Testimony
House Armed Services Subcommittee on Terrorism, Unconventional Threats and Capabilities
"Harnessing Technological Information: Challenges and Opportunities"
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Let me being by thanking the committee for this opportunity to testify before it on this important subject. I am going to make four points in my testimony that I will summarize for you now. First, technological leadership has contributed to U.S military superiority and economic strength for more almost seventy years. It is crucial for U.S. economic and military strength. Second, globalization and other changes means that U.S. share of innovation will decline, as other nations increase their efforts in science and technology. Third, U.S. policies reinforce this decline. These policies include under investment in science, a more difficult regulatory climate, and the unintended effects of many of the policies put in place since September 11, particularly in regard to immigration and technology transfer. Fourth, while the U.S. faces challenges when it comes to technological leadership, some of its own making, it also has opportunities to respond in ways that will advance its security and economic interests.

The key to technological leadership is innovation. Continued technological leadership depends on the U.S. capacity to innovate. Innovation is the ability to use knowledge to create new or better goods and services. The U.S. innovation system, with its mix of university research, entrepreneurship and venture capital is crucial for a steady flow of ideas that benefits both the commercial market and a military that often relies on commercial technology. The U.S. has been one of the world leaders in innovation, and our political and social makeup may provide America with something of an advantage over other nations when it comes to the ability to innovate. The question is whether this comparative advantage is, by itself, enough in an era of heightened global competition.

The first thing to note, perhaps, is that there is a strange anomaly in these concerns over the potential loss of technological leadership. That anomaly is that the U.S. spends more than any other nation on science and on research and development. The U.S. spends more that the next five nations combined. It is reasonable to ask how there can be a problem when we are spending so much more than other nations.

The answer is also relatively simple. We are not spending enough to maintain our lead, and we are not spending enough on the things needed for military technology. While our spending levels are flat, spending in other nations is increasing. If these trends continue without change, the long term result will be that the U.S. will no longer have the lead in important technologies.

The picture is complicated because, when it comes to research, nothing ever happens quickly. The results of misinvestment and underinvestment in science can take years to appear. We are coasting on the results of Federal spending from the 1960s and the 1980s, and the boost from that spending has not yet disappeared.

The picture is also complicated because the data is ambiguous. It is hard to measure innovation, so the normal practice is to use proxies, things that we know are part of innovation and science and which are easier to measure. Proxies for innovation include things like the numbers of patents awarded to a particular country, the number of Ph.Ds and engineers it graduates, or the number of scholarly articles published by its scientists. When we look at this data, it is not immediately clear that the U.S. is losing ground.

There are, however, some troubling trends. In a few key areas of research, scientists in other nations are publishing more than their American counterparts. The number of U.S. authored papers increasing by only 13% between 1988 and 2001 while the number of papers authored by Europeans increased by 60% (and Europe overtook the U.S.) while the number of papers authored by Asians more than doubled, increasing by 120%. Even more worrisome is that half of the U.S. publications were in the life sciences, whereas other nations were concentrated in the physical sciences. The age of our technological workforce in some key areas, like aerospace, is another troubling trend. Many scientists and engineers will retire in the next few years and will not be replaced. From an economic standpoint, this may not be bad – we do not want to train engineers only to find that there is no work for them – but from a national security perspective these are warning signs that suggest that the U.S. may want to consider whether if it is paying enough attention to the connection between science, technology and security.

Answering this question requires a look at the larger international environment. We are in a very different international environment. In political, economic and security terms, this environment is changing rapidly and in ways that we did not expect when the Cold War ended that challenge U.S. leadership and security.

Part of this challenge is the result of what we call globalization - the increasing integration of national economies into a single market. Globalization tends to diffuse technology around the world. Globalization has eroded the national character of science, as research is increasingly carried out by multinational teams, but it has not changed the need for nations to draw upon science for their security. Part of the challenge also comes from the rise of strategic competitors, national like China or India, and perhaps Brazil or even Europe in the distant future. These strategic challengers have seen how important science has been to U.S. military leadership and they seek to copy what we have done.

Saying that globalization creates security challenges can easily lead to the wrong conclusion. Some might argue that if we could slow or restrict globalization, the U.S, would be more secure. Unfortunately, this is completely wrong. First, globalization is the U.S.'s idea. It is the result of long standing foreign policies as to how the world should work – that a world based on free trade, rule of law and democratic government would ultimately be safer and more prosperous. Second, the U.S. has benefited as much or more from globalization as has any other nation. Finally, reversing globalization is out of the question unless we are willing to accept wrenching dislocations and a loss of wealth and power for the United States. The real question is how do we take advantage of the opportunities globalization creates while minimizing the risks that come with these opportunities.

