Testimony of

Norman R. Augustine

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"Five Years of the America COMPETES Act:

Progress, Challenges, and Next Steps"

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Mr. Chairman and members of the Committee, thank you for inviting me to appear before you today and in particular to do so in the presence of such a distinguished group of colleagues.

I should begin by noting that I am not here representing any of the organizations with which I have been associated, but rather appear simply as a private citizen. I have chosen to devote a considerable part of my retirement to what I consider to be among the very most important issues affecting the future of America: namely, its competitiveness. This is a topic that has enjoyed strong bipartisan support—support that has made it possible to implement some of the recommendations that have been offered by organizations such as the Council on Competitiveness and the National Academies of Science, Engineering and Medicine in their document commonly referred to as the "Gathering Storm" report.

The quality of life of America's citizens is to a considerable degree founded upon their opportunity to find and hold quality jobs. Further, it is those jobs, and the firms that provide them, that generate the tax revenues which enable our government to provide the services upon which our citizens so heavily depend, including national security, protection against terrorists, healthcare, a modern physical infrastructure, and much more.

In fact, it is about jobs that I would like to speak today. Underlying any such discussion is the truly remarkable change that has taken place in the employment market in the past few decades and now seems to be accelerating. This change, in my judgment, has been brought about largely by two developments in science and technology. The first of these is the highly expanded use of modern commercial jet aircraft that make it possible to move things, including people, around the world at nearly the speed of sound. The second is the revolution in information systems that has made it possible to move knowledge…ideas, data, text…around the world literally at the speed of light.

A problem with a computer in New York can now be resolved by contacting an expert in Bangalore. A CAT-scan recorded in Chicago can be read by a radiologist in Sydney or Mumbai—while you wait. A surgeon in New York can remove the gall bladder of a patient in Paris using a remotely controlled robot. A video made in California can contribute to riots halfway around the world.

It is a world in which distance no longer matters. Americans no longer simply compete for jobs with their neighbors around the block, but rather with their neighbors around the globe. If one needs a car, it can readily be obtained from Japan, Germany or Korea. If one needs software, it can be written in India and sent, in a few milliseconds, back to the U.S. If one needs flowers, they can be delivered overnight from Holland.

The critical question, of course, is how well we as a nation are adapting to this new reality. That is in fact the question that was asked approximately seven years ago of the National Academies on a bipartisan basis by members of this body and the House of Representatives. The essence of the Academies' assessment as contained in the Gathering Storm report is that "Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position. For the first time in generations, the nation's children could face

poorer prospects than their parents and grandparents did. We owe our current prosperity, security, and good health to the investments of past generations…"

Intel's Howard High's comments in this regard are fairly representative: "We go where the smart people are. Now our business operations are two-thirds in the U.S. and one-third overseas. But that ratio will flip over in the next ten years." Or, in the words of DuPont's then-CEO, Chad Holliday, "If the U.S. doesn't get its act together, DuPont is going to go to the countries that do." Bill Gates has said, "We are all going where the high I.Q.'s are."

The Academies' report offered 20 explicit, actionable recommendations to reverse the current decline in competitiveness, the top two which, in priority order, were to repair the U.S. K-12 public education system and to significantly increase the nation's investment in basic research. The reason for this emphasis, as viewed by the members preparing the report, is that the K-12 system is currently the weakest link in producing the Human Capital needed for Americans to compete for jobs in a global economy, and investment in basic research is the enabler that leads to the Knowledge Capital that underlies a substantial portion of job creation. Worthy of note, the U.S. has long enjoyed a significant advantage in the availability of Financial Capital with which to underwrite innovation; however, Financial Capital today travels at the speed of light, without regard to political borders, as it seeks opportunities.

In one of the Gathering Storm reports the National Academies itemized factors that it considered to play a major role as corporations determine where to establish new research laboratories, engineering facilities, factories and logistics centers. Although the factors were by no means of equal importance, in ten of the twelve factors the U.S. was ranked as inferior to representative rapidly developing nations. The categories included, for example, the cost of labor…an area where Americans are accustomed to receiving wages that exceed global averages by *factors* of as much as ten or even more for assembly workers and five to ten for scientists and engineers.

Given these considerations, many researchers who have studied the revolution in competitiveness have concluded that the United States' competitive advantage will have to reside in superior innovation: that is, creating new knowledge through leading-edge research; transforming that knowledge into goods and services through world-class engineering; and being first to the marketplace with those goods and services through extraordinary entrepreneurialism.

