Penn Engineering 2020: A Strategic Plan for Growth and Excellence

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Introduction

Founded in 1852 as the School of Arts, Mines and Manufacture at the University of Pennsylvania, Penn Engineering today continues to fulfill the original vision of Benjamin Franklin, our School's founder and our country's first engineer. It is a vibrant place where both "the useful and the ornamental" thrive. Undergraduate students receive an education that is both professional and inclusive, drawing from the resources of the entire University, and they graduate well-prepared for rewarding technology-based careers. Our faculty perform leading- edge research in state-of-the-art laboratories while being highly engaged in the School's educational mission. Penn Engineering's professional master's and research-based doctoral programs are among the finest in the nation. Complementary to our mission, technology is also taking center stage in society, and is emerging as the new "liberal arts" of education in the 21st century. After faculty hiring and infrastructure expansions in the areas of information technology, biotechnology and nanotechnology, Penn Engineering is poised for significant growth and a rise to an even higher standard of excellence.

Penn Engineering 2020 is a strategic plan that will guide investments in the School of Engineering and Applied Science over the next five years. This plan is strongly interdisciplinary and aligned with the Penn Compact 2020. It is anchored on the three themes of Inclusion, Innovation and Impact, and emphasizes the integration of knowledge with the other 11 schools at Penn.

Our Mission

Penn Engineering seeks an optimal balance between the creation and integration of knowledge through scholarly research, entrepreneurship and innovation in translating the products of our research into practice, and the dissemination of knowledge to our students on the Penn campus and beyond. Accordingly our mission has two facets:

- The creation, integration and dissemination of knowledge in both the fundamentals and their application in order to be an international center of engineering excellence and a catalyst for technological innovation; and

- The design and delivery of an engineering education known for its rigor, breadth and relevance to prepare students to become global leaders in technology-based fields.

The Goals of Penn Engineering

1. Excellence

The primary goal of Penn Engineering is to be internationally known for our scholarly research and our exceptionally trained students, and to be ranked with the top engineering schools.

2. Innovation and Impact

Technology is central to confronting all of the grand challenges faced by human civilization. Penn Engineering will become a catalyst for innovation by addressing these challenges in areas as diverse as human health, urban infrastructure, climate and energy, and education.

3. Growth

As technology emerges as "the new liberal arts," Penn Engineering will expand its footprint to educate and train students across campus and beyond, reaching out to a diverse student population.

Central to all three goals is the hiring and development of exceptional and diverse faculty, recognized as among the finest in the nation, and the recruitment of top students who will emerge as leaders in the field of technology and related areas.

Priorities for Investment and Growth

Penn Engineering has strong intellectual ties to a large number of departments and schools within the University. It must capitalize on its own special strengths and leverage the complementary strengths of the other 11 schools on campus.

Over the last decade Penn Engineering has developed expertise in important interdisciplinary areas, including: bioinformatics, cognitive science, computational science, embedded software systems, formal methods, molecular and cellular engineering, soft materials, micro- and nanoscale fabrication and characterization, network science, neuroengineering, programming languages, robotics, and systems theory. This has led to a steady climb in rankings at the departmental and school levels. The health schools at Penn are internationally known for their leadership in the large and aggressively growing fields of medicine and healthcare. Engineering science and technology are quickly emerging as the disciplines with the enabling tools for this growth, and healthcare continues to present new opportunities for Penn Engineering in particular. The emergence of new technology for micro- and nanofabrication and the improved understanding of biological, chemical and physical phenomena at small time and length scales point to a paradigm shift in engineering that will range from novel materials and techniques to new devices and applications. The emphasis on innovation across campus and our close ties to Penn Medicine, The Wharton School and the School of Arts and Sciences offer a unique synergy that is available on very few campuses.

Penn Engineering will strategically target opportunities that will differentiate our position among (typically larger) top-ranked peer institutions, while further strengthening core departmental needs. Our priorities lie within the following five thrusts involving faculty from all six academic departments and from other schools across campus.

Engineering human health

New and complex systems that bridge and advance both engineering and the health sciences include implantable devices, data-driven diagnostics, detection and drug delivery with wearables, precision biomedicine, robotics for surgery and hospital operation, autonomous and synthetic biology, cognitive systems, assistive technologies and neuroengineering. There are unprecedented opportunities for fundamental research and for catalyzing the translation of that research from the realm of discovery to the development of technologies at the interface of engineering and health. These opportunities can lead to the creation of an entirely new dimension at this interface, while also creating a new economic development opportunity to build on the health/information technology valley in the Greater Philadelphia region.