Globalization is an opportunity and a challenge. A related opportunity and challenge comes from Asia's economic ascent. The nations that lie along the Pacific Rim are now the central focus of global economic activity. The U.S. is part of this, but the most dynamic growth has been in Asia, first with Japan, then with Korea and Taiwan, and now with China. Asian nations now hope to repeat their success in manufacturing in scientific research. If Asia is today the world's factory, its nations hope that tomorrow it will also be the world's laboratory.

Part of the challenge also comes from changes in the ways societies create wealth. The most important of these changes is the transition to an information economy. An easy way to understand this transition is to look at earlier examples. In the 1800s, we saw a transition from agriculture to industry and manufacturing. This transition meant that the best way to generate wealth lay in industry, not farming. Now we are seeing an economic transition from manufacturing to information. This means that the best way to generate wealth will be in the creation of new knowledge, not in industrial production. However, while this transition away from manufacturing may be good for the U.S. our economy, it does have implications for U.S. leadership in military technology.

The cumulative effect of these changes is to put U.S technological leadership under some pressure. Combined with problematic U.S. policies, they create a new kind of risk for national security. The best way to describe this risk is that the vigorous research and technological base that has given the U.S. a military advantage for decades is in danger of being eroded.

The U.S. and other nations realized in World War II that sustained scientific research provided military advantage. The United States created institutions in the 1940s and 1950s to support scientific research for national security, including DARPA, the service labs, the National Science Foundation and others. These Federal institutions build upon and are closely intertwined with America's strong University system, and the graduate research programs found at these universities. The U.S. system of innovation, with its mix of university and federal research, entrepreneurship and venture capital, provides a steady flow of ideas that benefits both the commercial market and a military and it is the envy of the world.

Two sets of problems put U.S. innovation at risk. Congress can play a central role in addressing both sets of problems. The first set of problems has to do with funding. The second set of problems has to do with regulation. Erosion of capabilities should come as no surprise that if the trends are to under-fund and over-regulate.

Funding for research is the most important of these problems. While the U.S. continues to lead in many research areas, its investments are not enough to sustain this lead over the next decade. The problem lies with the absolute levels of investment, the distribution of investment among research activities, and the rate of change relative to other nations. U.S. spending in scientific research areas that are key to national security is flat or declining while other nations are accelerating their spending. This is not a long-term strategy that is likely to produce success.

Federal funding for basic research in engineering and physical sciences has experienced little or no growth in the last thirty years. As a percentage of GDP, funding for physical science research has been in a thirty-year decline and has fallen by about half. Total federal funding for R&D

was essentially flat from 1988 to 2001. Spending on mathematics research was roughly $190 million in 1985 and $200 million in 2004; spending on physics was flat between 1985 and 2001 and there were only slight increases in funding for chemistry. Funding for engineering research increased from approximately $6 billion to $9 billion between 1988 and 2001, but funding for some key research areas, such as electrical engineering, remained essentially flat.

The effect on security of underinvestment is acute and damaging in specific research areas. These include physics, aeronautics, mathematics, computer sciences, and engineering. There are three reasons for emphasizing the dangers of underinvesting in these areas. First, research in these areas provides the basis for improved military performance. Second, in relative terms, these areas have been the most seriously underfunded. Third, advances in these research areas enable other areas of scientific research – by providing better sensors and measuring tools or improved computing power.

The problem of underfunding is compounded by changes in research and development in the Department of Defense and in the private sector. In the past, about three percent of DOD spending on procurement ultimately went to R&D. However, the decline in procurement of new equipment has reduced the amount of funds for technological innovation for the military. In addition, government and private defense R&D investments are skewed - understandably - toward near-term priorities (e.g., upgrades or replacements for existing systems) rather than fundamentally new capabilities. Additionally, some research problems are too expensive for any company to undertake. The combination of changing research priorities in DOD and the private sector means that some key research areas are not adequately funded.

Another set of U.S. policies also threatens technological leadership. These are changes in immigration policy. It is useful to remember that U.S. national security and military power was strengthened in the 20th century by an influx of foreign scientists fleeing unstable conditions in Europe. The universities and institutions that received these scientists became global leaders in research, a role which they continue to play. Having these leading universities benefits the U.S., as leading students from other nations come to the U.S. to study and contribute to research.

