DRAFT COLLEGE OF ENGINEERING STRATEGIC PLAN

Introduction

Engineering touches all aspects of civilization. The great works of humankind, from the construction of the pyramids to the development of steel to the invention of the computer, are all products of engineering. Engineering is an evolving discipline that often reinvents itself to explore solutions to new problems. Fields such as molecular biotechnology and nanotechnology that did not exist in the recent past are expected to produce some of the next dramatic breakthroughs. Such progress in engineering is usually driven by the efficient application of many complex fields of human understanding and subject to episodes of especially rapid enlightenment brought about by advances in technology. Thus while strategic planning is important for any organization, it is critical for an engineering college, where its role is two-fold: analyzing the impact of recent technological advances on the college and anticipating the next round of technological breakthroughs in order to position the institution to lead in their development.

The process of strategic planning in an academic environment differs from its industrial application, in part because the inputs and especially the outputs of the academic endeavor and the value that they add are not as readily quantifiable as they are in industry. We want to attract a bright and diverse freshmen class every year, but brilliance and diversity are elusive attributes that cannot be measured by numbers alone. Obtaining a Ph. D in engineering from Cornell surely adds to the lifetime income potential of an individual, but how do we gauge the value added to society if that individual becomes a teacher who inspires generations of students? It will be important to factor such intangibles into the process, tempering the value that engineers traditionally assign to metrics with a healthy respect for elusive but very real qualities like diversity and collegiality.

A document that seeks to understand and manage change is especially important at a time of transition. The appointment of a new president of Cornell and a new dean of the College of Engineering are recent shifts in our administrative structure. With so much change in the air at Cornell, the time is right to conduct an exercise in understanding how to precipitate and manage change within the engineering college. That exercise has yielded this document.

Vision Statement

LEADING THE QUEST FOR A BETTER FUTURE

Cornell University's College of Engineering is a rigorous, dynamic intellectual community in a renowned, research-intensive university. Through excellence in education, enterprising research, and exemplary service, the college contributes to the betterment of society. With each student who embraces learning, each discovery that expands knowledge and understanding, and each application that improves society, we lead the quest for a better future.

Mission Statement

The College of Engineering's mission is to:

- attract the finest engineering students in the world, educate them as broadly and well as we can, and prepare them to lead in an increasingly complex technological world.

- continue to lead with creativity, responsibility, and accountability in the quest for discovery and creation of new knowledge and the design, management, and control of systems, products, and processes.

- improve the future through the application of ideas and the commitment of resources to the betterment of society.

Values

We are committed as a college to the following core values:

1. To do all well, to excel at what really matters, and, in our best moments, aspire to greatness;
2. To be worthy of the great trust placed in us: honest in science, open in process, accountable in finance, honorable in relationship;
3. To treat individuals with courtesy and respect: to judge without partiality, critique without scorn, and encourage without reserve; and
4. To value diversity and recognize that multiple perspectives enhance creativity.

Goals

GOAL 1: To be considered one of the nation's top five engineering colleges in both our undergraduate and graduate programs.

GOAL 2: To be the nation's premier research institution in advanced materials, information science, and nanotechnology and a leader in bioengineering, complex systems analysis, and environment and energy-related research.

GOAL 3: To establish and maintain facilities and technical infrastructure that are second to none in supporting the achievement of our vision, mission, and values.

GOAL 4: To educate future leaders who are the most sought after engineering graduates in the nation and the world.

GOAL 5: To attract and retain the best and a more diverse community of faculty, students, and staff.

Unique Characteristics and Strengths

Cornell University's College of Engineering admits only students with demonstrated academic excellence. Many arrive with interests and capabilities that extend beyond the traditional engineering focus, attracted by the breadth of the college's programs, the richness of Cornell's research-intensive environment, and the allure of a safe and idyllic setting. These bright and highly motivated students interact with a faculty of global leaders in education and research as well as a professional and dedicated staff in a community that reflects many different cultures, cherishes academic freedom, and values diversity of perspective and opinion. The result is open discourse fueling academic creativity. These endeavors are generously supported, both financially and through individual and collective endeavor, by alumni, industrial partners, and philanthropic foundations.

One of the founding colleges at Cornell, the College of Engineering offers an unusual blend of engineering and science characterized by non-traditional programs and interdisciplinary connections that benefit the college in many ways. Most notable are integrated programs with the departments of Biological and Environmental Engineering, Computer Science, and Earth and Atmospheric Sciences; cross-disciplinary partnerships with the Colleges of Arts and Sciences, Agriculture and Life Sciences, Veterinary Medicine and with the Weill Cornell Medical College; and close connections with Cornell's world-class departments in science and mathematics, often leading to collaborations in campus-based centers focusing on research, industry connections, and outreach. This activity further enhances the college's basic and applied research and the development of technology and systems to support such work, providing extraordinary educational opportunity and inspiring successful interdisciplinary research initiatives.

Academic programs have a strong theoretical basis that is complemented by experiential learning opportunities. Undergraduate and graduate students participate in design projects and research and vie for places on such project teams as the Autonomous Underwater Vehicle Team, RoboCup and the Formula SAE Car Team, which have all won international competitions. Undergraduate design experiences are embedded in the curriculum in capstone senior courses. Some fields, such as Earth and Atmospheric Sciences have field components in their curriculum. Internships and Cooperative Education job placements, many provided by alumni, also allow students to apply their engineering knowledge early in their undergraduate experience.

