[This piece will be preceded by an introduction, which all the case statements will contain, identifying the priorities of the university's capital campaign: endowment for scholarships, faculty, and facilities; and support for interdisciplinary efforts in life sciences, computer information science, sustainability, and humanities]

College of Engineering Accelerating Innovation

Cornell Engineering Around the World

"I think getting degrees from Cornell Engineering and École Centrale Paris is a great advantage for a Cornell student in the job market," says Ramin Farhangi, a junior engineering major in the new "2-2-1" partnership program between the two schools. "It shows that you've taken the initiative to embrace globalization, that you're capable of adapting to new situations—to a completely new system, in fact. It gives you a different perspective and it builds maturity." As the culminating event of a two-day visit by a delegation from École Centrale promoting the new program to Cornell engineering majors, Farhangi speaks to a group of Cornell faculty and undergraduates about his experience in the new program. Cornell students who choose this path spend their first two years in Ithaca, their next two in France, and return to Cornell for a year of master's study, receiving, in the process, three degrees: a BS in engineering from Cornell, a Diplôme d'Ingénieur from École Centrale—a prestigious degree in France—and an MEng from Cornell. "The combination of the French and American education, these two points of view, offer a very balanced approach to engineering," says Florence Mayo-Quenette, head of the ECP/USA University Relations.

This important visit showcases Cornell's budding ties with France's higher education system but also represents of the kinds of efforts the college is making to connect with institutions around the globe. In addition to the program with École Centrale, the College of Engineering is initiating three new international partnerships—with Hong Kong University of Science and Technology, China's Tsinghua University, and India's ITT-Kanpur. A landmark trip to China in fall 2005 by Cornell administrators and faculty, including engineering Dean W. Kent Fuchs and Interim University President Hunter Rawlings, signified the university's and college's initiative to invest in relationships around the world—to be members of the world community and to work toward addressing the sorts of problems that the people of the world are facing.

"We have tied the college's mission to the needs of society," says Fuchs. "And we work as a college to find ways that engineering can benefit people." To this end, the College of Engineering, capitalizing on its great diversity of strengths, has pinpointed six main areas of focus for the next ten years:

- Systems biology and biomedical engineering
- Nanomaterials, nanoscience, and nanodevices
- Energy, environment, and sustainable development
- Information, computation, and communication
- Advanced materials
- Complex systems and networks

This strategy covers everything from the development of new materials to alternative energy sources, from microelectronic mechanical systems (MEMS) to tools for understanding the complexity of the internet to applying engineering to improve human health. The vision is broad and deep, creating a role for the College of Engineering as a participant in an exchange of ideas on a global level, one committed to collaboration and creating a better future for all through its leadership and excellence in engineering education and research.

University Initiatives
Playing a Key Role

In Duffield 328, Eng Tek Ong, a sophomore in electrical and computer engineering (ECE), stands beside Anand Pappu, a fifth-year ECE graduate student, and Allysa Apsel, the Clare Booth Luce Assistant Professor of Electrical and Computer Engineering and one of Technology Review's *Top 100 Young Innovators of 2004. They are examining a receiver circuit, constructed on a sapphire substrate that is bonded to an array of photodetectors. Professor Apsel has been exploring the potential of optics as a means of information transferal. "We began to ask what an optical signal was good for, rather than just speed," she explains. "There's a lot of benefit to using an optical signal in a fiber when you want to transmit data from one point to another. We're looking at ways to make that system useful for a computer."*

Cornell University has outlined four broad areas of focus for the coming 10 years—life sciences, computer and information sciences, sustainability, and humanities—and Professor Apsel's work on data transmission is indicative of the way the college participates in these initiatives. The college is leading the way in life sciences, computer and information sciences, and sustainability through multidisciplinary efforts in Biomedical Engineering, Energy and the Environment, and computer engineering.