With regard to Human Capital, in the most respected international test U.S. students now rank in 14th place in reading, 17th in science and 25th in mathematics. Needless to say, this is not a formula for success in the jobs race. Yet, the U.S. spends more per public school student than all but two other nations. The issue is not *what* we spend, but *how* we spend it. The most important two actions we could take to improve the situation are to bring the Free Enterprise System to K-12 education and to assure that every classroom has a teacher who possesses a core degree in the subject being taught. Teaching our children should be the most respected profession in America.

Turning to the subject of creating knowledge, significant growth in basic research funding followed the initial passage of the America COMPETES Act; however, investment in

this endeavor has once again waned, particularly when inflation is included. Federal funding of basic research at universities and university research centers declined by 5.6 percent during the past year.

Margaret Thatcher described the importance of basic research in the following terms:

> "…although basic science can have colossal economic rewards, they are totally unpredictable…the value of Faraday's work today must be higher than the capitalization of all shares on the stock exchange … The greatest economic benefits of scientific research have always resulted from advances in fundamental knowledge rather than the search for specific applications … transistors were not discovered by the entertainment industry … but by people working on wave mechanics and solid state physics. [Nuclear energy] was not discovered by oil companies with large budgets seeking alternative forms of energy, but by scientists like Einstein and Rutherford …"

Today, the iPhone, internet, GPS, solar power, nuclear power and far more owe their very existence to the work conducted over many years by scientists pursuing such fields as solid-state physics and quantum mechanics. It is likely that none of these scientists were thinking about such devices when they performed their work…but this is the nature of basic research.

Although I emphasize the importance of science and technology in these remarks, I would hasten to add that the single most important academic subject we can teach our children is how to read, since that is the basis of almost all learning. But it is also important to provide our youth, including our scientists and engineers, with a sound understanding of history, literature and ethics so that they can use their talents for the good of humankind.

Nonetheless, a number of studies have found that between 50 percent and 85 percent of the growth in America's GDP in recent decades can be attributed to advancements in science and engineering. Similarly, it has been shown that about two-thirds of the growth in U.S. productivity can be attributed to advancements in these same two disciplines. The challenge is not, *per se*, to increase jobs for scientists and engineers; only four percent of the U.S. workforce is composed of scientists and engineers. Even doubling that number would not have an overly profound impact on the U.S. employment outlook. The point is that that four percent disproportionately generates jobs for the other 96 percent of our citizenry.

A recent study reported in the Journal of International Commerce and Economics states that (in 2006) the 700 engineers working on Apple's iPod were accompanied by 14,000 other workers in the U.S…and nearly 25,000 abroad. Floyd Kvamme, a highly regarded entrepreneur, has said that "Venture capital *is* the search for good engineers." Steve Jobs told the president of the United States that the reason Apple employs 700,000 workers overseas is because it can't find 30,000 engineers in the U.S. Data presented in the Chronicle of Higher Education reveal that during the past 30 years, an era of burgeoning importance of science and technology, the percentage growth in engineers ranks 27th among the 31 fields of study listed.

Perhaps the great irony is that America is never again likely to suffer a shortage of engineers. America's corporations have found a solution to that challenge which satisfies their shareholders. Simply stated, "If engineers are not available in America, simply move the engineering work abroad where there is in fact a rapidly growing body of qualified individuals." Similarly, in a world where distance does not matter, research can be moved abroad, and so can prototyping, manufacturing and logistics. In fact, an additional reason for doing so is to be near to one's customers and it has been estimated that by the mid 2020's there will be twice as many middle-income consumers in China as there are inhabitants in America. It has further been estimated that within a decade 80 percent of the world's middle class will reside in what are now categorized as developing nations.

It is occasionally argued that America is producing too many scientists. That, of course, is true. If one sufficiently under-invests in research then one will indeed have too many scientists. "If one does not purchase gasoline, there will be no need for cars."

Today, only about 15 percent of U.S. youth who *actually graduate* from high school (and nearly one-third do not) have the credentials to even *begin* a college curriculum in engineering. Of those who do begin, about 60 percent do not finish their studies in the that field. Additionally, the unfortunate fact is that U.S. youth show a surprising disinterest, even disdain, with respect to the study of science and engineering, notwithstanding their fascination with video games, television, automobiles and most other products of science and engineering.