The innovative Cornell Graduate Field system is uniquely structured to transcend traditional departments, fostering multidisciplinary research interactions, and providing a rich learning experience for graduate students. Students interact with faculty from different fields of study by pursuing appropriate minors, broadening their disciplinary perspective and preparing them to succeed as leaders in their own fields and as effective partners in interdisciplinary activities.

This rich university setting, programmatic breadth, extraordinary population, interdisciplinary strength, experiential learning environment, and sense of community all contribute to a special academic atmosphere that gives Cornell's College of Engineering much to celebrate and build upon.

Challenges and Limitations

Some of the strengths of the College of Engineering can also be disadvantages when viewed in a different context. For all its beauty and charm, Cornell's relatively remote setting is an obstacle to increasing diversity, meeting the professional needs of two-career couples, and establishing extensive connections to local industry. Local consulting opportunities, day-to-day contact with real-world engineering problems, and adjunct faculty are also more plentiful in large urban areas. Limited travel connections reduce faculty involvement in professional organizations and government service, and the distance from the medical school in New York City hinders some types of biomedical research. Without conscious effort to counter it, the collective impact of such limitations imposed by physical isolation could insulate the faculty and make the college overly theoretical.

The rich breadth of the college and university also has a flip side. The college has a number of small departments, which tend to compete with each other and with research and outreach centers for resources. Some research and teaching competence is duplicated in two or more departments. The limited turnover of faculty that is typical of such departments can hinder regeneration. And because part of the college is state run, with different cultures, funding support, and expectations than the endowed units, there can be an occasional clash or disconnect.

Facilities pose a third significant challenge. There is a pervasive shortage of space for both existing programs and new research initiatives. Aging buildings and infrastructure are critically in need of renovation, and because a large percentage of existing space is ill suited for emerging needs, it must be transformed to respond to new styles of research and instruction. In addition, the college lacks appropriate service and support space for students, faculty, and staff. The Engineering Library is outdated and does not adequately support the learning and study requirements of modern instruction, such as group projects, experiential learning, presentations, and computing. Student services are dispersed. Community space is sparse. Combining all these elements in settings that could become natural centers of gravity would promote cohesiveness and collegiality, continue the strides in climate improvement, and help attract and retain a more diverse community.

Emerging and Enabling Areas of Research

While a large number of exciting ongoing research initiatives will have a long-term positive impact on Cornell and its College of Engineering, three new major areas of inquiry span several departments and build on the current research excellence within the college. These emerging research areas should be particularly encouraged:

1) systems biology and biomedical engineering,
2) nanomaterials, technologies, and devices, and
3) energy and the environment.

Three other areas of research span several departments and address enabling techniques and technologies that provide interesting research opportunities as well as methods that can be applied to a wide variety of topics in current research and the proposed emerging research areas. These enabling research areas are:

1) computational science and information technology,
2) advanced materials, and
3) complex systems and networks.

Much of the ongoing research in the college and future activity in these emerging and enabling research areas is closely aligned with the national research agenda as well as Cornell University's strengths and priorities. Both the emerging and enabling research areas are strengthened by Cornell's unparalleled history of success in interdisciplinary research and distinctive graduate field structure. In addition, the college will continue to strongly support existing programs of established preeminence that support its mission.

New courses in all these areas will certainly appear at the graduate level and will have an impact on the undergraduate curriculum. The interdisciplinary nature of the research areas also suggests that changes may also occur in the common core curriculum (such as a common biology requirement).

EMERGING RESEARCH AREAS

Systems Biology and Biomedical Engineering

Research in the life sciences has advanced to a point where the quantitative and predictive methods of engineering can be used to obtain a greater understanding, design, and control of biological systems. The College is well poised to make important contributions at the interface of engineering and life sciences. In particular, the area of systems biology integrates many of the analytical and design-driven approaches familiar to engineers to facilitate basic biological discovery and to enable engineering design. As an example, genome sequencing projects and closely related studies provide a wealth of reductionist data on biological systems. However, because of the complexity of living systems, the ability to design and control cells cannot be achieved by investigating the various subcellular components alone. An integrative approach systematically organizing this data into quantitative frameworks that describe complex biological phenomena provides the opportunity to design more efficacious drugs and improve pharmaceutical production. Further, the college has the opportunity to develop the area of biomedical engineering integrating many of the analytical, experimental and computational tools commonly used in engineering with biological concepts to solve problems related to human health. Novel technologies and analytical approaches are relevant in:

- medical applications
- nanobiotechnology,
- bioprocess development,
- drug delivery,
- genomics and proteomics,
- environmental remediation,
- instrumentation,
- metabolic engineering, and
- biomechanics.

An important aspect of systems biology and biomedical engineering research is the opportunity for students and faculty within the college to work in partnership with students and faculty from other Cornell colleges. Further, the activities in this research area are synergistic with the other emerging research areas within the college (for example, energy and the environment) and also benefit from advances in enabling research areas (for example, complex systems and networks and advanced materials).

