Editors' Notes

Over 14 million students are enrolled in undergraduate programs in colleges and universities across the United States. Our goals as a democratic society can be met only if every one of these undergraduates has access to programs of the highest quality that prepare them for life and work in the world beyond the campus.

The premise of this volume is that the trustees, presidents, provosts, and deans responsible for shaping and securing the future of a particular college or university must commit to larger national objectives and translate them into action at the local level.

Today's world beyond the campus requires a new set of skills and sensibilities, a reality that is beginning to shape institutional transformation at colleges and universities across the country. A fundamental driver in such renewal efforts is the conviction that no citizen today can have a productive, self-fulfilled life without an educational experience designed to make him or her scientifically and quantitatively literate. Another conviction driving current institutional transformations is that the worlds of science and technology offer endless opportunities for students intent on pursuing a career in which they can make a difference. If grounding in the classics prepared leaders in colonial America, it is a solid preparation in science, technology, and mathematics that will help equip leaders for the twenty-first century.

To accomplish this for all undergraduate students will require a new social contract engaging everyone with a stake in a strong, vibrant society. This will be a costly endeavor requiring greater resources for investing in faculty, curriculum, facilities and instrumentation, new pedagogies, and technologies beyond those currently committed nationally or locally. It will require new partnerships within and beyond a single campus that collaborate in sharing ideas, insights, and materials that serve to strengthen student interest and learning in these fields. It will require time spent on individual campuses revisiting and reordering practices by which goals for student learning are set and met.

As a nation we must make a commitment, both philosophical and financial, to two objectives:

That all undergraduates in these early decades of the century have access to robust and engaging learning experiences that give them a deep understanding of the nature of science and of scientific process, alert them to the power and potential of science and technology in their world, make them facile with numbers and data and the use of technologies, and prepare them for responsible citizenship in a world dominated by science and technology

That each student, no matter the background, has access to a research-rich, discovery-based learning environment in which he or she is motivated to consider a career using scientific and technological capabilities, perhaps as a K–12 teacher, as an academic scientist or engineer, or part of the high-tech industrial community

There are several reasons for this imperative. One is that to be recognized today as an academic institution of excellence, a college or university must have robust, high-quality programs in science and mathematics. Applicants and their families seek such places; the retention of enrolled students in these institutions is high because students realize they can learn these fields and that this learning will make a difference in their lives. Those who make gifts and grants and those who seek employees ask for evidence that students are being well prepared for life and work in ways consistent with the institutional mission. Graduates, well equipped with the skills and capacities that leaders in this century need, become grateful alumni. This is a self-reinforcing process. But the fundamental reason is the historic American vision of an educational community that serves the larger national interest.

In addressing such objectives, decision makers in academe today must deal with challenges that are different in both magnitude and essence from those faced even as recently as twenty years ago: students are more diverse, resources are more limited, and the public is asking for greater accountability. But the single most significant difference between then and now is that the programs and spaces, policies and practices must serve all students.

When in earlier times, for example, the primary goal of a department of chemistry was to prepare students for graduate school, decisions about faculty, programs, budgets, and spaces could be made by members of that department with little consultation across campus. Presidents then took pride in the numbers and percentages of students admitted into prestigious graduate programs, and deans rewarded faculty and departments producing those results. Science and society were served.

This targeted approach had its roots in the national response to the *Sputnik* challenge in the early 1960s. The pressure then was to identify the best and the brightest students early in their college career and prepare them as quickly as possible as professional scientists and engineers. Courses were designed to filter for those best and brightest, and faculty interest in students was primarily to find apprentices for their research lab.

The strongest undergraduate programs in Science, Technology, Engineering, and Mathematics (STEM) fields today still have as a core mission to prepare those students who will be the next generation of professionals for the nation's scientific and engineering communities. Our society continues to have a desperate need for persons passionate about exploring, discovering, and designing at the frontiers of science and technology, people ready and well equipped to take the intellectual risks that lead to new understandings about the natural and the man-made world in the service of society. This need becomes even greater now as many *Sputnik*-era scientists reach retirement age.

But if academic leaders have agreed that the larger national objectives are relevant for their college or university, the process of planning becomes more complicated and more interesting. Decisions must be made from a wider perspective, including but going beyond how to serve a small cadre of students preparing for professional school.

It is precisely this expansion of the mission of undergraduate STEM programs that requires renewed campuswide attention to strengthening the learning environment in mathematics and the various fields of science, engineering, and technology. A commitment to make science a more visible part of the undergraduate experience for all students has implications for every decision to be made about programs and facilities that serve students in these fields, as well as the more general decisions in regard to policies for budgeting and for faculty review and reward. When the attention moves from the quality of teaching of a single faculty member to the quality of learning of all students, it becomes a community responsibility to make the right decisions.