Data science and computation

While technological innovation and new algorithms continue to advance computational science, data science is now revolutionizing the scientific discovery process, going well beyond the now conventional experimental, analytical and computational techniques. Data science is impacting medicine, drug discovery, marketing, synthesis of novel materials, climate research, policy-making and social science, and it will transform the way our students learn and conduct research across all 12 schools. Opportunities for Penn Engineering include neuroengineering, computational biology, the materials genome, applied mathematics and statistics, and cognitive science. Penn Engineering will also lead the development of a curriculum in data science for all Penn students.

Nanoscale engineering, devices and systems

Penn Engineering will build on our existing strengths in materials, micro-electro-mechanical systems, microfluidics and nanofabrication. Our state-of-the-art facilities in nanotechnology have positioned us to become a hub for excellence in the industry-rich mid-Atlantic region and provide a nano "maker-space" for the greater Philadelphia area. There are new and exciting opportunities in nanomaterials, including characterization, microscopy and scalable approaches to synthesis; and in nanodevices, including the design and integration of nanosystems with applications to information technology, healthcare, robotics and manufacturing.

Energy science and technology

Developing the science and technology to provide sustainable energy solutions is an important area for Penn Engineering, and it exploits our strengths and programs spanning fundamental to translational materials, devices and systems. We will capitalize on our intellectual and physical proximity to the School of Arts and Sciences, the School of Design, and the Kleinman Center. Penn Engineering will develop technologies in order to harvest and convert energy into useful forms, creating renewable and energy-efficient devices; and to manage energy utilization, building intelligent systems. This will serve to ensure a more sustainable future.

Security, resilience and sustainability

Our urban infrastructure integrates both the cyber world with its communication networks and computational nodes and the physical world with sensors, machines and people. It is essential to be able to understand the interdependencies between the physical, cyber, geographical and logical networks and design feedback loops that allow communities to be resilient in the face of natural disasters and emergencies, while also being robust to cyber and physical attacks. In addition, we must address questions of privacy and security that will require close collaborations between engineers, legal scholars and policy-makers. Penn Engineering will build on our unique ability to nurture and sustain cross-disciplinary interactions across schools to make investments that build towards a secure, sustainable and resilient urban infrastructure.

Education

The Penn Engineering undergraduate educational experience has as its core mission the creation of a cohort of students who can think critically, solve problems, and innovate in the 21st century global environment. We will enhance undergraduate education by reimagining the freshman experience, using technology to teach efficiently, actively and effectively and engaging students in

research that is both "useful" and "ornamental." We will create and opportunities for local and global service learning. We will also introduce customized summer courses to support students with wide-ranging backgrounds and diverse interests.

We will teach through a combination of active learning, laboratory training, online learning and evaluation. Penn Engineering will become a technology hub for Penn students to take courses in data science and computation; nanotechnology; engineering and human health; energy science and technology; and security, resilience and sustainability. These five educational areas parallel the priorities for research investment and provide opportunities for all six academic departments.

The doctoral program is the hallmark of Penn Engineering's educational programs. Attracting, educating and mentoring outstanding doctoral students is a priority of the school. Penn Engineering doctoral graduates should be educated, trained and mentored for leadership positions, not only in academia, but also in industry and government. The education that we provide our doctoral candidates must embrace the challenges of the 21st century. The barrier to entry in the field of engineering is being lowered, and some technologies are becoming commoditized, even as new disruptive technologies are being developed. The gap between industry research and development and academic research is narrowing. It is important to strike the right balance between training in basic, curiosity-driven research while ensuring that our students are able to innovate and become leaders in today's quickly evolving disciplines.

In addition to our undergraduate and doctoral programs, professional master's programs meet an important need in today's rapidly changing technological landscape. Leaders in technology in the next decade are more likely to have a graduate degree in engineering than before. Penn Engineering's reputation will be increasingly linked to the impact of our masters' students in addition to that of undergraduate and doctoral students. To this end, we must focus on improving the admissions and placement process for our master's students, and train these students in entrepreneurship and innovation in addition to the fundamentals.

Finally, with the lowering barrier to online learning, the next five years will see new opportunities in non-degree professional programs. We must capitalize on these opportunities, build on our existing research strengths and new investments, and create specializations that will greatly extend the footprint of Penn Engineering.

On all fronts, we must redouble our recruiting efforts to increase the quality and diversity of our applicant pool of domestic students, including students from underrepresented groups.