Nanomaterials, Technologies, and Devices

Engineering at very small length scales has the potential to produce important technologies utilizing materials with new and fundamentally different properties. Advances in engineering mean that it is now possible to fabricate structures on the molecular level using techniques derived from the microelectronics industry (top-down processes) or grow them using newly developed molecular fabrication techniques (bottom-up processes). Today it is possible to create microscopic structures with desired dynamical response for use as sensors and optical switches and devices the size of biological cells with the ability to operate autonomously. This explosion of new processes means that one can imagine electronic devices the size of molecules that interact directly with biological systems. Such developments will completely revolutionize the way we live and work. Nanoscale research involves a broad range of expertise from different disciplines and relates to a number of facets of the college. Our strength in nanotechnology, which stems from pioneering efforts starting in 1977 with the establishment of Cornell's National Submicron Facility, has grown and is highlighted by several national research centers and ongoing and future research activities that include:

- microfluidics,
- microchemical systems,
- microelectromechanical systems,
- nanomaterials and actuation, and the
- fabrication of materials at the molecular level.

Many current and future research thrusts involving nano and micro-scale systems interface directly with the other emerging research areas within the college (for example, systems biology and biomedical engineering) and build upon developments from enabling research areas (for example, information technology and advanced materials).

The existing infrastructure that supports research at small length scales at Cornell is among the best in the world. It should be reinforced and supported to facilitate participation of a greater number of researchers with interests of increasing diversity. With the rapid developments in this discipline, it will be especially critical to keep facilities current.

Energy and the Environment

Preservation and renewal of the environment is an important goal for all of society. One of the important issues that we confront today relates to the production and use of energy. Oil and natural gas provide more than 60% of the energy used in the United States; 50% of electricity is generated by coal. Over the next 50 years it is expected that the earth's population is expected to increase by two-thirds to 10 billion people with concurrent energy demand predicted to rise from 15 terawatts to 50 terawatts. This population growth will no doubt affect the environment and require an enormous change in the way people live.

Alternative energy sources, such as hydrogen fuel cells and energy derived from renewable resources such as biomass, are possible. They may become viable with appropriate research and development. Hydrogen-based fuel cells could provide low weight, high power sources and substantially reduce environmental emissions. Fuel cells would power simple electronic devices such as laptop computers powered for days without refueling and lead to a complete redesign of the concept of a car. Other areas of technology, such as lighting, are being developed to cut energy use, provide much longer lasting products, and come in new formats (such as light-emitting panels) that will change the way they function. Cornell is positioned to make a fundamental contribution to the discovery, development, and implementation of these alternative energy sources, and to the sustainability of the environment.

As in other areas, progress here is often based on multidisciplinary efforts (in combustion, biomaterials, and bioremediation, for example) and will benefit from interactions with other initiatives and colleges at Cornell. The activities in this research priority also interface directly with the other emerging research areas within the college (for example, nanomaterials) and are facilitated by advances in enabling research areas (such as computational science).

ENABLING RESEARCH AREAS

Computational Science and Information Technology

Computer simulations are now capable of predicting the behavior of many exceedingly complex systems and are beginning to play a role in engineering research equal to that of physical experiments. While the ability to perform rapid and reliable simulations is taken for granted in many areas of engineering research, there is a need for continued development of novel methods and algorithms in other areas such as the modeling of multi-scale phenomena. Fatigue fracture, for example, can be simulated at the component, grain, and atomistic levels, but coupling these simulations effectively requires new insights

Numerical methods play a key role in a variety of engineering applications. Examples are the pricing of various options in financial engineering and the cataloging, warehousing, and analysis of huge amounts of data in applications to marketing, speech recognition, machine learning, and genomics. Often, optimization algorithms must be developed to design and operate these and other engineering systems.

A change is occurring in how high-performance computing platforms are organized. Over the next decade, it is likely that most computation will be performed on grids consisting of globally distributed networks of computers, databases, and instruments. This will be especially true of those that involve collaborations among many research groups and/or the production of or access to large data sets. In this model, computational science will continue to be important, but high-bandwidth communication and efficient processing of large data sets will also be critical. The effective use of such grids to simulate engineering phenomena requires advances in numerical and mathematical modeling, computer architectures, networks, algorithms, databases, data mining, and visualization. Finally, the availability of low-cost MEMS, low-power transmitters, and cheap computing make it possible to deploy large-scale sensor and actuator networks. These networks may revolutionize the activity of data gathering and impact fields as diverse as traffic management and patient monitoring.

Efforts in this enabling research area can be applied to any of the emerging research areas (for example, systems biology and biomedical engineering) and are synergistic with developments in the complex systems and networks enabling research area.

Advanced Materials

It has been said that all future advances in microelectronics depend on advances in materials. Materials research will continue to be a major driver of this and many other technologies. New materials with unprecedented properties having structures tailored atom by atom are being developed at Cornell. Fundamental advances in the characterization of materials are enabling new understanding of structure-property relationships. Some anticipated themes based on current research activities are (1) more emphasis on computationally designed materials, (2) increased materials functionality by convergence and integration of biological, organic, electronic and structural materials, (3) materials created using self-assembly methods in which materials build themselves, and (4) tailoring of materials interfaces to produce materials such as nanocomposities. Just one type of new material, organic semiconductors, has the potential to allow the realization of smart credit cards, displays flexible enough to be worn around an arm, and cost competitive terrestrial solar cells through the integration of many of these concepts.