Apsel's lab in Duffield Hall occupies the corner of a row of new labs that house a broad spectrum of research, from photonics to nanobiology. Elsewhere in Duffield, Professor Manfred Lindau's lab, in the School of Applied and Engineering Physics (AEP), works on quantitative measurements of neurotransmitters. Manfred's AEP colleague, Harold Craighead, conducts research in the physics of ultrasmall solid state devices and structures. Nanoscale research is playing an important part in connecting emerging technologies with possible applications in the real world. Lindau's work, for instance, is accelerating the pace of basic neuroscience research and drug discovery; among Craighead's many projects, his lab has recently devised a prototype high-speed, ultra-sensitive chemical biosensor that might be useful in medical diagnostics or monitoring the food supply.

Twenty-first century engineering is at the epicenter of an explosion in new knowledge. Revolutionary discoveries in science, engineering, medicine, mathematics, and the social sciences have not only changed the way we interact with the world around us but have also blurred the boundaries between academic disciplines. Engineering is the catalyst for bringing disciplines together and pushing forward the amazing advances made possible by those collaborations.

Duffield houses three distinct centers of nano-related research: the Cornell Nanofabrication Facility, the Nanobiotechnology Center, and components of the Cornell Center for Materials Research. When fully populated, 20 disciplines from several colleges will be represented in Duffield, promoting multidisciplinary collaborations across campus.

People
Real-world Interface

A group of undergraduates and master's of engineering students are working on the problem of how to fill trucks at a fictional computerized distribution center. Their task is to optimize the supply chain in order to increase profits. The hurdles in their way, thanks to the computer game devised by Jack Muckstadt, the Acheson-Laibe Professor of Business Management and Leadership Studies in the School of Operations Research and Industrial Engineering (ORIE), are much like what they would face in the real world. "Our students are competitive in the workplace," says Muckstadt, the recipient of numerous university and national teaching awards, "because they have a reputation for getting things done—not just for theorizing, but for doing."

In addition to his popular courses, Muckstadt is deeply involved in ORIE's pioneering new master's degree program in financial engineering. This three-semester program not only offers students collaborative classroom experiences but also a semester internship with a Wall Street firm that is facilitated by the Operations Research Manhattan Center, ORIE's liaison office to Wall Street. "A lot of schools," says Muckstadt, "are following the lead of this program."

ORIE is also a major player in the University's Business, Leadership and Enterprise Initiative, as it brings quantitative solutions to management's problems. The interface between business and engineering is a crucial aspect of what we need as engineers to focus on, says Muckstadt, who has consulted for everyone from the U.S. Air Force to Amazon.com. "I think in the future we're going to have much closer ties with companies," he says. "The future of the college and the corporate partners are highly intertwined, because the promulgation of ideas will only be of use if we can find companies that will undertake their implementation."

The College of Engineering's world-class faculty continue to be its greatest asset. "Our faculty," says Dean Fuchs, "are the heart of the college. Among our highest priorities are recruiting the best, recognizing their contributions through endowed professorships, and enabling their success by providing technology and facilities for their teaching and research."

Programs
Far Ahead of the Curve

Abhishek Ramkumar, a new graduate student in biomedical engineering, watches as a knee is replaced at Weill Cornell Medical College on Manhattan's Upper East Side. Ramkumar is part of the Department of Biomedical Engineering's Summer Immersion Program, a unique opportunity that allows incoming doctoral candidates in biomedical engineering to work closely with medical professionals—the end-users of the products they design. "The surgery gave me a feel for the kind of user interface the surgeons are comfortable with," says Ramkumar. "I have learned one thing from this experience that I will always remember when I design instruments and devices in the future—keep everything simple and ready to use. It's not that the surgeons don't understand how it works, but it's the simple fact that in the operating room there is no time."

This cutting-edge immersion program is an example of the College of Engineering's progressive strategy to promote experiential learning—real-world experiences that aid, in this case, the students, the doctors they will design instruments for, and, ultimately, patients themselves. The immersion program sent five students to the New York City campus in 2005, its first year, but Michael Shuler, the James and Marsha McCormick Director of the Department of Biomedical Engineering and the Samuel B. Eckert Professor of Chemical and Biomolecular Engineering, says that this number will triple for 2006.

