U.S. House of Representatives
Committee on Education and the Workforce

"Challenges to American Competitiveness in
Math and Sciences"

May 19, 2005

Mr. Chairman and members of the Committee,

Thank you for the opportunity to appear before you today. I should perhaps begin by noting that I am representing only myself and am here because I, like you, care deeply about the future of our nation. Further, I have three grandchildren who will live in the world we are in the process of creating.

In addressing the future quality of life in America one cannot help but notice warnings of what appears to be an impending Perfect Storm. The elements which underlie this possibility are, first, the pervading importance of education and research in the fields of science and technology to America's standard of living, and the disrepair in which we find many of our efforts. Second, the precipitousness with which a lead in science and technology can be lost. Third, the prolonged period of time it takes to recover once a lead has in fact been lost, if indeed it can be regained at all. I would like today to briefly discuss each of these considerations.

A number of studies have shown that over half the jobs created in America during the past half century were the direct consequence of earlier investments in science and technology. That is, the ability to provide jobs for our citizen's and support their standard of living can be seen to depend to a very substantial degree on our nation's competitiveness in science and technology. But modern science and technology do not respect geopolitical borders. We all know that if we buy a camera or television set there is a high probability it was built abroad. But this trend has not stopped with manufacturing. For example,

> A patient in a U.S. hospital today may well have their x-ray interpreted by a doctor in India.
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> Visitors to a company located a few yards from the White House are greeted by a receptionist in Pakistan whose image is seen on a flat-screen video display.
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> A person in Wichita calling the help-line of a U.S. company is assisted by a technician in India.
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> A patient undergoing surgery in an American hospital is operated on by a robot directed by a world-class surgeon seated in another part of the room; a surgeon who could one day just as easily be located in China.

Turning to National Security, the Hart-Rudman Commission, on which it was my privilege to serve, stated in its final report that ". . . the inadequacy of our system of research and education poses a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine." It is noteworthy that this was a principal finding of a panel established by the Congress to investigate national security; not research or education.

In short, whether we are addressing the creation of jobs, the provision of homeland security, the supplying of energy, the delivery of health care, or almost any other important challenge confronting our society, much of the solution will have to be found through American preeminence in science and technology.

Turning to the second consideration, the rapidity with which our scientific and technological seed-corn becomes obsolescent, it has been noted that the time between the introduction of entire new generations of dynamic random access memories, the building blocks of the modern electronics industry, is only about 30 months. Intel has said that nearly 90 percent of the products it sells today did not exist a year ago. The "half-life" of published research articles in scientific and technical fields, as measured by the frequency with which they are cited, is about two to five years depending on the field. Similarly, the subject matter reflected in university course catalogs in these fields ranges from three to ten years. Even consumer product companies, makers of such everyday items as soap, toothpaste and diapers, are critically dependent upon their prowess in research and development. The retired CEO of Procter and Gamble has described his firm as primarily an R&D company.

Third, with regard to seeking to recover from any ill-advised attempt to under-invest in research and education, it takes a very long time to produce additional productive research scientists. A youth wishing to become a mathematician, scientist or engineer must decide in ninth grade to take courses which preserve the option to pursue a career in any of these fields. This is a consequence of the hierarchical and interdependent character of a science or technology education. Further, the "leakage" rate in the process of producing credentialed researchers is very high indeed. In the field of mathematics, for example, based on current trends one must begin with 3,500 ninth-graders in 2005 to produce 300 freshmen qualified to pursue a degree in mathematics. Of these, about 10 will actually receive a bachelors degree in the field. Finally, one PhD in mathematics will emerge in about 2019.

How well equipped is America to deal with these challenges? On the positive side, we have built what is generally recognized to be the world's finest higher education system, but it is noteworthy that over half the PhD's awarded in engineering in our universities are granted to foreign citizens. Until recently, many of these talented individuals remained in America and became major contributors to our society, but more recently fewer foreign students are enrolling in America's universities and of those who do more are returning home once their academic work is completed. Further, only 20 percent of bachelor's degrees in engineering are received by women; still fewer by minorities, with the consequence that this major potential source of talent goes underutilized.

Even in this age of burgeoning technology the number of graduates with bachelor's degrees in the physical sciences, mathematics and engineering has been declining for two decades. China now graduates about 200,000 engineers a year; India and Japan, 100,000 each; the United States, 50,000. In the U.S., five percent of all bachelors degrees awarded are in engineering. In China, the corresponding figure is 40 percent. In Singapore, the fraction is still higher.

A few years ago, when America did not finish in its traditional first-place in Olympic basketball the uproar could be heard throughout the nation. How should American's feel about being in 15th place out of 16 nations in the advanced math, based on international examinations of high school seniors? Or about finishing 16th out of 16 in science?

