Conference on the Role of Research in the Natural Sciences at Undergraduate Institutions

"Renewing Scientific Leadership: Lessons of Our Age"
Lisle, Illinois.
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I want to thank the sponsors of this meeting, especially Mike Doyle of the Research Corporation, for inviting me. This is an occasion for me to see some old friends and to connect once again with people who care about science in the way that I do. But there is an awkwardness. This occasion is a little like a picnic to which David has invited Goliath. The subject of the conference is the state of research in the natural sciences at what are, for the most part, small colleges and universities. I happen to be president of the largest university in the nation, with more than 50,000 students. Some of you might argue that I am the least qualified person in the room to address the subject at hand. Like other Texans, I may not grasp all there is to know about an issue, but that won't stop me from expressing my opinion.

This conference has been organized by people who have long understood that undergraduate colleges have historically educated a remarkably large share of the nation's scientific leadership. For decades, there has been broadly shared confidence that research experiences offered to undergraduates in these institutions have been important in encouraging talented graduates to pursue doctoral education, and ultimately to assume leadership in science. This conference was convened in the desire to preserve the health of that chain, but probably also in the suspicion that the chain may not be as healthy as in the past.

I, too, share the view that the engagement of undergraduates in research is important. I, too, am suspicious that the overall enterprise is not as healthy as it once was. This view may reflect nothing more than the fact that I am not as young as I once was, but probably there is more to it than that.

You have now spent a good number of hours considering all of this, and you must have views of your own that have been elaborated and refined by the day's discussions. Your picture is fuller and better considered than mine, so I will not try to address the whole picture. Instead let me just make four points that have a chance of influencing your further thinking as you continue tomorrow.

First let me note some good news in the findings of the study on academic excellence that is being used as a basis for your discussion. The interest of students in science is showing no signs of collapse.

I was impressed by the fact that the number of baccalaureate degrees in science conferred by the undergraduate institutions actually increased between 1990 and 1997--from about 26,000 in 1990 to 42,000 in 1997. This is a gain of almost 38 percent. You must be doing something right. The majority of that gain has been in the biosciences, which is not a surprise, given the nature of scientific progress and promise over the past decade.

I am also encouraged to see that the number of summer research students in these institutions has increased in the period from 1991 to 2000.

These points make it clear that there really is not a problem with numbers. The real issues of this conference are the intensity with which individual students engage science and how to promote engagement in a manner that will renew the scientific leadership of the country in the best possible way. Those topics are always worthy of discussion, and they bring me to my second point.

What motivates people to do the things they do? There is a long list, starting with the big four: hunger, thirst, sex, and greed. Beyond them are love, hate, loyalty, ego. Revenge, ideology, altruism, acceptance.

And fascination.

To become absorbed in a subject—fascinated by it—opens the door of creativity. In very large measure, the commitment that people make to the arts, to the humanities, to science, to virtually all bedrock elements of civilization, arises because they become fascinated beyond any level justified by utility or self-interest. Fascination generally drives people in positive directions and deserves to be encouraged. In thinking about how to elevate the intensity with which individual students engage science, I judge that the problem distills to how to promote fascination.

Recent years have brought us a good deal of public discussion about the technological possibilities for revolutionizing teaching and learning at the collegiate level, and that discussion has led me to think much more deeply about the things of real value that I derived from my own undergraduate experience. (Incidentally, that was in a small private university with a strong undergraduate orientation, Southern Methodist University in Dallas.) The valuable things were not the facts of the curriculum. They were things like proper standards; exposure to the ways in which powerful minds, of different kinds, address problems; how to foster creativity; and the elevation of my fascination with science (and, by the way, my fascination with other things, too). All of these are non-curricular matters. It has struck me powerfully that we who lead colleges and universities, not just at the presidential level, but also at the level of the faculty, spend virtually no time at all considering how to foster and optimize these critical results of an undergraduate experience. It’s time that we changed that. The details of the curriculum, on which we spend endless time, pale in value beside these more lasting consequences.

An early fascination with astronomy led me to science even in my teenage years. In college, I started with engineering, which was practical and was much favored by my father, but was not fascinating. Chemistry ignited my interest, and the faculty at SMU fostered it wonderfully. In the fall of 1965, when I was a senior and an applicant to the graduate school at UT in Austin, Professor Allen J. Bard visited SMU. He dropped by my qualitative organic lab to meet me. I was carrying out an extraction with ether. A few moments before he arrived I had clumsily allowed the ether to pop out of the separatory funnel. When he entered the lab, I was embarrassed by the terrible mess on my lab bench and apron. That meeting had a tremendous influence on my life. The following summer I enrolled in one of Al's classes at The University of Texas. It was the beginning of a long journey for me. His fascination with science, conveyed from the perspective of a player-coach, was captivating. After completing the course, I asked to join his research group. The research was venturesome and exciting, and it taught me the pleasure of inquiry and discovery.

Oddly enough, the first thing that attracted me to Al and the resulting partnership was not fascination, but gratitude for his pretending not to notice the mess in my organic lab back at SMU. But a lifelong partnership, to this day fostering our mutual fascination with science, has grown from those humble beginnings.