Advanced materials is a crosscutting enabling research area that has made and continues to make key contributions to the progress of research across the College of Engineering. Historically Cornell has had tremendous strength in materials research. Cornell was awarded one of the first three materials research centers, funded in 1960 by the Department of Defense, and has continued to maintain its materials research center on campus since then. In addition, three other major research centers, the Cornell Nanofabrication Facility (CNF), the Cornell Nanobiotechnology Center (NBTC), and the Cornell Nanoscale Systems Center (CNS), all rely on advanced materials. Advanced materials characterization techniques such as ultra high resolution Transmission Electron Microscopy (TEM), scanning probe based techniques (such as atomic force microscopy), and a new synchrotron X-ray facility (currently under development at CHESS/G) provide unique opportunities for the study of the structure and dynamics of multiple materials systems.

Given the breadth of research at Cornell, it is not surprising that there are many proposed research initiatives including the computational study of materials, energy and environmental materials for fuel cells, bio-technological materials, electronic materials (such as photonic crystals, wide bandgap semiconductors, organic semiconductors, nano-crystalline materials), and materials for high resolution lithography. This enabling research area touches on most of the emerging and enabling research themes described in this strategic plan.

Complex Systems and Networks

We rely on engineered complex systems to deliver critical services including water, power, transportation, information, financial analysis, and emergency response. These complex systems also include intelligent machine systems that integrate actuation, sensing, and digital communication and control into physical devices to create automated systems to meet complicated design requirements. Engineered complex systems include networks (such as internet, transportation, and manufacturing), infrastructure (such as healthcare and homeland security), and services (such as supply chains and financial engineering). The management, operation, and control of these complex systems are increasingly difficult for many reasons (for example, escalating demands by customers or rapid developments in technology). Further, complexity is engineered naturally in living systems in the interactions of molecules, cells and tissue and organ systems.

The foundation of this enabling research area is the recognition that integrative, rather than reductionist, approaches are essential to capture their dominant behavior. Because many such systems, both engineered and natural, exhibit properties, that are more than the sum of the properties of their parts, studies of robust design and risk analysis to mitigate unintended outcomes are also important.

Cornell Engineering has a broad-based foundation in the study and analysis of complex systems, including expertise in:

- communication systems such as the internet and information technologies,
- electric power systems,
- transportation systems,
- intelligent systems, and
- systems biology.

The activities in this Enabling Research Area can be applied to any of the Emerging Research Areas (for example, the Environment) and are synergistic with developments in the computational science and information technology enabling research area.

Objectives, Strategies, and Metrics

Community

The College of Engineering is a complex community of students, educators, researchers, administrators, staff members, and alumni relating to each other, professional and educational colleagues, and leaders of industry and government. At its best, this convergence of human effort builds and nurtures a supportive, socially responsible, interactive academic community that provides the base for a more promising future, ensuring that we learn from each other, grow as groups and individuals, and reach our goals. Because engineers of the future and the jobs they choose will be more diverse, and because the demand for engineers is projected to exceed the supply, the nature of engineering education is changing. An increasing emphasis will be placed on the versatility of the graduate. A high value will be placed on both group and individual achievement, attaching a high premium to the development of teamwork and leadership skills and the recognition that human factors will be more important than ever.

The college is becoming increasingly diverse as engineering research and education attract more women and underrepresented minorities, groups that are projected to provide most of the growth in the eligible college-age population over the next 20 years. They are adding new and vital perspectives to an environment already rich with representatives from many nations. Already, a preponderance of graduate students comes from abroad. The college must not only attract the most qualified students in these groups, it must also offer an environment that welcomes, values, and supports them; encourages interaction among all constituents; and unites the community to work towards common purposes.

These new foci require better communication between professors and students and more cooperation and collaboration among students, faculty, TAs, staff, and alumni—mandates that have sizeable implications for faculty workloads and measurements of success. Meeting those standards will rely on sensitivity to a variety of modes of teaching and learning, an evolution of attitudes, a redesign of facilities, and the development of a new form of community. This evolving educational model must be implemented in a college and on a campus that place equal emphasis on research and teaching, and where Cornell's historically high standards are maintained. It is an educational model that must be monitored regularly to ensure that the faculty provides the best possible preparation for graduates and students accept appropriate responsibility for learning.

Research relationships are also changing. Members of the Cornell faculty are expected to do world-class research, usually working with graduate students, post-doctoral associates, research staff, and, increasingly, undergraduates. Research teams are becoming larger because funding agencies are emphasizing research that involves cooperation between teams and outreach beyond institutional boundaries. At Cornell, collaborative research, carried out across departmental and college boundaries, has a long tradition of success. Such collaboration is fostered by the success of research centers, such as the Center for Materials Research and the Center for Applied Mathematics, and is encouraged by associations developed with researchers outside the university.

There is a need for facilities that promote a sense of community. Communal activity for the upper-level undergraduate and graduate students in the college has traditionally centered on their school or department. School/department lounges and other community space are insufficient and those that do exist need renovating. First- and second-year undergraduates, not yet affiliated with a school or department, have no focus or facility to help them develop peer and faculty relationships and attachment to the college. The Duffield Hall atrium will serve as a center of informal social activity for some in the college, but it will not address the need to enhance the cohesiveness engendered by identification with a school/department or the college. The core community space needs of the schools/departments and the college must be addressed. New and better community space is necessary.

Cornell Engineering's enduring reputation as a leading educational institution has long been enhanced by graduates who have gone on to distinguished careers as leaders in industry, the professions, education, government and the community at home and abroad. Alumni participation in the Cornell experience provides an advantage for the college and students alike. Engineering alumni recruit prospective students, serve on advisory boards, present case studies on campus (the Manufacturing lectures), provide cooperative education program jobs and internships, and form an employment network useful for identifying job opportunities and candidates.