A recent study by the National Science Foundation notes that in terms of the fraction of baccalaureate degrees that are granted in the field of engineering, the U.S. now ranks 79th among the 93 nations included in the study. The nation most closely resembling the U.S. in this regard in both engineering and science is Mozambique. The only countries that rank behind the U.S. are Bangladesh, Brunei, Burundi, Cambodia, Cameroon, Cuba, Gambia, Guyana, Lesotho, Luxembourg, Madagascar, Namibia, Saudi Arabia and Swaziland.

In the past America has been able to excel in science and engineering in considerable part because of its ability to attract outstanding foreign-born individuals to our universities and encourage them to remain and contribute to the creation of domestic jobs. In fact, about two-thirds of those receiving doctorates in engineering from U.S. universities have been foreign-born. However, this circumstance is beginning to change as opportunities for scientists and engineers expand abroad. Foreign graduate students now indicate much more frequently an intent to return to their native countries upon receiving their degrees and gaining a few years experience in the U.S. Our nation's policies regarding such matters as the granting of H1-B visas are exacerbating this problem.

Some individuals, particularly strong believers in the free-market system, simply say, "Let the free-market solve the problem." But the problem is that the free-market *is* solving the problem … it is just not doing so in a fashion that most Americans will like.

So what should we do? The answer is straightforward: we as a nation must *compete.* And that, of course, is what the America COMPETES Act is all about. Renewing the COMPETES Act is of the utmost importance. I cannot over-emphasize that fact. But as a

mathematician might say, it is a necessary but not sufficient condition. We must also follow-through. In that regard, a very good beginning took place under the administrations of both President Bush and President Obama. Upon initial passage of the America COMPETES Act, investment in basic research increased, as did scholarships for future STEM teachers. ARPA-E was established, albeit under-funded. However, with the decline of the economy much of that progress has now waned. Meanwhile, U.S. corporations continue to spend over twice as much on litigation as on basic research; the pressures of the stock market cause U.S. firms to discount future investments such that research funding is greatly diminished; firms remain burdened with high medical costs and what recently became the highest stated corporate tax rate in the world.

When the Gathering Storm study was first published, as its chairman I was often asked to speak to government gatherings in other countries, ranging from Australia to Saudi Arabia to Singapore to Canada. Not only were these nations listening, many took action. Today, America's continuing decline in competitiveness is due not only to our own lack of aggressive action but to the fact that others are accelerating their competitiveness strategies.

When the committee preparing the Gathering Storm report issued its second assessment five years after the first report, it concluded that America had fallen even further behind during the intervening period, noting, for example, that another six million students had dropped out of U.S. high schools during that period, placing themselves in positions of little opportunity to obtain quality jobs or to contribute to the creation of jobs for others.

But as if these challenges were not sufficient, an altogether new problem has arisen since the Gathering Storm report was prepared. This new challenge deals with an issue that, to the best of my knowledge, was unforeseen by any of our committee's members—most assuredly not by myself.

We had noted in our report that our nation's great research universities were among America's most significant assets in the crusade to create jobs—along with our freedom and our free enterprise system. It is noteworthy that it is our universities that produce the talent we need to compete as well as much of the knowledge. Even today, according to *The Times of London*, the top five universities in the entire world and 18 of the top 25 are located in the United States.

But these same institutions are now endangered. The share of their operating expenses funded by state governments is rapidly declining and now represent the lowest fraction of such resources in a quarter of a century. In three decades state financial support of higher education as a fraction of personal income has, on average, declined by 71 percent.. One result is, for example, that at the highly regarded public universities in California, tuition and fees have grown by 240 percent in the past dozen years. Throughout the nation tuition and fees at public universities have increased by an average of 85 percent over the past decade, *net of financial aid.*

Faculty have on average seen their salaries decline by 1.2 percent during the past year—not including the effect of inflation; layoffs are not uncommon among junior faculty; and teaching loads are increasing. This reduction in state support is, in effect, privatizing our public universities—with much of the cost being shifted to the students—thereby fundamentally threatening the continuation of the American Dream. On the other hand, it may be appropriate

for our universities to reconsider their own priorities and even their *raison d'être*. According to *USA Today*, major college football coaches receive an average compensation of $1.47 million per year, "a jump of nearly 55 percent in six seasons."

Such developments have led institutions of higher education in many other nations to prepare lists of exceptional faculty members in the U.S. whom they might attract to their countries. One foreign university that I recently visited had added 14 new senior faculty…of whom 13 came from America. The attractiveness of such offers is facilitated, in the case of engineering, by the fact that 40 percent of U.S. faculty members were born abroad.

