Engineering and Applied Science at Princeton University

A statement by President Christopher L. Eisgruber and Provost David S. Lee

November 14, 2016

Technology is rapidly reshaping the world's challenges and, along with them, the questions that our faculty can investigate and the subjects that our students want to study. Princeton University's strategic framework, adopted in January 2016, singled out technological change as one of the trends most relevant to the University's future. The framework made clear that Princeton will have to act both thoughtfully and boldly to seize opportunities presented by the digital revolution and other innovations and to address their impact on liberal arts education. Although every field of the University is affected by these developments, the School of Engineering and Applied Science will inevitably play a leadership role in the University's teaching and research about them.

The School of Engineering and Applied Science Strategic Planning Task Force has issued a report that articulates a compelling vision for how the School can play that role. The report is founded upon a clear sense of the School's distinctive purpose: "the School of Engineering and Applied Science creates new knowledge and technologies, educates tomorrow's leaders, and serves society through discovery, design, and invention within a cross-disciplinary environment and a liberal arts setting." With its emphasis on creativity and service, and its insistence on the integration of engineering with Princeton's broader liberal arts mission, the report captures the excellence of Princeton's engineering program and points the way to an even more vibrant future. If we invest wisely and aggressively to build upon its already substantial strengths, Princeton's School of Engineering and Applied Science will continue to make unique contributions to this University and the world.

We are grateful to the task force for its insightful work and thoughtful recommendations. In this memorandum, we respond to the report by identifying recommendations on which we will take immediate action, those that will need further collaboration and development, and those that we believe, at this time, to be of lower priority.

New facilities to support 21st-century research and teaching

The task force report says forthrightly that "to realize our vision and achieve our goals our top priority need is for more and better space." As the report notes, the current Engineering Quadrangle was built in 1962. The price tag was around $8 million, making the EQuad perhaps one of the great bargains in the University's history. For more than 50 years, exceptional faculty and students have pursued their studies and research in its classrooms and laboratories. With the help of many generous donors, we have renovated old spaces to modern standards and supplemented them with beautiful facilities such as Sherrerd Hall, the Friend Center, and the new Andlinger Center for Energy and the Environment. Aided by such additions, the EQuad has served for more than a half-century as a functional home for an extraordinary School. It cannot do so for much longer.

As the task force correctly observes, the building's fixed walls and outdated utilities cannot support effectively the collaborative and innovative research, teaching, and other activities that are the lifeblood of a 21st-century engineering school. The School needs new facilities that will enable it to address new problems in existing fields and to forge new paths in fields such as bioengineering, urban design, the information sciences, and robotics (all of which the task force discusses). The time has come when we must begin the process of replacing the EQuad with newer buildings.

The University's strategic framework also recognized the need for new engineering facilities. It stated,

> "Most of the School … remains housed in facilities that were constructed to a utilitarian standard more than a half-century ago and that are no longer adequate to the School's research and teaching. The University will need to invest aggressively to support both the School's existing programs and new initiatives in emerging fields."

New facilities for the School of Engineering and Applied Science will be among the University's highest priorities in the coming years. This project will require both energy and patience: we have already asked our campus planners to identify potential locations for new buildings, but construction of each new building will proceed only as funds become available. We will need to seek generous gifts from the University's alumni and friends. The amounts required will be substantial if we are to create facilities that do justice to the quality of our engineering school, and that enable its students and faculty to address the problems that matter most to the world.

An interdisciplinary institute of bioengineering

The task force highlights multiple fields and challenges that deserve the School's attention over the coming decade, but its report emphasizes in particular the "importance of … biological engineering research" as a growing field with "critical implications for understanding life, advancing human health, and addressing environmental challenges." In recent decades, scientific advances have enabled engineers to use biology as a foundation for technological innovation. Bioengineering figures prominently in the National Academy of Engineering's list of Grand Challenges for Engineering.

The task force notes that all of Princeton's peers have created academic units focused on bioengineering. Princeton is fortunate to have several outstanding biological engineers on its faculty, but we agree with the task force that Princeton must invest more heavily in this field if the University is to participate in some of the most exciting and consequential areas of engineering research. We also agree that an interdisciplinary institute is the best way to leverage Princeton's distinctive strengths both inside and outside the School of Engineering and Applied Science. We accordingly endorse the report's recommendation for an institute of bioengineering.

The report optimistically claims that, by pursuing a new institute, Princeton can "within five years … become one of the country's leading centers of bioengineering." Princeton has already begun to invest in bioengineering—by, for example, renovating the Hoyt Laboratory for

bioengineering and hiring faculty in the area. Certainly the University should continue to build on these efforts. The creation of an institute may, however, require a longer timeline. To succeed, it will need the modern facilities that we have described above and an endowment to support its research. The University will accordingly need to raise major new gifts before it can establish the institute envisioned by the task force.

Other research priorities

The task force recommends that the School emphasize three other priority research areas: "resilient and smart cities, data and information, and robotics and cyber-physical systems." The task force describes the significance of these areas as follows:

> These interdisciplinary areas represent opportunities where Princeton is well positioned to provide tremendous benefits to society, but that require SEAS and the University to make a more conscious effort to put them on a path to success. Departments have already begun to conduct searches in these areas and progress will involve even more collaboration and interactions with the whole of campus. These priority areas can guide cluster hiring among departments, be candidates for the [creation of small, flexible] centers …, inform the campus planning effort, and be targets of fundraising, particularly for innovation seed grants.

