

**Research Universities and America's Future
Commencement Remarks—Indiana University
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It is a great pleasure to be back at Indiana University. I spent four years of my life as a student on this campus, and they were truly inspiring and formative years. The faculty was outstanding, at the leading edge of their disciplines, and they set high standards for their students. I should add that I met my wife at IU, we were married while we were both students here, and last summer we celebrated our 56th wedding anniversary.

Since leaving IU, I have kept a close watch on the institution, and there is no question in my mind that it is one of America's finest universities. I have often wondered if the citizenry of Indiana—or the Indiana legislature—quite recognizes the excellence of the institution and the remarkable contributions its graduates and faculty have made to society. When I was here as a student, William Bryan was still alive. He had served as president of IU for 35 years and, although retired, was still active on the campus. The president at that time was Herman Wells who had a 25-year career leading IU. Presidents Bryan and Wells were great academic leaders and their long tenures as president did much to establish a tradition of academic excellence at IU. I should add that your current president—Michael McRobbie—is very much in that tradition of great university leaders.

So, to the graduates, let me congratulate you on receiving your degrees from IU. The course of study you have completed was rigorous, challenging, and at the forefront of developments in your field. You and your family can be proud of what you have accomplished and of the fact that you are graduating from one of America's leading research universities.

Note that I have used the term “research university” to describe this institution. According to the Carnegie Foundation for the Advancement of Teaching, there are well over 4,000 institutions of higher education in the United States. However, only about 50 institutions qualify as research universities. What do we mean by the term research university? It is an institution that has both undergraduate and graduate curricula; but the critical element is the fact that the institution places special emphasis on original research—research, conducted by faculty and students, that contributes to basic knowledge in the sciences, the humanities, and the arts. Because the faculty are involved in research, there is a spirit of inquiry and discovery that amplifies the excellence of the students' educational experience.

The Council of Economic Advisors to the President of the United States recently released a report stating that 50% of America's economic growth since World War II was due to investments in research and development (R&D)—namely, the array of activities involving basic research, applied research, and the development of new products and processes. Basic research is motivated by the researcher's curiosity about some aspect of nature. It is not carried out to solve practical problems, but rather to acquire knowledge for knowledge's sake. Basic research lays down the foundations for applied research

leading, in turn, to the development of new products of commercial value. We cannot foresee where basic research will lead, or the practical applications that may follow. But experience has proven that a nation cannot have a strong and viable R&D enterprise without a significant investment in basic research. In the United States, the private sector—corporations and industry—is the major supporter of both applied research and development, but research universities are the wellspring for basic research.

However, until World War II universities were decidedly on the side lines of the nation's R&D effort. Their ascendance was due to the remarkable contributions they made to the war effort. The atomic bomb, high frequency radar, sonar, proximity fuses, penicillin, cryptography to name a few—developments in which university scientists played a key role, either at their university or at a national laboratory managed by a university (e.g., Los Alamos or Lincoln Laboratory). The military, Congress and President Roosevelt were well aware of the decisive role university research played during World War II. What followed was a proposal to use the experience of the war years to craft a new strategy for the nation's R&D. That strategy was formulated in a 1945 report entitled *Science: The Endless Frontier*, which established both the legitimacy and the need for federal funding to support basic research at select universities.

According to the metaphor used in the report, university basic research should maintain and replenish the pool of knowledge on which industry could draw. The report argued that industry lacked the economic incentives either to perform or support the bulk of basic research that would be required in the post-war era. And that it was in the nation's long-term interest to have the federal government ensure that there was adequate funding for basic research. Economic incentives provided by the marketplace ensured that industry would invest in applied research and development, but such incentives were not relevant for basic research.

In capsule form, those were the proposals put forth in *Science: The Endless Frontier*. Applied research and development were the responsibility of the private sector (i.e., corporations and industry). The funding of basic research was the responsibility of the federal government, but the actual research should be carried out at select American universities. The nation's adoption of this model for R&D created a sea change for universities. Today research universities and the basic research they produce are at the center of America's R&D efforts. With a few caveats, the R&D arrangement I have described is unique to the United States. No other nation depends on its universities to the extent we do for basic research. Several nations have attempted to follow our example, but with limited success. I do sometimes worry that the current financial crisis might cause the federal government to severely cut back its support for basic research; hopefully, the well-documented role of R&D in our economy will dissuade any such action.

The last 50 years were marked by stunning change and progress, much of it driven by research at universities such as IU. Wireless communication, ubiquitous computing, nanotechnology, digitized DNA, and biopharmaceuticals are a few examples. What will the next 50 years bring? A recent book with the odd title, *The Singularity Is Near*, offers an interesting perspective on that question. The author is Ray Kurzweil, a scientist and inventor who has had an excellent track record of anticipating new developments. In the early 1980s he predicted the explosive growth of the Internet and also a computer chess champion by 1998. He was off by a year for the computer chess

champion—IBM’s Deep Blue chess victory occurred in 1997. Now he is predicting that solar power will be competitive with fossil fuels in 5 years and that within 20 years all our energy will come from clean sources. Within 10 years there will be drugs that let us eat freely without gaining weight, and within 15 years our life expectancy will increase as fast as we age.

The term “singularity” can be easily explained in terms of an exponential function—a curve that increases fairly slowly at first, but at a certain point (at the knee of the curve) bursts off at an explosive rate. That explosive change at the knee of the curve is called a singularity. This definition is not quite correct mathematically, but it’s close enough.

Kurzweil argues that the change we have experienced during the last 50 years represents the first stage of the exponential function—gradual incremental growth—and that we are now near the knee of the curve and about to witness explosive change. In his view, within several decades information-based technologies will encompass all human knowledge and proficiency, ultimately including pattern-recognition, problem-solving skills, and the emotional and moral intelligence of the human brain. His book provides a thoughtful analysis of various fields of research and makes a case that indeed “the singularity is near”.

The changes we have seen over the last 50 years will be overshadowed by the changes that today’s graduates will experience in the next 50 years. Perhaps this generation of graduates should be called the “singularity generation”, because they are coming of age in an era that will be defined by unprecedented change. Some people may claim that such change will be dehumanizing. On the contrary, I believe it will enrich human consciousness and ennoble the human spirit.

At this moment our nation is facing a financial meltdown, but when today’s graduates look back 50 years from now the current economic crisis will be long forgotten, and the progress and innovations of their generation will dominate their thoughts. Once again, congratulations to the graduates, members of the singularity generation. You have great opportunities ahead and your education at a very special university has prepared you well for America’s future.