



## The School of Engineering Strategic Planning Summary Fall 2005

### **Vision**

#### **Aspirations:**

- To be a leader among peer Engineering Schools in interdisciplinary research and engineering education
- To achieve an international reputation for educating engineering leaders with excellent communication skills, interdisciplinary technical preparation, management skills, and an understanding of globalization and the societal impact of technology
- To build a faculty, student body, and infrastructure that will support these goals

#### **Current Strengths:**

- Strong traditional undergraduate engineering programs
- High undergraduate student quality (in terms of performance and breadth)
- High student satisfaction
- Large percentage of women students and faculty
- Collegial atmosphere
- Strong individual faculty researchers
- Presence of strong professional schools and the Gordon Institute that offer opportunities for interdisciplinary research and education

#### **Challenges:**

- AS&E administrative structure and budgetary practice that limit the SOE's ability to plan strategically
- Low national visibility among Research I peers
- Inadequate infrastructure to support research and doctoral education (laboratories, support staff, grad student offices, IT)
- Uneven participation in funded research
- High teaching loads for tenure track faculty (relative to Research I peers)
- Traditional curricula and teaching facilities that need to be modernized
- Relatively small numbers of racially and ethnically underrepresented groups

#### **Current Reputation:**

The SOE's reputation is as a good engineering school embedded in an excellent liberal arts college. It is particularly known for excellent programs in K-12 outreach and the quality of its undergraduate instruction. Although its graduates have been extraordinarily successful and the SOE has a cadre of very strong and world-renowned faculty members, its national ranking and visibility does not reflect its current strengths. This may be due, in part, to its small size among peer institutions and to the fact that the SOE was elevated from College to School status only within the last five years.

### **5-10 Year Vision of Strengths and Reputation:**

- Enviaible infrastructure - state-of-the-art labs, cutting edge teaching facilities, top-notch research/support staff
- World-class faculty dedicated to innovative education/research
- School of choice for aspiring technological leaders
- Internationally renowned for interdisciplinary research programs – place of choice for top graduate students in these areas
- Nationally known for innovative curriculum and leadership programs
- Substantial growth in space
- Improved student to faculty ratio through 25% growth in tenure-track faculty size

### **Strategic Areas**

#### ***Selection***

To achieve its aspirations, the SOE plans to build core strength and visibility in a small number of strategic areas. **Criteria for the selection of strategic areas include:**

- Cross-cutting among existing SOE departments (interdisciplinary)
- Strong links to A&S and Tufts professional schools
- Links to University priorities
- Links to Boston area industry/state partners
- Foundation in existing core faculty strength
- Student interest
- Societal impact
- Research funding availability

Based upon these criteria, the following **strategic areas** have been identified:

- Bioengineering
- Environmental Sustainability
- Engineering Education Innovation

#### ***Brief Description and Connection with other Tufts Units/Initiatives***

The strategic areas identified above will provide many opportunities for interactions and linkages across school boundaries. In particular, it is anticipated that many of the SOE new faculty appointments will be joint with other Schools and core laboratory/research facilities and centers will have active participation from investigators outside of the SOE. Each of the strategic areas is discussed briefly below.

#### **Bioengineering**

Bioengineering has emerged as a major program at the interface of disciplines in science and engineering at Tufts, bridging biology and health sciences with various programs in engineering. Synergy between basic scientists, engineers, and clinicians has promoted innovation in diagnostic, therapeutic, and health monitoring applications. The environment at Tufts fosters opportunities in this program and therefore steady growth in bioengineering has occurred over the past ten years. This growth has been driven by many factors including student demand, employment opportunities and the learning, research, and working environment in and around Boston. Advances in quantitative and analytical aspects of biology, physics, chemistry, clinical sciences, genomics, proteomics, computer sciences and engineering are all embraced in the field of bioengineering and provide the fundamental tools upon which specific areas of research are organized. These advances have led to studies at the intersections among these fields and highlights the need to look beyond single disciplines.