We applaud the task force for identifying themes that transcend disciplinary boundaries and that can help to guide planning in departments, the School, and the University. The School's emphasis on data and information intersects with broader themes in the University's strategic planning. The framework emphasizes that fields related to information science—including computer science, statistics, and machine learning—are "revolutionizing the organization of human society and transforming scholarly disciplines throughout the University." We have already allocated new lines to the Department of Computer Science to support research and teaching in these areas. Statistics and machine learning are the subject of another task force report, to which we have published an administrative response. It will be important to work closely with the leadership and faculty in SEAS as we plan for the University's growth in these fields.

The infusion of new resources into bioengineering and data and information science should enable the School to marshal existing resources in support of the research opportunities in resilient and smart cities and robotics and cyber-physical systems. As the task force notes, departments are already hiring faculty members in each of these areas. We will ask the campus planners and architects to take these research areas into account as they site and design future facilities.

Faculty and graduate student growth

The excellence of the School depends first and foremost upon the quality of its faculty. Though the SEAS faculty is smaller in size than at most peer institutions, Princeton's engineering professors are exceptionally eminent and productive. Their extraordinary quality is evident in the impressive array of honors and awards regularly bestowed on the School's faculty.

Like the rest of the University, and consistent with its liberal arts ethos, the School's educational model emphasizes close contact between its superb faculty and its outstanding undergraduate and graduate students. In the words of the task force,

> SEAS is also known for the close connection between faculty, graduate students, and undergraduates. The small student-to-faculty ratio and the requirement that all students perform independent work enable SEAS to offer an unparalleled engineering education and provide opportunities for undergraduates to work closely with world-renowned faculty. Our cohesive graduate school, and our emphasis on fundamentals, provides a uniquely Princeton experience for graduate students, who begin research early as part of a supportive community under the guidance of experienced mentors.

As these observations make clear, in the Princeton model, quality matters far more than numbers or size.

The task force report observes that the University's research priorities may call for growth in the size of its faculty and graduate student body when justified by University commitments, such as the development of new research areas. We agree that initiatives such as the new bioengineering institute will require new faculty, and, as we noted earlier, we have added lines to the Department of Computer Science as part of our effort to build strength in data and information science. We note with enthusiasm the task force's commitment to diversifying the faculty; the University makes available additional faculty lines to assist with that goal. We believe that it may also be desirable for the Dean of the School to seek gifts for SEAS faculty lines that can be allocated to the School's highest needs.

Princeton's strategic framework recognized that when the University adds faculty, it must also add graduate students. We agree with the task force that the faculty growth described above will entail corresponding growth in the graduate student body. The task force also calls for selective adjustments to existing graduate student cohorts. The Academic Planning Group considers such requests on a case-by-case basis, and it will continue to do so in the future. We expect that any adjustments made by it would be small and consistent with the basic approach described above: Princeton's graduate teaching program is small and intimate by design.

Other priorities

The task force report is extensive and makes a wide variety of other recommendations, many of which the School has the capacity and authority to implement on its own if it is willing to make them a high priority for its resources and its faculty. We comment on a few of these recommendations below:

- *First-year curriculum.* The report recommends that the School revise its first-year course offerings to "include an option that more dynamically introduces students to the purpose and practice of engineering and infuses design into the curriculum." The School's curriculum is under the principal superintendence of the Dean and the School's faculty, with oversight by the Dean of the College and the Committee on the Course of Study. The Dean of the Faculty and the Dean of the College stand ready to work with the Dean

of the School of Engineering and Applied Science to shepherd the proposed reforms through the relevant processes and overcome logistical barriers.

- *Nimble centers for research.* The report recommends that the School develop a new structure to enable the creation—and dissolution—of temporary, nimble research clusters. We applaud this idea. While some fields or topics are sufficiently fundamental to merit funding them in perpetuity (bioengineering meets this test), most are not. If designed well, short-term collaborative projects with a clearly specified endpoint may be more efficient, more consequential, and more attractive to financial sponsors than would be permanent centers.

- *Entrepreneurship and "maker space."* The report recommends continued development of the University's entrepreneurship initiatives. These were the topic of a separate report and response, and we are pleased that the SEAS Strategic Planning Task Force endorsed the directions that the University is pursuing. The report also identifies a need for additional "maker space" on campus where students can tinker, innovate, and develop projects. The campus planners have been asked to take this request into account.

- *Diversity initiatives.* We commend the task force for making multiple recommendations to increase diversity and inclusion at the School. One of those recommendations was to create a new associate deanship, to be held by a SEAS faculty member, devoted to promoting those values. We are pleased that Dean Emily Carter has accepted the recommendation to create an associate dean for diversity position, and we support her decision to fill it with a full-time administrative staff member with proven expertise in this critical area. A search for the School's first associate dean for diversity is underway.

- *Calendar reform.* The task force strongly endorsed reforming the academic calendar to create a "January Term" that could be used for academic enrichment and international experiences. This suggestion has now received support from multiple task forces and is under consideration by the task force examining Princeton's general education requirements.

Conclusion

The coming decade promises to be an exciting one for the School of Engineering and Applied Science. Its teaching and research is central to the mission of the University, and we have a unique opportunity to build on its excellence by creating the facilities our faculty and students need to explore questions that will matter profoundly in the 21st century. We look forward to working with Dean Emily Carter and the School's faculty, alumni, and friends to realize this vision.