Faculty with scholarly expertise in these fields must be actively engaged in shaping the future of programs for which they are responsible. The decisions made, however, will be more creative and more productive over the long term if they are the outcome of serious conversations involving each member of the community whose work can affect the character and quality of student learning on that campus. That decision-making groups are more productive and creative when they include persons with different experiences and responsibilities is well known to corporate leaders. Faculty informed about pedagogies such as collaborative learning are also familiar with the power of having diverse perspectives at the table in the process of identifying and solving problems. Trustees from the corporate communities can speak to expectations that graduates have the higher-level problem-solving skills, analytical competency, and technological sophistication needed to succeed in the workplace.

Think about decisions that must be made, based on challenges presented in the chapters in this volume:

- *The challenge of bringing advances in science into the learning environment.* In Chapter Seven, Diane Halpern challenges academic innovators to use in the shaping and reshaping of curricula and pedagogies what is known from research in cognitive science about how people learn. How can this become more than an isolated effort by a single faculty member? Is there a learning and teaching center, such as Susan Singer describes in Chapter Ten? Is there a team in place that links assessment of student learning to broader institutional goals, such as Christine Brooks Cote and Marianne Jordan address in Chapter Eight?
- *The challenge of expecting all students to succeed.* In Chapter Three, George Campbell challenges the community to expect that all students can

learn in these fields and to put aside the sorting and tracking that has led to such dismal underrepresentation of persons of color in scientific, technical, or engineering fields. Is the campus community prepared to make the full-court press that the University of Texas El Paso has made, as Thomas Brady describes in Chapter Six, to build learning communities in which no student is left behind?

• T*he challenge of nurturing faculty careers that serve new and persisting institutional objectives.* In Chapter Sixteen, James Gentile echoes the challenge in Chapter Nine from Project Kaleidoscope on investing in faculty: that someone on the campus take responsibility for knowing the needs and aspirations of faculty, individually and collectively, and for ensuring that those needs are met in a timely manner. Are institutional policies and practices in place that support faculty at each career stage and recognize and reward faculty for their contributions to strengthened student learning? Does each faculty member have a multiyear plan against which his or her scholarly achievements are measured?

Project Kaleidoscope is one of the leading advocates in the United States for building and sustaining strong programs in science, engineering, and mathematics. For more than a decade, its driving goals have been to equip teams of faculty and administrators for leadership in reform at the local level so that students and science are better served, as well as to encourage broad understanding of how strong undergraduate programs in these areas serve the national interest. To achieve these goals, the approach has been kaleidoscopic, giving attention to all facets of the undergraduate learning environment, from the quality of the faculty to the character of the facilities, from the design of the curriculum to the shape of the institutional culture and budgets.

• *The challenge of making the right capital investments in facilities and technologies.* Several chapters, in particular those by Arthur Lidsky (Chapter Twelve) and David McArthur (Chapter Thirteen), address the challenge of starting from the point of the institutional mission as decisions about major capital expenditures are being made. For many colleges and universities, a new or renovated facility for science is the largest investment made in decades in the physical plant; for all institutions, the constant demand for state-of-the-art technologies is requiring heavy financial commitments in the short and long terms. What are the goals for student learning that shape decisions about facility location or traffic patterns to and through a new facility? Are spaces designed to accommodate active learning communities and a research-active faculty and student body? Is the planning strategic or random for infusing technologies into the environment for learning?

• T*he challenge to take bold steps.* Daniel Sullivan in Chapter Fourteen and James Appleton in Chapter Seventeen suggest that the transformation of these programs must be in the president's heart as well as in his or her head. Their counsel is that the more that the president and other senior decision makers are science-savvy, the better they will be in imagining and realizing objectives that strengthen the reputation of the college or university as one truly meeting the needs of students, science, and society.

There are more challenges, explicit and implied, in the chapters in this book. Collectively, they challenge academic leaders to take immediate and informed action. There is an urgency with the growing national need for a well-equipped talent pool from which the scientific, technical, and engineering workforce in the twenty-first century will be drawn. Today's undergraduates are that talent pool, and decisions made at the local and national levels about the quality and character of the learning that each student experiences will shape the quality and character of the national talent pool for decades to come. These decisions will shape the future of education at the K–12 level, as well as the capacity of the United States to sustain global leadership in exploring new scientific and technological worlds.

In a festschrift (1960) in memory of President Woodrow Wilson, poet Archibald MacLeish used the words of noted educator and public servant, James Bryant Conant: "What [President] Wilson meant by the wholly awakened person who should be the ideal product of American higher education is a person awakened through the power of the imagination to a consciousness of possibilities" (p. 7). MacLeish explains that "Conant assures us that scientific discovery begins not in the finding of the laboratory but in the glimpses of the imagination. . . . that the true scientist takes off, as the true poet does, not from the notes on his desk, but from a hunch, a feel in the bones, in intimation. If that is true, Mr. Wilson's whole person will make the better scientist, as he or she will be the better citizen of a free nation" (p. 8).

Reference

MacLeish, A. "Mr. Wilson and the Nation's Need." In Woodrow Wilson Foundation, *Education in the Nation's Service: A Series of Essays on American Education Today*. New York: Praeger, 1960.

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Part One

Social Demands and Student Needs