leaving. The **Vision** and **Embedded** Systems groups are better established, with one full professor and one assistant professor in each. And so, while important to get a third person in each, it is perhaps less urgent to hire in these areas than in Theory, Algorithms, Bioinformatics and Graphics. Finally, we are interested in pursuing joint hiring opportunities with the Department of Communication (most likely in issues of IT Policy), the Department of Cognitive Sciences (primarily in the area of Human-Computer Interaction) and with the Rady School of Management.

## DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
## Mission and Areas of Excellence

The mission of the Department of Electrical and Computer Engineering is:

To provide our students with training in the fundamental science and mathematics that underlie engineering, and with a general breadth and depth in engineering and in engineering design so that they are prepared for graduate school and for engineering careers. Students should have both proficiency in a specific technical area, and the flexibility and broad knowledge base needed for life-long engineering careers in a changing technical environment.

The central theme of the Department as outlined in Charting the Course III had been Information Technologies, under which there are two major areas of development: Networks/Systems/Sensors and nanotechnology.

ECE's theme for the coming 3-year period is "*Advanced Technologies for future Systems*". This encompasses several interdisciplinary areas of excellence such as information systems, engineering of solid state-biological interfaces, system-on-a-chip, networked systems and sensor networks, networked storage, and energy/power systems. To further strengthen our research portfolio in these areas, we will emphasize faculty growth in two main clusters, namely: Networked and Computer Systems, and Nanotechnology:

1. Nanoscale materials and device technology for communications and information systems.
2. Nanoscale materials and device technology for energy systems.
3. System-on-Chip architectures in the nanoscale era.
4. Scalable networked systems architecture.
5. Human to machine interface including voice/image analysis and understanding; video displays; and machine learning.
6. Sensor Network emphasizing video compression and distributed detection and estimation.

## DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING
## Mission and Areas of Excellence

The mission of the Department of Mechanical and Aerospace Engineering is:

> To rank among the top ten MAE departments, provide first-class education to undergraduates and graduates, and to conduct nationally and internationally acclaimed research for societal benefit.

The department currently has extremely strong research activities in

- combustion and energy-related research
- dynamic systems and control
- fluid mechanics
- solid mechanics

There are internationally renowned faculty members in all these areas, and the department has an enviable reputation in these topics, evidence of which can be found, for example, in the high percentage of NAE members in MAE.

We intend to build on our existing research strengths in solid and fluid mechanics, combustion and energy research, and dynamic systems and control to drive scientific and engineering innovation in these fields. The department has, since its inception, had a strong basis in engineering science and this has allowed it to interact in many interdisciplinary activities across the campus and to train highly valued students capable of adapting to changes in society and in the profession and to become leaders in their fields. We intend to retain this ethos and the consequent activities.

## PROPOSED DEPARTMENT OF NANOENGINEERING
## Mission and Areas of Excellence

The mission of the Nano Engineering (NE) Department at UCSD is foster research in areas related to the synthesis, assembly, and fabrication of nanocomponents into higher order structures, materials and devices. Department research will address how to carry out the effective hierarchical assembly of diverse molecular and nanoscale components into higher order structures, which retain the desired electronic/photonic, structural, mechanical, or catalytic properties at the micro-scale or macro-scale level. Particularly important to Nanoengineering will be the development of novel fabrication technologies, which will lead to viable manufacturing processes. The NE Department will explore novel ways to combine the best aspects of both 'top-down' and 'bottom-up' processes to create a totally unique paradigm change for the integration of heterogeneous molecules and nanocomponents into higher order structures. *Applying multi-disciplinary engineering approaches and principles to nanoscale systems will lead to scientific discovery and technology innovation. It is the primary goal of NE to train future leaders in Nanoengineering through inspiring education, state-of-the-art instrumentation training, and dedicated mentorship. The NE Department strives to become the number one Nanotechnology-related academic department in the country, and establish itself as the benchmark by which all future Nanoengineering departments are measured.*

The NE Department includes three key research areas of focus within Nanotechnology: 1) Biomedical Nanotechnology, 2) Nanotechnologies for Energy Conversion, and 3) Molecular and Nanomaterials. While we are recommending a major thrust in the Biomedical Nanotechnology area, a key component linking the new NE department with the School of Medicine, the areas of 'Nanotechnologies for Energy Conversion' and 'Molecular and Nanomaterials' will be strongly supported within the department, and are viewed as necessary, critical components to the success of the department. All three areas are crucial to the transition of the basic science of nanoscale structures into the nanotechnology application arena. The majority of the faculty transitioning to the NE department have strong backgrounds in the Materials Science and Engineering area, and constitute a significant fraction of the Molecular and Nanomaterials area. We will not recruit faculty into this area specifically during this Charting the Course plan, however it is anticipated that several of the hires in the other areas will necessarily involve individuals with strong Materials Science backgrounds. It is expected that some of the faculty hired in the Energy Conversion area will have a strong background in Chemical Engineering and will support the continuation of the Chemical Engineering Program within NE. The development of Computational Nanotechnology expertise within the evolving department will serve to bridge the three main research activities. The creation of computational nanotechnology tools will facilitate the transition of nanoscale science and engineering understanding to commercial applications. During this Charting the Course plan, we are targeting recruitments in the areas of BioMedical NanoTechnology (3), Nanotechnologies for Energy Conversion (5), Computational Nanotechnologies (2), and one additional person in the area of Electron Microscopy for Nanostructure Fabrication and Characterization, with particular expertise in Focused Ion Beam Technologies to support the development of our Shared Departmental User Facility.

## DEPARTMENT OF STRUCTURAL ENGINEERING
## Mission and Areas of Excellence

The mission of the Structural Engineering Department at UCSD is:

Shape and define the future in the general field of Structural Engineering, within a framework that is equally applicable to civil Infrastructure facilities, light-weight structures, land/air/sea mobile unmanned vehicles, aerospace, sports/recreational and mechanical structures, and nano- and bio-inspired structures.

The Department leads and excels in the areas of:

- Large-Scale Experimentation, and Computational Validation
- Advanced-material Structural applications
- Computational Mechanics
- Information Technology and life-cycle systems engineering
- Structural Design, including Buildings, Bridges, and Aerospace applications