Written Testimony of John Hennessy
Committee on Foreign Affairs
Friday, January 15, 2010

Good morning, Mr. Chairman and members of the Committee. My name is John Hennessy. I am president of Stanford University and served as co-chair of the National Academies' Committee on Science, Security and Prosperity. In January 2009, the National Academies released the committee's report, *Beyond "Fortress America": National Security Controls on Science and Technology in a Globalized World.*

Although I will reference the committee's findings in my remarks, today I speak on behalf of higher education and the scientific research community, rather than as a representative of the committee or the Academy.

It has become a broadly accepted principle that the United States' leadership in science and technology is crucial both to our national security and our country's economic prosperity. Last April, in a speech at the National Academy of Sciences, President Obama called science (quote)

> "more essential for our prosperity, our security, our health and our environment than it has ever been." (end quote)

The American Recovery and Reinvestment Act of 2009 approved by Congress included $17 billion for scientific research, research infrastructure and education, mostly through the National Science Foundation and the National Institutes of Health. This followed on the promise of the America COMPETES Act.

What is less well understood, however, is how the conduct of science and technology has changed — over the past two decades in particular — as a function of both the end of the Cold War and the globalization of science and technology. In this new century, the conduct of science takes place in a highly collaborative and geographically distributed research community, with the Internet enabling exchanges of information at an unprecedented pace. Much of it — particularly the breakthrough advances and innovations — involves many players from wide-ranging backgrounds and areas of expertise. Thus today, excellent science happens not only in the United States and Europe but also in countries such as India and China.

Thirty years ago, the United States dominated in many fields of science and technology. Today the United States is still the overall leader, but in many fields we are one of the leaders rather than the sole leader, and in a few fields the United States is clearly not at the top. As noted in a quote cited in *Beyond "Fortress America"*:

> "Japan leads in a number of key technologies such as flat screens, Korea has become a world leader in semiconductor memory, Europe leads in some aspects of telecommunications and embedded systems, and China is increasingly a center for high-technology manufacturing." (end quote)

Or if we look at the attached graph showing the papers published over the past 25 years by the American Physics Society in *Physical Review* and *Physical Review Letters*, the trend is clear: The rate of publication among physicists outside of the United States and western Europe has increased at an astonishing rate.

In the coming decades, remaining a leader requires that we fully participate in the international research community. To do so requires that unclassified information be able to flow among researchers and industry leaders in the various fields, and it requires the United States to continue to attract the best and brightest minds from around the world to work in our laboratories. As the Center for Strategic and International Studies' (CSIS) Commission on Scientific Communication and National Security noted (in a quote cited in *Beyond "Fortress America"*):

> "In a world of globalized science and technology, security comes from windows not walls." (end quote)

I would add that those windows onto global science are equally vital for scientific leadership and for economic competitiveness.

There is no question that the U.S. needs export controls to maintain military advantage on the battlefield and to sustain the homeland. However, as advances in science and technology have transformed our world and our ways of conducting research, many of the export controls regulations that served the United States well 40 years ago no longer meet the country's needs. The current system actually impedes our national security and thwarts our ability to compete. As the committee noted in its report, our success depends on our ability to "Run Faster." A more agile and responsive system of controls would allow us to focus our energies on serious challenges, make informed decisions and make them more quickly.

I would like to look specifically at the impact of export controls on higher education in the U.S. and the implications for innovation.

Last week President Obama expanded the "Educate to Innovate" campaign, a K-12 initiative to inspire American students to excel in science, technology, engineering and mathematics, often referred to as the STEM fields. He was unequivocal about their importance, saying (quote):

> "Make no mistake: Our future is on the line. The nation that out-educates us today is going to out-compete us tomorrow." (end quote)

A strong educational foundation is key to the innovation that occurs later in universities and industry. Other countries realize this, as evidenced by the flow of international students to U.S. universities seeking degrees in the STEM fields.

So what is required to lead today and tomorrow? We must continue to attract and retain the best scholars and researchers worldwide and nurture their work by providing an environment that encourages innovation.

We have a long and rich tradition of doing so: The United States' 20th-century dominance in science and technology owes much to immigrants such as Albert Einstein, Edward Teller, Enrico Fermi and An Wang. Indeed, Intel, Google, Yahoo! and Sun

Microsystems — as well as an estimated 52 percent of Silicon Valley startups — have one or more founders who were born outside of the United States. Today, we continue to attract brilliant young minds from around the world, and it is important that we continue to attract and to retain them.