In strengthening our community, we will provide additional support, encouragement, advocacy and friendship to all in the college and improve the professional, academic, and social climate. We will celebrate and promote respect for individual perspectives, experiences, and expertise. Objectives and strategies to build community through effective recruitment, the provision of common space, presentation of events and activities, innovative teaching, effective advising, leadership opportunities, professional development, and academic support are critical to every aspect of this plan. Thus we have consciously avoided sequestering them in a single section. Our goal is to make them integral to every area and activity in the college. Together we will lead the quest for a better future.

Faculty

The engineering faculty is responsible for both teaching and research, and the typical teaching load is meant to reflect this. To this point, the college has resisted separating teaching and research responsibilities. However, it seems inevitable that the pressure of increasing numbers of undergraduate and M. Eng. students will provoke the consideration of faculty members devoted exclusively to teaching. Likewise, the perceived research efficiencies to be gained by research faculty insure that such appointments must also be entertained. It might also be appropriate to consider expanding the definition of research, and the associated responsibilities of the faculty, to include technology transfer and patent entrepreneurship. In any case, all present and future faculty members should be highly productive, top notch in their field and effective and dedicated teachers. The strategic plans submitted by all the departments in preparation for this college plan requested a total of approximately 45 additional faculty members. There is a strong emphasis on bioengineering (be it biomedical, biomaterials, biophysics or biomolecular depending on departmental focus), nanomaterials and nanotechnology, and, to some extent, energy issues and systems. In addition, a large segment of the present faculty is expected to retire within the next 10 years (9% of the total College faculty is above 65 years old and 36% is above 55). This should give the departments and the college an opportunity to realign priorities while maintaining existing areas of excellence.

The task force analyzed the benchmarking data with peer institutions and reached the following conclusions:

- The number of undergraduate students per faculty member at Cornell is about 14 and is the second highest after Texas-Austin. This number is very high compared to the corresponding number for our private institution competitors (between 3 and 5 for MIT, Stanford, and Caltech) and is comparable or higher than the numbers for our state university competitors, Illinois and Michigan. These numbers clearly call for an increase in the size of the college faculty, if the current size of the undergraduate population is to be maintained. Ultimately an even larger increase in faculty than proposed in the objectives should be considered.
- The ratio of Ph.D. students to faculty at Cornell is low. Only Texas-Austin has a lower number. Increasing the number should be a very high priority.
- The number of Ph.D.s granted per year is low. The numbers hint that it takes too long to get a Ph.D. in Engineering at Cornell.
- The percentage of faculty in Cornell College of Engineering in the National Academy of Engineering is below average in the top-ranked colleges, as are the total annual research expenditures. Total research expenditures will grow with increased faculty size.

Faculty Objectives

Objective A: Improve the undergraduate-faculty ratio from 14:1 to 12:1 and improve instructional delivery

- Increase the number of faculty members in the engineering college by 30, and
- Create 10 endowed instructional enhancement positions (lecturers, skilled laboratory instructional staff and classroom technical support staff).

Objective B: Attract and retain diverse and excellent faculty candidates

- Raise an endowment for faculty start-up funds,
- Establish a minimum start-up package for new assistant professors including graduate student support and summer salary,
- Expand bridge funding for diverse faculty hires,

- Continue aggressive faculty pay practices,

- Create six term chairs for recruitment and retention of strategic hires and 10 endowed professorships for retention of senior faculty stars,

- Create an endowment for a systematic way of providing cost-sharing on NSF, DOD and other proposals requiring significant matching dollars,

- Encourage the nomination of members of the College of Engineering faculty for national and international awards including the NAE and hold regular events to recognize those honored,

- Incorporate a faculty common room in the proposed College Learning, Library and Service Center to promote research collaborations among members of different departments, thus increasing the likelihood of serendipitous encounters between researchers working in diverse fields, and

- Support university-wide initiatives to reconstitute a university club.

Objective C: Address dual careers

- Work with the central administration to establish a well-funded university level program, and

- Develop a consortium of regional employers to assist in job placement of spouses/partners.

Facilities

- The Cornell College of Engineering is hampered by an obsolete and obsolescent physical plant that hinders its teaching and research mission in a number of ways. The experimental equipment, computing power, and research materials used in modern engineering were not remotely envisioned when most of the college was built (70% of the college's facilities were constructed in the 1950's, primarily as classroom space). In many cases the infrastructure (exhaust and structural support capacity as examples) has been expanded to maximum capacity. The inability to further expand could prevent Cornell from pursuing vital research priorities. Conversion of space to research and teaching laboratories has occurred over time, distancing students from faculty members and research activities. Mechanical and data systems in over 90% of the facilities on the engineering quadrangle do not meet the power, plumbing, exhaust, and cooling requirements to conduct modern research and instruction. Mechanical systems in 11 of the12 buildings there are essentially a half-century old, and 10 of these buildings require communications network upgrades

- The College confronts pressing space issues. These include an immediate need for space in three severely overcrowded departments (Computer Science, Electrical and Computer Engineering, and Mechanical and Aerospace Engineering), a pervasive shortage of space for both existing and new research initiatives, aging facilities and infrastructure critically in need of renovation, and the requirement to transform existing space to respond to new styles of research and instruction. The current needs in ECE require immediate action. Even space freed up by new buildings will be inadequate to solve the needs of these departments. A large percentage of the college's existing space is ill suited for emerging research needs.