I am certain that I would not have been nearly so venturesome in developing my relationship with Al Bard and in becoming so active so quickly in graduate-level research without the confidence fostered by my undergraduate research advisor, Professor John J. Banewicz of SMU. In his lab, I did not find the same sense of discovery that I later came to enjoy with Al Bard, simply because it was not possible to work on the leading edge in quite the same way. But John had superb standards, took a great enjoyment in scientific phenomena, and did all he could to introduce me to science as a human enterprise, where I could also be a part and could aspire to the same pleasure that he took from it. These were powerful lessons.

My charge to you tonight is to consider the matters that I have posed here and to consciously examine ways to infuse the professor-student relationship with inspired fascination. It's an elixir for which there is no substitute. I am very sure that participation in undergraduate research is a valuable means for success, but only if the mentor feels the fire, too.

And that brings me to the question of whether real scientific research is still receiving the fullest practical dedication of imagination and energy from the faculty in undergraduate institutions.

According to your study on academic excellence, all 539 pages of it, the greatest change in time allocation during the 10-year period under review was caused by the effort to incorporate information technology into teaching. There is no question that this activity is time consuming, and I believe that much of the technical skill and imagination that was once devoted to research is being redirected into it. Sometimes this kind of work is even called "research," and students are brought into it as partners. Certainly they can develop useful skills in such projects, and they may even find fascination in them.

But I question if this kind of work is a good trade-off of faculty time. I suspect that very little of their creativity and energy will result in inspiring students to pursue advanced degrees in science. It may inspire them to go into information technology. They may end up having productive and lucrative careers working for Accenture or PriceWaterhouseCoopers. That's not bad, but it is not going to give the nation the next generation of scientific leadership. No one but the science faculty can open the world of active scientific investigation to young students in undergraduate institutions. When that kind of contribution is not made because the faculty are doing something else, the loss will not be recovered elsewhere, so the "something else" must have equivalent or greater value. It's pretty clear that we are not really thinking about trade-offs like this. Probably we should.

My final point is not about undergraduate institutions at all, but it does concern the health of the chain that renews our scientific leadership. Last October, I was invited to present the Edward Goodrich Acheson Award Address to the Electrochemical Society, and using the title "The Heartbeat of Science," I spoke on the periodic advance and consolidation that marks the progress of science. Many of the points made there are also relevant to the context of your meeting here. One point that I wish to mention now (even to the extent of drawing some paragraphs from that talk) concerns the ability of science to attract talent of the first quality. In short, I perceive some major problems with the graduate experience as it exists today.

When I started graduate school in 1966, I was fortunate in that I had a supportive wife, who was then working as a schoolteacher. She dropped me off at the campus every morning at 7:30. The people around me—my mentor, the faculty, my family—helped to make my time productive. I finished my Ph.D. in a little more than three years. These days, graduate school lasts longer than many marriages.

Just out of curiosity, would everyone here who earned a Ph.D. in three years raise your hand. Four years. Five years. Six years. We won't go further. In fact, the last group—those taking six years—still comfortably beat the current average of 7.3 years. In the United States, the average time required to earn a doctoral degree in science has lengthened markedly—by two years or more—over the past three decades.

Moreover, the emphasis has shifted from development of the student to production of publications, posters, and meeting abstracts. Results have always been important. After all, it was Michael Faraday whose motto was "Work. Finish. Publish." But publications have not always been everything in graduate school.

When students of ambition, energy, and talent look at the current system of graduate education, many opt for other ways to develop a career, ways that allow them to see quicker results and to become professional sooner and on a defined timeline. Moreover, the system is so tightly focused that it tends to eradicate fascination in students as they proceed, and that is a real shame. We need to find ways to shorten graduate education and to breathe life back into it.

I see the system, as it has evolved, as a major threat to the health of science, not only in America, but globally. Of course, none of this is the fault of the predominantly undergraduate institutions. I suppose you can blame me and places such as The University of Texas at Austin. You can and you should put pressure upon us to fix it.

Let me close with some news of the "silver-lining" variety. In January 1999, I was invited to speak at a technology summit in Austin, Texas. The entrepreneurs in the room had great faith that their businesses represented the future of the Texas economy, indeed the global economy, and that the University was outdated and much too slow to change. They wanted degree programs, course availability, research partnerships, continuing education programs, and faculty-consulting arrangements—all tailored to corporate needs of the time. I made the comment that universities had been with us for 900 years because they are quite adept at adaptation, and that the University of Texas at Austin would continue to operate long after most of the organizations represented in the room had ceased to exist. This was not a well-received comment. The conferees threw whiffle balls at me in protest. As a university president, I don't get thrown at all that often. At least not by business executives.

This week, about 30 months later, as I drove to the airport to attend this meeting, I passed the idle carcass of an abandoned skyscraper in downtown Austin—the Intel Building. All across the city, companies with names like Zillions.com and Cappuccino.com are going out of business. There is much bad news in all of this, not least that 401(k) accounts may be declining. The better news is that a lot of those young minds that might have been tempted into information technology and computer science may now end up studying chemistry, biology, and physics. It's up to us to create the excitement that will entice them, fascinate them, and reward them.