However, several factors have made the U.S. a less attractive destination for scientific talent than it once was. Measures imposed in the attacks of September 11 have the unintended consequence of deterring some researchers from coming to the U.S. Other changes prevent researchers form staying here once they complete their educations. This is particularly damaging - when a foreign student has completed their training and is ready to begin work, U.S. policy is to have them leave and work in another country. At the same time, other nations have recognized the economic and military advantages provided by scientific leadership and have attempted, with some success, to capture a greater share of scientific talent and to duplicate the success of research centers found in the U.S. This means that the U.S. faces new competition for scientific talent at the same moment that it policy is to discourage needs to compensate as foreign supplies of scientists and engineers shrink in the face of increased demand from other countries.

U.S. restrictions on technology transfer also works against maintaining technological leadership. In some areas, there are restrictions that prevent scientists from exchanging unclassified information or working together on research projects. In other areas, restrictions on U.S. exports

have encouraged other nations to invest in their own research and technologies. The unintended effect of these restrictions, and the restrictions on immigration, has been to create incentives for people to move research outside of the United States. The unintentional effect of some U.S. policies is to create new competitors.

It is worth noting that there is something of a tendency to overemphasize the negative in this debate - whether it is hand-wringing about manufacturing or the constant barrage of news and reports about the weaknesses of American elementary and secondary education. A few historical anecdotes help to illustrate this. In 1957, after the Soviet Union shocked the U.S. by launching the first satellite, President Eisenhower's science advisor predicted that because of the Soviet lead n math and science education, they would surpass the U.S. in ten years. He was wrong. In the 1980s, many pundits said that Japan's rapid growth, astute trade policies and dominance of manufacturing would make them the leading economic power within a few years. They were wrong as well.

Now we hear similar predictions about China and other nations. In thinking about these latest predictions, it is useful to ask why the Soviets or the Japanese did not succeed in displacing the U.S. Some of the reasons for this have to do with the weaknesses found in those countries. Every nation has strengths and weaknesses, and we want to be careful not to exaggerate or misinterpret. The U.S. has some unique advantages that other nations cannot match. China, India, Europe and the other competitors the U.S. faces today all have their own problems and handicaps.

A more important factor, however, in explaining why these predictions were wrong, is the U.S. response. In each case, the U.S. changed is policies and practices to respond better to foreign challenges to its technological leadership. In the late 1950s, government policy was most important and the U.S. responded with new programs to expand scientific and mathematical education. In the late 1980s, the private sector response was important as U.S. companies changed how they operated to become more competitive. The U.S. has had an advantage in its ability to blend public and private sector that other countries sometimes find hard to match. The lesson from this is that if the U.S. can find the right set of responses, the problems it faces today are eminently manageable.

There has already been some progress in the search for the responses needed for the new international environment. A number of eminent studies and commissions have reported and made their recommendations. The President announced the "American Competitiveness Initiative in his 2006 State of the Union Address. And both parties in Congress have put forward programs for strengthening innovation.

However, these are only initial steps. Both the government and the private sector still have much work to do. As the Committee contemplates next steps on the challenges and opportunities the U.S. faces in harnessing technology for national security, it may wish to consider these general recommendations.

First, make the promotion of innovation a benchmark and a goal for policy and law. This may require that the U.S. streamline and simplify the regulatory burden for innovation. The U.S.

tends not to ask whether a proposed action will accelerate or degrade its innovative capabilities. In the past, it could afford this but that may no longer be the case.

Second, the U.S. should look identify where government action is appropriate and can be effective. One area is in the funding for basic research in the physical sciences. Absent government support, the U.S. lead in these sciences will continue to decline.

Third, look for ways to expand and exploit our comparative advantage. Our market-oriented economy gives us an advantage over many countries, and policies that enable markets will help innovation. Measures that strengthen the institutions we have created to link science, technology and national security will provide immediate benefits. These institutions include – DARPA, the service labs, NSF and NIH, and of course the graduate research programs at our Universities and keeping them strong is crucial to American power.

Fourth, the U.S. would gain from initiatives that embrace international cooperation. The U.S has benefited greatly from globalization and efforts to restrict globalization will backfire. In defense, closer cooperation with allies in research, development and production can provide real advantages to national security.

All of these recommendations may sound very far from the Defense policy. They certainly are not conventional national security issues. The challenges the U.S. faces today are also not conventional. In this changing security environment, an accelerated ability to create new technologies will remain crucial to America's security.

I again thank the Committee for the opportunity to testify.