- Undergraduates have become distanced from faculty, a consequence of a decades-long transformation of teaching space into office and laboratory space. Most departments lack an environment in which undergraduates and faculty can study and work in close proximity because there is little or no teaching space in research-dominated buildings.

- Successful interdisciplinary programs require collaborators be situated close to each other, and near research resources. Several major research priorities in biology depend on collaboration between faculty in engineering, computing and information science, and life sciences. In particular, Cornell's life sciences facilities will be relatively far from engineering, requiring that this issue be acknowledged and addressed.

- The college lacks appropriate service and support space for students, faculty, and staff. The Engineering Library is outdated and does not adequately support the learning and study requirements of modern instruction, such as group projects, experiential learning, presentations, and computing. Student services are dispersed. Community space is sparse. Bringing all elements together in settings that could become natural centers of gravity would promote cohesiveness and collegiality, continue the College's strides in improving climate, and help attract and retain a more diverse community.

- The college "master plan,"(a development roadmap that looks decades into the future and identifies possible building locations and the college footprint with attention to future expansion, aesthetics, convenience, program needs, etc.) has been rendered outdated by such events as the construction of Duffield Hall.

- Major investments in new facilities and major renovation of existing facilities are not candidates for a pie-in-the-sky wish-list; they are essential and urgent priorities. The upcoming Cornell campaign represents a timely opportunity to transform the college reestablishing an environment that provides the highest quality educational experience for undergraduates; attracts the world's best students, researchers and faculty members, especially in emerging and enabling research areas; and promotes the success of multi-disciplinary research initiatives vital to the long-term health of the institution.

- A guiding principle in the provision of new space, given the long useful life expected of university buildings together with the impracticality of forecasting future program needs, must be flexibility to accommodate future assignments with minimum obsolescence.

Facilities Objectives

Objective A: Develop a long-range facilities plan for the upcoming capital campaign

- Develop a new master building plan including studies of proximity requirements and addressing the need for a larger college footprint.

Objective B: Renovate existing facilities and infrastructure in the college

- Identify or build new space that will be used as swing space as existing buildings are renovated and provide the college with flexibility of accommodation in the future.
- Renovate the interior, exterior, mechanical, and information infrastructure of existing facilities.
- Turn department/school student lounges into vibrant centers of academic and social interaction.

Objective C: Create a College Learning, Library, and Service Center

Objective D: Provide more research and instructional space for ECE, CS, and MAE

- Construct a new building for Computer and Information Engineering and Science and reallocate and renovate Rhodes Hall and Upson Hall.
- Expand ECE space in the renovation process.

Objective E: Provide new and decompression laboratory, research and instructional space for CBE, ECE, MAE, and MSE

- Construct new laboratory space.

Objective F: Provide space for the Biomedical Engineering and Biophysics programs

- Contribute to the new life sciences technology building, or provide separate space for biomedical engineering research if it cannot be accommodated in the new building.

Objective G: Provide space for Applied and Engineering Physics

- Contribute to the new physical sciences building.

Graduate Studies

The Graduate Program Task Force (composed primarily of faculty) was charged to review graduate education and professional studies in the college with a focus on improving quality and rankings of these programs. The Graduate Student Strategic Planning Committee (composed primarily of students) was established to identify opportunities to improve the quality and impact of a Cornell engineering graduate education. This is a summary of the findings of these groups from the perspective of the College's Strategic Planning Advisory Council:

- The current method for allocation of resources generated by the MEng program constrains and limits opportunities to improve the overall quality of graduate education in Engineering. Ideally, each field should be able to pursue a MEng program of an appropriate size to that discipline without regard to the size of MEng programs in other unrelated disciplines and without regard to the impact on the Ph.D. program (via faculty workloads). Departments should be free to pursue a smaller and more selective MEng program without concern for the impact of that decision on allocations. A smaller, more select pool of MEng students would raise the demonstrable qualifications of the graduate student population as a whole, increasing a key component organizations use to rank graduate engineering programs. This change could be achieved only by raising enough funds to support such a change.

- The average time to degree for graduate students could be shortened by reducing the number of PhD students in residence past the seventh year.

- Building on successes from the Engineering Graduate Student Association, there is a need for continued support of graduate students with respect to diversity and community.

- The graduate experience would be greatly enhanced by (1) improving the working environment (when resources and space allow) and (2) implementing increased visibility and awareness of services, funding opportunities, graduate student responsibilities, and expectations. Well-documented and analyzed exit interviews may provide a useful source of information to fields about causes, concerns, and issues related to graduate students.

Some strategies to achieve this support are outlined below. In addition, the college should explore the development of a distance-learning program that would enhance the impact of the current MEng program without affecting the number of MEng students in Ithaca.

Graduate Studies Objectives

Objective A: Increase the number of Ph.D. students and the number of PhD students per faculty

- Increase the number of faculty members in the engineering college by 30.

- Increase the number of Ph. D fellowships available with an emphasis on fellowships for underrepresented minority and female students.

- Increase resources for TA support throughout the college.

Objective B: Improve the infrastructure to support graduate students of all levels

- Implement workshops for professional development.
- Create a Website dedicated to communication to and among graduate students about life in the engineering college, responsibilities, and expectations.
- Improve the physical work environment and provide space for graduate student events.