"The marriage of medicine and engineering," says Shuler, "in the form of specific education of biomedical engineers is critical to our ability to generate the next level of medical therapies and devices that truly solve medical problems at a price that society can afford. Our students must appreciate the challenges faced by clinicians to design effective therapies and devices." This means that the interns need an understanding not just of current technologies but also of the shortcomings of those technologies in clinical practice.

The educational link between the Ithaca campus and Weill Cornell Medical College is a powerful partnership that few of Cornell's competitors can match, and one that is helping Cornell biomedical engineering to become one of the leading programs of its kind anywhere.

Providing support for graduate students in all the engineering disciplines is a high priority for the College of Engineering, as fellowships allow Cornell to recruit the most outstanding graduate students, as well as helping in the recruitment of outstanding faculty members.

Facilities
Expanding to Meet the Future

Standing on the bridge connecting the third floors of Duffield and Phillips Halls, the view to the south is of the Duffield atrium, where students gather in groups to work on projects or at the café to chat over lattes, their voices muffled by the sheer size and acoustics of the space. Earlier today, over 100 students held a poster session for visiting alumni, exhibiting work they'd been doing as undergraduate researchers on everything from neural networks to medical imaging tools. Tomorrow, the Cornell RoboCup team—one of over a dozen student project teams located within the college—will be exhibiting their first-place robots here. The atrium, running nearly the length of a football field, is an unsurpassed multipurpose space. It is at once a corridor from central campus into many of the college's buildings as well as a workplace destination, equipped with wireless internet and lined with alcoves where students congregate night and day to work on projects "These sort of collaborative spaces are invaluable for engineers-in-training," says Richard Evans, the Robert Noyes Director of the Engineering Communications Program. "When our students graduate, they will likely be working in teams, communicating to multiple and diverse audiences. Having the facilities where they can interact in these ways makes a world of difference to their growth as communicators."

Duffield Hall, in addition to its many other uses, houses one of the world's most advanced nanotechnology centers. It is the first in a coming wave of state-of-the-art buildings and facilities on the Ithaca campus intended to expand the research and educational capabilities of engineering faculty. The others include three buildings that will be shared among several Cornell colleges—the Life Sciences Technology Building, which is already under construction on Central Campus; the Physical Sciences Project, which will stand in front of Clark Hall and house teaching and research labs for some of the world's foremost scientists and engineers; and William H. Gates Hall to house Computing and Information Science, which will interface with nearly all disciplines.

As Duffield has, the new facilities will foster cross-pollination between disciplines, with plenty of formal and informal meeting spaces to encourage the exchange of ideas. "They are being designed to accommodate the applied and collaborative work engineers do and teach," says Harold Craighead, "and to coordinate all of our facility needs, from research labs and offices to teaching and conference spaces."

The college also intends to renovate several other buildings around the Engineering Quad over the next five to ten years to bring classrooms and laboratories in line with the changing multidisciplinary work of engineers and researchers.

Annual Fund
Launching Ideas

Bryan Jarrett ' 05 and Michael Springer '05 prepare to connect a pressure gauge to a "trachea assembly" for BMEP 401, Biomedical Engineering of Metabolic and Structural Systems. In this lab, students study a healthy sheep's trachea as well as a trachea whose wall structures have been weakened by enzymatic action. The temperature gauge will measure the change in pressure as the experiment progresses. In a series of five labs taken by undergraduate biomedical minors, students work on everything from using an assay-on-a-chip to look at how a potential drug would affect cells to measuring nerve activity in crawfish. The Biomedical Instructional Labs, which are in part funded by annual giving, provide students with the crucial opportunity of rolling up their sleeves and testing theory. "This is different than just having an idea on paper," says Shivaun Archer, manager of the Biomedical Engineering Undergraduate Instructional Laboratories. "Here, students get a broad picture of where technology can take you, its benefits. They get an idea of what's out there and where they can contribute." Archer, who collaborates with faculty from a number of departments to design the experiments, says that the students in these courses get exposed to a lot of new technology, much of it, like nanobiotechnology, quite unique to Cornell.