But there is still more. A tsunami of an altogether different kind is now beginning to engulf America's universities. For some two centuries higher education around the globe has largely consisted of a professor, a library, a blackboard and a piece of chalk… seemingly managing to resist change with a truly remarkable tenacity. But now, when distance no longer matters, students carry entire libraries in their pockets and have access to extraordinary professors located throughout the world. Not long ago three courses at Stanford were offered online and 350,000 students from 190 countries promptly signed up. Although no degrees were offered, no tuition was sought.

It seems foregone that America's universities are going to have to remake themselves, and how well they are able to do so will have either a profound positive or negative impact on America's overall competitiveness. As this occurs, it will be of the utmost importance for government at all levels to recognize this challenge and, among other things, provide adequate funding of basic research; appropriately fund operating budgets; pay the true cost of research grants; increase need-based financial aid; and enable private universities to continue to build their endowments.

Several years ago while I was testifying before a committee of the Congress in support of increased funding for education and research a member asked whether I understood that America was suffering a budget crisis. I responded that I of course was aware of that circumstance, but that as an aeronautical engineer, during my career I had worked on a number of airplanes that during their development programs were too heavy to fly. Never once did we solve the problem by removing an engine. In the case of creating jobs for Americans, it is research, education and entrepreneurialism that *are* the engines that propel the creation of jobs.

Over the years, my experience in business has taught me that even during difficult times when budgets are being cut, and I indeed saw such times when, for example, during about a five-year period some 40 percent of the employees in our industry and three-fourths of the companies departed, some areas must be provided additional funds. The point is that one must continue to invest in the future, even during hard times. The key is to distinguish between spending for consumption and spending for investment.

Again, thank you for the privilege of sharing these views with you.

NORMAN R. AUGUSTINE was raised in Colorado and attended Princeton University where he graduated with a BSE in Aeronautical Engineering, magna cum laude, and an MSE. He was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi.

In 1958 he joined the Douglas Aircraft Company in California where he worked as a Research Engineer, Program Manager and Chief Engineer. Beginning in 1965, he served in the Office of the Secretary of Defense as Assistant Director of Defense Research and Engineering. He joined LTV Missiles and Space Company in 1970, serving as Vice President, Advanced Programs and Marketing. In 1973 he returned to the government as Assistant Secretary of the Army and in 1975 became Under Secretary of the Army, and later Acting Secretary of the Army. Joining Martin Marietta Corporation in 1977 as Vice President of Technical Operations, he was elected as CEO in 1987 and chairman in 1988, having previously been President and COO. He served as president of Lockheed Martin Corporation upon the formation of that company in 1995, and became CEO later that year. He retired as chairman and CEO of Lockheed Martin in August 1997, at which time he became a Lecturer with the Rank of Professor on the faculty of Princeton University where he served until July 1999.

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years, Chairman of the Council of the National Academy of Engineering, President and Chairman of the Association of the United States Army, Chairman of the Aerospace Industries Association, and Chairman of the Defense Science Board. He is a former President of the American Institute of Aeronautics and Astronautics and the Boy Scouts of America. He is a former member of the Board of Directors of ConocoPhillips, Black & Decker, Proctor & Gamble and Lockheed Martin, and was a member of the Board of Trustees of Colonial Williamsburg. He is a Regent of the University System of Maryland, Trustee Emeritus of Johns Hopkins and a former member of the Board of Trustees of Princeton and MIT. He is a member of the Advisory Board of the Department of Homeland Security and the Department of Energy, was a member of the Hart/Rudman Commission on National Security, and served for 16 years on the President's Council of Advisors on Science and Technology. He is a member of the American Philosophical Society, the National Academy of Sciences and the Council on Foreign Relations, and is a Fellow of the National Academy of Arts and Sciences and the Explorers Club.

Mr. Augustine has been presented the National Medal of Technology by the President of the United States and received the Joint Chiefs of Staff Distinguished Public Service Award. He has five times received the Department of Defense's highest civilian decoration, the Distinguished Service Medal. He is co-author of *The Defense Revolution* and *Shakespeare In Charge* and author of *Augustine's Laws* and *Augustine's Travels*. He holds 29 honorary degrees and was selected by Who's Who in America and the Library of Congress as one of "Fifty Great Americans" on the occasion of Who's Who's fiftieth anniversary. He has traveled in 111 countries and stood on both the North and South Poles of the earth.