Tufts has established strong programs in a variety of sub-areas within bioengineering, including: biomedical instrumentation and imaging, metabolic engineering, regenerative medicine and bioinformatics. Each of these themes provides a multi-disciplinary focus and integration with programs in various Departments within the SOE, among faculty within A&S, and in concert with clinical and

veterinary faculty on the various Tufts campuses. Along with these themes, the SOE continues to establish core analytical facilities to support advanced research and education in bioengineering, including biophysical characterization facilities funded by the W. M. Keck Foundation and the Dept. of Defense DURIP program, the Tissue Engineering Resource Center funded by the NIH and a biomechanics facility funded by the NIH and the NSF. Research grants, faculty appointments, post doctoral fellows and graduate students that function across schools and disciplines are a hallmark of the bioengineering program. Strong undergraduate opportunities in research and education also characterize this growing synergy. Graduate level educational programs are well-established and have already attained widespread visibility among the bioengineering community in Boston, with programs in bioengineering, biomedical engineering, biotechnology engineering, chemistry/biotechnology and biology/biotechnology. These programs serve students who come to Tufts for part or full time graduate programs, as well as a valuable recruiting tool for students in the Boston area. Similarly, undergraduate programs are evolving to address this growing field, as evident with changes in curricula in chemical engineering to embrace biology, and the new undergraduate major in biomedical engineering.

The vision for further development in bioengineering is based on continued growth in efforts outlined above, both in depth and breadth, to enhance research and education and to interface with industry. In particular, recognizing the intrinsically interdisciplinary nature of bioengineering offers unique opportunities to create interfaces across departments and schools at both graduate and undergraduate levels. In this respect, the academic diversity of Tufts, together with the current dynamic period in the SOE, can play a key role in providing an enriched environment to develop effective programs in bioengineering.

### **Environmental Sustainability**

Environmental resources development, management, and use, from the local to the regional to the global scale, are in a major transition. For example, expanding urbanization, continuing loss of biodiversity, wasteful consumption, increasing connectedness and globalization, reemergence of serious diseases, and deteriorating physical infrastructure, all place our planet at a cross-roads. Controversies have erupted over such diverse issues as how to respond effectively and creatively to the potential risks and vulnerabilities of environmental resources under natural (e.g., global climate change, surging human population) and artificial (e.g., terrorist attack, mutant carcinogens) threats. Such accelerating environmental changes pose significant scientific and engineering challenges and opportunities. We argue that it is no longer adequate to educate environmental professionals who are competent within a narrow domain of expertise, but have little appreciation for the social and economic dimension of the problems. Unfortunately, in many institutions, environmental research and education are viewed as discrete “technology” or “policy” topics. There is an increased awareness that such a framework is not particularly effective to address emerging environmental problems. Emphasis needs to be placed on prevention of future problems through sound scientific analysis and redesign of economic incentives around the concept of sustainable development.

This will require fundamental rethinking of how we educate the next generation of environmental professionals and how we engage in environmental research. This rethinking around environmental sustainability resonates well with existing expertise within the SOE as well as with on-going research programs in A&S and other Tufts professional schools. For example, key SOE faculty are engaged in research related to water sustainability (watershed management, pollution remediation and prevention, transboundary water issues, public health), sustainability of the built environment (bridge safety, earthquake design), alternative energy (alternative fuels, nanocatalysts for fuel processing and fuel cells), and remote sensing and acquisition and synthesis of environmental data (sensor technologies, signal processing, image processing, wireless communications).

Furthermore, the SOE has already embarked on this journey towards preparing future generation of environmental professionals through its leadership role in the development and implementation of a new graduate interdisciplinary educational and research program entitled *Water: Systems*,

*Science, and Society* (WSSS). This program was launched in the Fall of 2004 and is a collaborative effort of faculty and student participants from six of Tufts' Schools: Arts and Sciences, Engineering, Medicine, Veterinary Medicine, the Friedman School of Nutrition Science and Policy, and the Fletcher School of Law and Diplomacy. The premise of the program is that an integrated, interdisciplinary approach is crucial to the analysis and management of complex water-related problems. Its vision is to train a new kind of professional, one who understands the dynamics of water-related issues from multiple points of view, yet has the skills to be an expert in one discipline. Much of the research is located in watersheds and regions throughout the world where Tufts faculty have long-term research partnerships with local organizations and researchers. WSSS also builds on Tufts' strengths in the areas of international relations and active citizenship.