Annual giving is the backbone of innovation within the college, whether it is for the many teaching labs in every discipline, or for funding which helps to recruit outstanding new faculty. Annual giving directly benefits the undergraduate students, supporting programs such as the undergraduate research program, which enables students to work in faculty labs; and services such as academic advising, peer tutoring, career services, and courses in communications.

Nearly all of the college's many project teams have gotten their start from gifts made to the Cornell Annual Fund for Engineering. Teams like CUSat—a group of 70 undergraduates that launches two nearly identical satellites that then monitor one another—are unique aspects of undergraduate life in the college that have proven to be exceptional opportunities for student growth.

"Our undergraduates are leaders," says Dean Fuchs of these teams. "In contrast to other universities, our team projects are not driven by faculty. The students make them happen."

Every year, unrestricted giving provides Dean Fuchs with the flexibility to fund emerging projects and urgent needs that help our students and faculty drive innovation.

The Cornell University Campaign (actual name of campaign will be substituted)
Taking on the Problems of the Next Century

A committee on energy and the environment meets to discuss the hiring of a director for the incipient energy and environmental initiative. As strategic plans were created around the college in 2002, a pattern began to emerge—a lot of faculty members were working on questions related to energy and the environment. Christopher Ober, the Francis Norwood Bard Professor of Materials Engineering, who was chair of the Department of Materials Science and Engineering at the time, says that within his department, the interest in these areas was striking. "And when we got together with other departments," he says, "we saw the same was true there." Soon, Dean Fuchs asked Ober and Sid Leibovich, the Samuel B. Eckert Professor of Mechanical and Aerospace Engineering, who now co-chairs the university's Task Force on Sustainability in the Age of Development, to delve into the matter further. "We looked around the college and the entire university for people who might be working in these areas and we found a lot, which convinced us to move forward," Ober says. This grassroots swell of activity continued to gain steam. A committee was put together to examine the possibilities of integrating the work. That committee, which included members from nine engineering departments, published the "Report of the College of Engineering Dean's Committee on Globally Sustainable Development: Energy and Its Environmental Impacts," which inventories the important energy and environmental problems facing the world and proposes the college's plan of action.

[We are considering replacing the following material with the voice of an engineering alumnus, urging others to support the campaign; possibly David Croll]

Though still in its infancy, the initiative on energy and the environment stands poised to grow and bring people together from across the college and the university in a concerted cross-disciplinary effort to tackle the most daunting challenge to face the world in the coming century—how to deal with the many facets of our looming energy problem. From the question of what to do about greenhouse gasses to the promise of alternatives like solar energy, fuel cells, and biomass, the initiative will combine its research and education forces to come up with answers.

"Students are beginning to flock to the engineering disciplines that deal with questions of renewable energy and environmental clean-up," says Paulette Clancy, director of the School of Chemical and Biomolecular Engineering and part of the committee that drafted the report. "It is clear to them that these will be important areas to be working in."

Dean Fuchs stresses the value of this kind of work when he says that the College of Engineering's role is one of leadership, and one committed to addressing itself squarely to the needs of people of this planet. "What's unknown for the future for us all," says Dean Fuchs, "is how we will—in

our companies and universities, in our careers, as a nation—interact globally. How will we act in the world?"

The Campaign will ensure that inventive students have access to a Cornell Engineering education and are prepared to deliver tomorrow's innovations where they are most likely to be useful, on the intersections between disciplines, on the cusp of theory and practice. It will also help the college grow the faculty by 30 new members in the next five to ten years, half in the life sciences and half in the six strategic areas.

Working across disciplines and across borders, learning from the best and passing that knowledge to the wider world, making a real difference in the quality of life is what the College of Engineering is all about. Supporting this work at Cornell is a step toward improving the quality of life on the planet.

<segue to Campaign tag line here>