At Stanford, we attract leading researchers and faculty from around the world, and 32 percent of our graduate students are from countries other than the U.S., with the percentage of international Ph.D. students exceeding 50 percent in engineering and the physical sciences. As a matter of policy, we do not engage in classified research that would limit participation of any of our students or faculty on the basis of citizenship. Our focus is on fundamental research, which both by its nature and by National Security Decision Directive 189 is intended to be open to all and freely communicated.

Nonetheless, current export controls and related security measures have caused us difficulties. Let me give you three brief examples from Stanford.

Gravity Probe-B

> Gravity Probe-B is an experiment being undertaken to test Einstein's general theory of relativity. A satellite orbiting above the Earth houses an instrument that includes four spherical gyroscopes and a telescope, designed by Stanford researchers. The instrument's design and fabrication were basic research; for example, it required making the world's most perfect sphere, which is at the core

of the instrument. The technical details — blueprints and schematics — are openly published. It does not have a strategic use, but it happens to be on a satellite. Because the International Traffic and Arms Regulations (ITAR) consider satellites to be munitions, Stanford researchers are prohibited from providing "technical assistance" to foreign national students and scholars abroad by discussing the published performance characteristics of the materials and hardware used in the development of the probe. U.S. universities consider their ability to share the details of published research results to be a crucial element of scientific inquiry and a requirement for evaluating the instrument and its measurements of the basic physics of our universe. ITAR, however, considers the activity to be a "defense service" requiring an export license. With deemed export regulations, there are even limitations in sharing information with some international students here on our campus.

Synapse microchip

A U.S.-based Fortune 100 high-technology company has been given a DARPA contract to develop a microchip that will attempt to simulate the human brain based on what we know of the electrical properties of neurons and synapses. While this work is quite basic, the potential future applications from treating brain disorders to building autonomous systems are both widespread and of high impact.

This is the kind of research we excel in at Stanford, and the technology company has asked us to participate on the project. Our team is headed by a faculty member, who is a leader in his field, and includes half a dozen Stanford graduate students. The faculty member is a U.S. citizen; some of the students on the team were born outside of the U.S., and two are Chinese nationals. Soon after the project began, we learned that the use of export-controlled technology was central to the work. For the Stanford team to participate, our Chinese students would have to be excluded. Stanford does not, and will not, discriminate between its students or disadvantage them on the basis of citizenship: All of our students and faculty must be able to participate and contribute to the intellectually significant portions of research. Since the export-controlled technology is central to the project, the Stanford research team's involvement and the benefit of their potential contributions to the project have been greatly reduced. This has impeded the progress of the collaboration and Stanford's ability to contribute its full wealth of intellectual capital.

Vaccine creation

A closely related problem has occurred in the area of biosecurity. Professor Stanley Falkow, one the world's most distinguished researchers in the area of microbial pathogenesis, had been working with a non-pathogenic version of plague, a version actually used in the creation of a vaccine. After the USA PATRIOT Act, this organism was designated as a Select Agent, requiring greatly enhanced security and background checks on lab personnel. Falkow viewed this as incompatible with his research approach, destroyed the organism and stopped working in the area. The result was clearly a net loss for our country.

In these examples, our nation can lose multiple times. First we lose the benefit of input from great scientists, both students and faculty, and the advantages of their research contributions. Second, recognizing that many of the young researchers are likely to remain and contribute to the advancement of our country's knowledge in science and technology, we lose when we deprive them of opportunities to innovate. And the impact on students — who might have become loyal and contributing citizens and residents of our country — can be devastating. As these examples illustrate, the negative impacts of control regulations can lead to a loss of scientific leadership and a reduction in our nation's security.

Our goal should be to design national security controls without negatively impacting our ability to conduct fundamental research that can benefit the United States economically and militarily. The growing trend to label fundamental research as "Sensitive But Unclassified" is a deep concern, since it would further blur the lines between controlled and uncontrolled research in an unpredictable fashion.

There are policies in place that can serve as a straightforward and rational interpretation of export controls. Through National Security Decision Directive 189 (NSDD-189, also known as the National Policy on the Transfer of Scientific, Technical and Engineering

Information), for example, government agencies with concerns about work could specify restrictions when they issue the contract, including, when appropriate and necessary, classifying the work. Maintaining the openness of basic research as clearly intended in NSDD-189 is crucially important for the long-term health of U.S. academic research.

Export controls are challenging and complex, and I am very pleased that this committee has undertaken this important task of examining them and considering the need for reform. I will close with my thanks for the important work you are doing. As you move forward, if there is any way my colleagues in higher education and the scientific community can assist you, we would be honored to do so.

Physical Review and Physical Review Letters Published
1983 - 2008

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