But talent is only part of the issue. The other part concerns investing in our universities the funds needed to benefit from that talent. Our government has done a superb job in recent years of

strengthening research in the health sciences, but somehow over the last several decades the physical sciences, math and engineering have been neglected. It too often goes unrecognized that much of the recent progress in the health sciences, has been underpinned by earlier achievements in mathematics, the physical sciences and engineering. Deciphering the human genome, for example, was heavily dependent upon advancements in robotics and computers. The development of modern imaging machines was made possible to a great extent by advancements in engineering and mathematics.

I recently had the occasion to visit factories in Vietnam where the wage of the lowest-level assembly workers was about 25 cents an hour. Factories that had moved from the U.S. to Mexico a decade ago are now moving from Mexico to Asia. But the trend does not end with factory workers: today one can hire eleven well-educated engineers in India for the price of one in America. Further, the exodus that began with assembly workers and then spread to software designers is now moving to the most advanced research laboratories. The U.S. for the first time has a negative trade balance even in high-tech products, and the jobs associated therewith are fast becoming one of our larger exports. Let me emphasize that this not a partisan issue – it is the result of a decades-long trend that will take decades to fully correct.

What, then, must America do? There is but one answer: We must compete. And we must do so while suffering a disadvantage in the cost of labor. We must be more innovative than ever before; we must have a vastly better K-12 educational system then we now have; we must unburden our companies from excessive regulation, litigation and health-care costs; we must significantly increase our federal investment in research.

I would offer the following eight recommendations as a starting point:

1. Bring the Free Enterprise System to K-12 education in America. This system, along with Democracy, is what has made America great and it can make our public schools great once again. We must introduce competition among schools, administrators and teachers. We must lengthen the school year. We must pay teachers for performance and pay them in accordance with their important contribution to society of preparing the nation's youth for productive, rewarding lives. We must establish standards, standards that have consequences. This works in our companies and in our universities and it will work for K-12.

2. Provide K-12 teaching credentials to subject-matter experts who successfully complete a brief program to acquire and demonstrate fundamental teaching skills. There is a certain irony that upon retiring from my own career in engineering and business I was permitted to teach in the Engineering School at Princeton but would not have been permitted to teach ninth-grade math or science in most of our nation's public schools.

3. Initiate an America's Scholars Program which will fully fund the undergraduate and graduate education in the physical sciences, math, biosciences or engineering of the outstanding 1,000 high school seniors in the nation each year who score the highest on a standardized examination and maintain that high degree of excellence during the remainder of their education.

4. Double in five years federal spending on basic research in mathematics, the physical sciences and engineering. It should be noted that the steady-state cost of doing this is, in the overall scale of things, modest, equaling the amount by which health care costs in America increase every two months.

5. Provide non-citizen graduates of America's universities in the fields of science and technology special consideration for visas, work permits and, especially, citizenship. Offer expedited entry processing to foreign-born scientists and engineers who seek to work in America.

6. Provide a tax credit to corporations that fund basic research in science and technology at our nation's universities.

7. Provide tax incentives to companies that fund continuing education for their employees in science and technology. This is particularly important if members of the science and technology workforce are to remain productive throughout their entire careers.

8. Revise the capital gains tax law such that, in a manner neutral to overall tax generation, gains on assets held for less than six months are taxed at a very high rate, assets held ten years or more are untaxed, and those in-between are taxed in a continuous fashion between these limits.

Finally, and most difficult to accomplish, America must change its attitude toward careers in science, technology and teaching. Probably everyone in this room knows who Allan Iverson and Shaquille O'Neill are. But how many know who Bob Noyce and Jack Kilby are? The latter two arguably affected the lives of Americans in a manner matched by only a handful or so of people who lived in the previous century.

We are living in a time of intense competition, a time in which the quality of life in America will be severely tested. In this regard, I would like to close with a poem by Richard Hodgetts that I used to quote to my colleagues at Lockheed Martin who were chosen to represent our company in intense business competitions. It goes as follows:

> Every morning in Africa a gazelle wakes up.
> It knows it must outrun the fastest lion or it
> will be killed.
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> Every morning in Africa a lion wakes up.
> It knows it must outrun the slowest gazelle
> or it will starve.
>
> It doesn't matter whether you're a lion or a
> Gazelle, when the sun comes up, you'd
> better be running.

Thank you.

Norman R. Augustine is the retired Chairman and CEO of the Lockheed Martin Corporation and a former Under Secretary of the Army. He serves on the Boards of Black and Decker, ConocoPhillips and Procter & Gamble and has been a trustee of MIT and Princeton and is currently a trustee of Johns Hopkins. He was a founder of the Maryland Business Roundtable for Education, chaired the (National) Business Roundtable's Education Initiative and has been Chairman of the National Academy of Engineering. He has served as a Lecturer with the Rank of

Professor at Princeton and is a recipient of the National Medal of Technology. He holds eighteen honorary degrees.