Objective C: Improve the graduate student experience especially in terms of diversity and community

- Hold town meetings where graduate students can express opinions on any matter to a receptive audience of professors and staff.
- Improve faculty and graduate student diversity.
- Implement a Web-based exit interview process specially designed for students of different degree levels.

Objective D: Increase the selectivity of the MEng program

- Obtain funds to adequately finance departmental operations so that the current method of allocation of resources based on the MEng formula can be discontinued and departments can determine the size of their MEng programs independent of financial pressures.

Undergraduate Studies

The future of the engineering profession is tied to its ability to expand its talent pool, widen its perspectives, and increase its influence. The most obvious untapped talent pool is comprised of women and members of minority groups, both are significantly underrepresented in engineering education and the engineering workforce. Female and underrepresented minority students who do enroll in engineering programs have successfully demonstrated that they are interested in, and prepared for, the study of engineering. Their retention and graduation should be the college's top priority. Outreach to elementary and secondary schools, targeted recruitment of qualified candidates, and enrollment of those who apply and are accepted are essential to ensure Cornell's leadership in attracting more women and members of underrepresented minority groups to the profession.

These are other priorities relating to undergraduate education in the College of Engineering:

- Retain and graduate traditional students. Steps should be taken to insure that all students can major in the school or department of their choice. Practices that promote excessive competition and barriers to affiliation should be modified and/or eliminated. Workload in engineering should be monitored to determine that it is not excessive. Curricula should be made more flexible to accommodate breadth of inquiry, non-traditional interests, and international study.

- Meet the demands of an increasingly diverse world society through evolution of the learning environment and curricular content. Teaching methods are changing to engage the wide range of learning styles of a more representative student body. Group work and experiential learning will enhance the assimilation of knowledge, contribute to the retention of all students, and better prepare students for entry into the profession. Building community and relationships - peer-to-peer, student-to-faculty, and student-to-staff - will advance the undergraduate experience from excellent to superb.

- Enable students to build increasingly non-traditional careers. This will require constantly updating core skills and technical knowledge across disciplines, cultures, and continents. Work in the next few decades, for example, will further blur the lines between engineering, biology, and medicine and will contribute to the improvement of medical technology and health delivery systems in third world countries. The basic fabric of an engineer will become a more intricate tapestry: a weaving of knowledge with analytical, problem solving, and technical skills, enriched by societal, ethical, cultural, environmental, and international threads.

- Maintain facilities and infrastructure that are fundamental to success in all areas. Eighty-one percent of the undergraduate students surveyed during the planning process said that a common public facility would help to build college community. The Engineering Library's priority is a new facility "that will provide a learning and discovery environment that is attractive, technologically advanced, well-equipped, and inspiring for both individual and group study and research." Undergraduate Programs and Student Services envision a new facility that will support student learning, team and project work, and one-stop shopping for student services.

- Enhance education through technology. We have the opportunity to design asynchronous learning experiences for our on-campus undergraduates such as on-line TAs or Wizards, tutorials, or full courses to enhance, or provide alternatives to, classroom delivery.

Undergraduate Studies Objectives, Strategies and Metrics

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Objective A: Become a leader in the education of women and under-represented minority engineers

- Increase the diversity of the undergraduate student body by enrolling 35% women and 10% underrepresented minority students.

- Increase the graduation rates of women and underrepresented minority students to equal those of white/Asian students through stronger outreach, recruitment, financial aid, and retention initiatives.

- Increase faculty diversity.

Objective B: Improve the engineering undergraduate curriculum

- Conduct a comprehensive review of the curriculum to simplify requirements, ensure currency, accommodate emerging areas, and provide students with flexibility to pursue breadth in their studies and extra-/co-curricular experiences (such as internships, cooperative programs, and international study).

- Enhance the cultural, societal, ethical, environmental, and international focus of engineering courses.

Objective C: Improve the undergraduate educational environment and experience

- Review the undergraduate workload, class sizes, and affiliation process to determine if they are appropriate.

- Provide opportunities for all undergraduate students to experience hands-on learning by participating on a design or research team and recognize faculty leadership of these teams.

- Develop international study and work (internship and coop) programs and increase the number of students participating in them from 2% to10%.

- Institute programs that support diverse learning styles, reduce excessive student competition, improve the quality of teaching, and encourage the use of innovative teaching strategies and technologies.

Staff

Staff members work with faculty, students, and alumni as well as representatives of industry, government, and other constituencies to fulfill the mission of the college. They should be valued as members of the college community and recognized for their skills and contributions. Their work environment has changed rapidly in the last few years with increased performance expectations at a time of decreasing numbers. The nature of work has also evolved. Staff members are increasingly asked to perform technical work and, therefore, must constantly develop new skills as technology rapidly advances.

This new reality challenges the college to ensure the recruitment, retention, and promotion of highly qualified staff as well as to provide a positive and healthy work environment. Staff members need adequate facilities, equipment and tools in support of their responsibilities; reasonable performance expectations and workloads; rewards and fair compensation linked to performance; frequent opportunities to develop and refresh their skills; and a positive work climate. The responsibility for fostering a productive and harmonious work environment, and ultimately the success of the college, is shared by all.

As part of a college that emphasizes collaborative learning and teamwork, the staff's partnership with faculty is a visible model that demonstrates how we "walk our talk." Staff members contribute to the goals and activities of the College of Engineering. Their knowledge, skills, experience, and commitment improve the operation of the college and enable faculty to concentrate on teaching and research. It is critical to support initiatives that ensure staff retention.