Our vision is to build on existing strengths within the SOE and our ongoing collaborative partnerships with A&S and Tufts professional schools to develop research and educational programs that address environmental sustainability in all of its dimensions and forge intellectual connections among engineering and the natural, physical, and social sciences. Through such programs we seek to educate engineering leaders and to stimulate new technological solutions to contemporary environmental problems. We believe that the SOE and Tufts are uniquely poised for this initiative and can attain national leadership in this area.

### **Engineering Education Innovation**

Tufts SOE has long been recognized for its innovations in engineering education, both at the college and pre-college level. The freshman-level "half courses", the Engineering Psychology program, the Musical Instruments Engineering program, the Multimedia program, the Mystic Watershed project, the Robotics Academy, and the Bringing Engineers into New Disciplines (BEND) program are all unique to Tufts and have attracted students both in and out of SOE. Some programs, like the robotics academy and the BEND program (aimed at bringing engineers into nutrition research), require non-engineers to be part of the design team. Many of the programs have A&S faculty members as participants and all involve A&S students. The Department of Chemical and Biological Engineering has also been a national leader in curriculum innovation, recently launching a major effort to develop a curriculum integrating biological engineering into the traditional chemical engineering course program. This work was supported by an NSF-Education Department planning grant on revitalization of US engineering curricula. These and other innovations have resulted in substantial improvement in recruitment and retention of undergraduates (a net zero attrition rate in engineering) and also make us attractive in faculty recruitment.

At the pre-college level, the SOE currently administers the Center for Engineering Education Outreach (CEEEO), which focuses on bringing engineering concepts into K-12 education. The CEEEO, with faculty participants from A&S and SOE, is internationally known for its K-12 engineering curriculum tools, which reach millions of students a year in 16 different languages. The center also has a national leadership position in developing and implementing programs (STOMP - Student Teacher Mentor Outreach Program) that provide opportunities for undergraduate and graduate students to work with K-12 teachers and perform research on the effectiveness of teaching methodologies for science and engineering. The CEEEO also partners with industry to implement programs in which the company's employees work with local community schools to bring more engineering into their curriculum.

As a strategic focus area of the SOE, it is proposed to better integrate educational research at all levels, through a broadening of the CEEEO's mission (the CEEEO will likely evolve into the Center for Engineering Education Innovation) and the recruitment of faculty (tenure and/or non-tenure-track) whose scholarship focuses on education. It is proposed to extend and strengthen collaborations with A&S and to develop more emphasis on research related to learning and curricula/tools evaluation. For example, the CEEEO already has formal links with the education and child development departments, and we hope to forge better links with psychology and neuroscience faculty.

We believe that Tufts has the potential to serve as an international model for engineering education innovation at all levels. Our strategic focus is to significantly increase our impact on how pre-college and college students learn engineering and learn through engineering. It is hoped that these efforts will result in more excitement for engineering as a profession, improved teaching methods for engineering and science, and a more technologically literate population.

## **Strategic Planning**

### ***Summary of Planning Process***

- Prior to the Dean Abriola's arrival in 2003, Interim Dean Vin Manno presided over the completion of an extensive SOE Departmental review process that involved both internal and external reviews of each Department. These review reports were made available to the new Dean in fall 2003 and have helped shape the strategic directions outlined here.
- Dean Abriola holds bimonthly meetings with all Department Chairs, Associate Deans, and the Director of the Gordon Institute to discuss space and faculty planning and strategic directions for the SOE. The SOE aspirations (presented above) and a formulation of strategic steps (see below) are an outgrowth of these meetings.
- These aspirations and steps have been presented and discussed with SOE faculty in open meetings. Dean Abriola also presented this vision at a joint AS&E faculty meeting last spring (2005).
- Aspirations and strategic steps have also been presented and discussed with the SOE Board of Overseers.
- Next steps in the strategic planning process will involve refinement of specific objectives under each of the strategic steps, the development of an action plan to achieve these objectives, and the development of an assessment plan to monitor progress.