Staff Objectives

Objective A: Increase the job satisfaction and retention of staff with the experience, skills, and professionalism to attain college goals

- Provide staff with proper facilities and equipment, including updated computer software.
- Endow the college assistant deanships (administration, alumni affairs and development, strategic planning, assessment and new initiatives, and student services).
- Set reasonable workloads and regularly evaluate them during times of change.
- Implement an ongoing college evaluation process to improve work and cost efficiency, consistency, and productivity, including identification of best practices, review of work cycles and coordination of resources, elimination of duplicate and valueless work, and clear communication of changes in policy and process.
- Conduct regular exit interviews and retention analysis, and address retention issues.
- Reward excellence in innovation, leadership, initiative, efficiency, and productivity through continued efforts to improve merit-based staff pay and the development of other pecuniary and non-pecuniary recognition and reward programs.

Objective B: Improve the work climate

- Develop and articulate a "Statement of Workplace Values" that acknowledges staff members as full partners in the success of the college and is adopted across the college.
- Implement a new employee orientation program that is consistent college wide.
- Support work-life balance through the application of flexible policies (flexplace, flextime, job sharing), stress management training, and attendance at university health-related events and programs to support a healthy workforce.
- Sponsor events and programs that bring together all members of the community.
- Provide community space, including eating facilities, on the engineering quad.

Objective C: Improve the quality and diversity of our staff through continuous professional development and enhanced recruitment

- Develop a college-level staff diversity plan and a process for continuously updating it and evaluating progress towards its goals.

- Train search committees in processes and techniques to improve the quality and diversity of the applicant pool and hiring decisions.

- Communicate Cornell's *Staff Skills for Success* and offer staff members the opportunity to attain the skills, and training required to develop professionally.

Appendix

Description of the Planning Process

In January 2003, the College of Engineering commenced a collaborative strategic planning process led by Dean Kent Fuchs with the assistance of Deborah Cox, Assistant Dean for Strategic Planning, Assessment and New Initiatives. The goals of the planning process were to:

1. complete the first draft of a strategic plan to ensure the college's leadership in learning excellence, preeminence in research, and engagement with society by September 2003,
2. present the draft to the college community in October and November for review and input, and finalize the plan by December 2003, and
3. produce a brochure highlighting the most salient points of the strategic plan by early 2004.

Initial work included the concurrent design of a planning process and committee structure. A Strategic Planning and Advisory Council (SPAC) made up of seven faculty and representatives from undergraduate student, graduate student, alumni, and staff constituency groups, was formed. Chaired by James Shelby Thorp, C. N. Professor in Electrical and Computer Engineering, the council was responsible for the coordination of the planning process, the identification of college-wide priorities and metrics, the development of criteria to prioritize department strategic initiatives, the recommendation of the prioritization and funding of those initiatives, and the writing of the draft strategic plan.

Five advisory committees assisted SPAC. Four of these committees had representatives on the council (undergraduate student, graduate student, alumni and staff). A Faculty Advisory Committee was also formed to ensure additional faculty participation with a focus on including center directors and Assistant Professors. The primary role of this group was to review and provide feedback on draft documents.

In addition to the five advisory committees, the Strategic Planning and Advisory Council established three task forces, in graduate studies, faculty, and facilities. Each task force was initially composed of four faculty members (the Graduate Studies Task Force added a fifth) and a professional staff member with expertise and responsibility in the area of the task force charge. The task forces were charged with looking at issues in their area that cut across the college, and each of them submitted a report with recommendations on June 30, 2003.

Guidelines for the development of academic department strategic plans were drafted as the college planning structure was formed. Non-academic units were also encouraged to follow the guidelines and adapt them as necessary to meet the unique needs of their units.

Concurrent with the development of their strategic plans, academic departments also developed facility plans and priority funding lists. Departments were asked to assess their existing space, compare it to the college's defined minimum standards, and identify any gaps between what currently exists and the minimum standards. As part of its charge, the Facilities Task Force reviewed these documents. In preparation for the upcoming university capital campaign, academic units also submitted departmental priority funding lists. The academic unit strategic plans, facilities plans, and capital campaign funding priority lists were submitted on March 28, 2003 as drafts and continued to evolve as planning proceeded.

The Strategic Planning and Advisory Council developed an outline of the strategic plan (attached), and, as SPAC completed sections of the plan, they were presented to academic department directors and chairs for discussion. The feedback of directors and chairs was used to improve the draft section. Prior to the release of the draft College Strategic Plan to the general college community, the Plan was shared with a small select group of faculty for further review and fine-tuning.

In October and November 2003, the plan was presented to College of Engineering faculty, staff, alumni, and students. Feedback from these constituency groups was discussed by the SPAC and final changes made to the College Strategic Plan in December. The plan was made public on ____?_____.

Add committee membership lists as an appendix.

Timeline

2003

January	Planning process commences.
March	Departments submit their strategic plan, facilities plan, and funding priority lists.
September	Draft College Strategic Plan is completed.
October-November	Draft College Strategic Plan is presented to faculty, staff, alumni, and students and feedback is gathered. Production of brochure highlighting plan commences.
December	College Strategic Plan is edited to include community feedback. Final College Strategic Plan is completed and released.

2004

January-February	Brochure is completed.