### ***Strategic Steps and Selected Progress***

#### **I. Put in place a process for ongoing assessment and revitalization of the undergraduate curriculum while maintaining core strength**

A new Associate Dean of Undergraduate Curriculum position was created in 04-05 to spearhead efforts to assess and revise the undergraduate curriculum. The new Associate Dean has brought together a Task Force (faculty, engineering alums, students, and members of the Engineering Board of Overseers) to develop a template for revision of the curriculum.

#### **II. Identify strategic areas for research excellence**

See above

#### **III. Hire faculty and build critical mass in strategic areas**

During the past two academic years, the SOE has recruited new faculty in every department, many of whose expertise is aligned with the strategic areas identified above. Three of the new faculty members have joint appointments.

#### **IV. Foster cross-school collaboration and development of integrated research and cross disciplinary educational programs in strategic areas**

Two new interdisciplinary graduate programs were launched in 04-05 (Water Systems Science and Society and Masters of Engineering and PhD programs in Biomedical Engineering). The Center for Engineering Education Outreach has undertaken a strategic planning effort.

#### **V. Devise and implement policies for faculty development**

A junior faculty mentoring program has been implemented. Analysis of teaching loads is in progress. The SOE's first Bernard M. Gordon Senior Faculty Fellow was appointed.

**VI. Assess space and infrastructure needs and initiate focused efforts to secure needed resources**

A series of space planning meetings was held over the 2003-04 academic year with SOE Department Chairs and Directors to inventory existing space and develop space needs projections for the Campus Master Planning process. The Master Planning process led to the identification of a number of potential sites for facilities expansion and to refined estimates for space needs. Programming for an Integrated Laboratory Complex is currently underway and transitional space needs are being addressed through leased space.

**VII. Identify and separate key budgetary items from A&S**

In the last academic year, Provost Bharucha announced a revised administrative structure for the Schools of Arts and Sciences and Engineering. This structure clarified and streamlined the reporting lines to each Dean. A cross-school Academic Priorities Committee (chaired by Vice Provost Newell) was also charged by the Provost to formulate and implement budget structural changes, with the goal of enhancing the strategic autonomy of the Schools.

**VIII. Enhance SOE administrative infrastructure to provide support for achievement of strategic goals**

The SOE has added new administrative positions that include: Director of Computing Systems (IT infrastructure planning), Executive Associate Dean (financial planning, space assessment, staff reorganization), and Senior Director of Development (capital campaign strategy). A search is underway for a new Director of the Gordon Institute. This search is critical to providing strong collaborative leadership for TGI going forward. It represents an opportunity to move towards better integration of TGI and the SOE.

**IX. Identify and adopt methods to improve graduate student recruitment and enhance pool quality**

In academic year 03-04, the SOE Graduate committee developed a set of recommendations to improve graduate student recruitment. These recommendations were implemented in 04-05 and resulted in a five-fold improvement in yield on fellowship offers.

**X. Develop and implement programs to support recruitment and retention of underrepresented groups**

Through a series of working group meetings (03-04), the Center for Diversity and Inclusive Leadership in Engineering and Science (DILES) was established in 04-05 to improve the recruitment and retention of underrepresented groups and the education of SOE and A&S students in inclusive leadership.

**XI. Assess needs and develop external relations plan**

Board of Overseer Task Forces have been formed for: undergraduate curriculum (see above), interdisciplinary research opportunities/corporate relations, and SOE marketing/resources. The SOE marketing/resources Task Force is currently assisting in the development and implementation of an external relations plan.