Testimony of
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Before the
Senate Commerce, Science & Transportation
Subcommittee on
Technology, Innovation, and Competitiveness

March 29, 2006

Chairman Ensign, Ranking Member Kerry, and members of the Committee, thank you for this opportunity to testify on the importance of basic research. It is a pleasure to appear before you for the first time today.

I am especially pleased that we are able to be talking about competitiveness. As you are well aware, the National Science Foundation is an integral part of the President's American Competitiveness Initiative. The President's request for an 8% increase at NSF this year represents the first step in the Administration's firm commitment to doubling the NSF budget over the next 10 years.

The ACI encompasses all of NSF's investments in research and education. These investments – in discovery, learning, and innovation – have a longstanding and proven track record of boosting the nation's economic vitality and competitive strength.

For over fifty years, NSF has been charged with being a strong steward of the scientific discovery and innovation that has been crucial to increasing America's economic strength, global competitiveness, national security, and overall quality of life.

For many years, the United States economy has depended heavily on investments in research and development – and with good reason. America's sustained economic prosperity is based on technological innovation made possible, in large part, by fundamental science and engineering research. Innovation and technology are the engines of the American economy, and advances in science and engineering provide the fuel.

Investments in science and technology – both public and private – have driven economic growth and improved the quality of life in America for the last 200 years. They have generated new knowledge and new industries, created new jobs, ensured

economic and national security, reduced pollution and increased energy efficiency, provided better and safer transportation, improved medical care, and increased living standards for the American people.

Investments in research and development are among the highest-payback investments a nation can make. Over the past 50 years technological innovation has been responsible for as much as half of the nation's growth in productivity.

Sustaining this innovation requires an understanding of the factors that contribute to it. The Council on Competitiveness, a consortium of industry, university, and labor leaders, has developed quantitative measures of national competitiveness: the number of R&D personnel in the available workforce; total R&D investment; the percentage of R&D funded by private industry; the percentage of R&D performed by the university sector; spending on higher education; the strength of intellectual property protection, openness to international competition; and per capita gross domestic product. A similar set of indicators has been developed by the World Bank Group, and voluminous data have been compiled by NSF. The important point underscored by these indicators is that, for America to remain a prosperous and secure country, it *must* maintain its technological leadership in the world.

Perhaps the Council on Competitiveness' 2004 *National Innovation Initiative* report captured it best by simply stating, "Innovation has always been the way people solved the great challenges facing society."

Often the connection between an area of research, or even a particular scientific discovery, and an innovation may be far from obvious. Fundamental research in physics, mathematics and high-flux magnets supported by NSF led to the development of today's Magnetic Resonance Imaging (MRI) technology. Today, MRIs are used widely to detect cancer and internal tissue damage. Fundamental research on extremophiles, or microorganisms living in extreme environments, led to the polymerase chain reaction, a procedure essential to modern biotechnology, as well as one that allows us to use DNA for forensic evidence. Continuing progress in basic science and engineering research promises more discoveries as well as further improvements in living standards and economic performance.

And still, science and engineering is becoming an ever-larger portion of our nation's productivity. In the early 1950s, Jacob Bronowski wrote, "The world today is powered by science." I would take this premise one step farther, "No science; no economic growth." Our current level of scientific and technological productivity is what keeps us ahead of our global competitors as the playing field continues to become more level.

NSF has helped advance America's basic science and engineering enterprise for over fifty years. Despite its small size, NSF has an extraordinary impact on scientific and engineering knowledge and capacity. While NSF represents only four percent of the total federal budget for research and development, it accounts for fifty percent of non-life

science basic research at academic institutions. In fact, NSF is the *only* federal agency that supports *all* fields of science and engineering research and the educational programs that sustain them across generations. NSF's programs reach over 2,000 institutions across the nation, and they involve roughly 200,000 researchers, teachers, and students.

NSF specifically targets its investments in fundamental research at the frontiers of science and engineering. Here, advances push the boundaries of innovation, progress and productivity.

Compared to other commodities, knowledge generated from basic science investments is unique, long lasting and self-leveraging. Knowledge can be shared, stored and distributed easily, and it does not diminish by use. Incremental advances in knowledge are synergistic over time. NSF is proud to have built the foundation for this knowledge base through decades of peer-reviewed, merit-based research.

Innovation has become the watchword for our nation's future. It is both a rallying cry and a challenge, one that is now touted by every sector of society—industry, academia, and government.

At the National Science Foundation, we have long heard this clarion call and consider it our most important challenge. Innovation is at the core of what we are about at NSF, and our vision statement reflects that. It is direct and crisp: "enabling the nation's future through discovery, learning, and innovation."

To realize our mission, we see to it that each of our investments builds intellectual capital, integrates research and education, and promotes partnerships. In all of these endeavors, we focus on the frontiers of knowledge and beyond—the fertile territory where new ideas are born, nurtured and eventually bear fruit in economic and social returns.

America has always measured its own progress not by comparison with others, but with an eye on the next unmet challenge, the territory unexplored by other nations. That is becoming increasingly difficult with the prospect of nations like China and India building powerful economic momentum through a burgeoning science and engineering workforce and strong research capacity. There is fierce competition for ideas and talent, for comparative advantage and market opportunities worldwide.

As we consider our options for policies that promote and foster innovation—whether it is funding for science and engineering research and education, or incentives for increasing venture capital, or reforms in math and science education—we need to recognize that policies should leave ample room for experimentation and exploration. That is a hallmark of innovation, and a key to our future.

Early last year, the American Electronics Association (AeA) published a report[1] that included the chart below. It illustrates how some of today's ubiquitous technologies have been generated by federally funded frontier research, and the tremendous role that the Foundation has played in helping U.S. competitiveness and innovation.

Innovation Resulting from U.S. Federally Funded Research

Innovation	Funder
The Internet	DARPA/NSF
Web Browser	NSF
Bar Codes	NSF
Fiber Optics	NSF
Routers	NSF
MRI	NIH/NSF
Doppler Radar	NSF
Speech Recognition	NSF/DARPA
Nanotechnology	NSF
Computer Aided Design	NSF/DARPA
Global Positioning Satellites	DARPA
The Mouse	DARPA

Note:

NSF = National Science Foundation
DARPA = Defense Advanced Research Projects Agency
NIH = National Institutes of Health

There was a time, in the 60s and early 70s, when the norm was 20 years for the results of fundamental research to find their way to the marketplace. The AeA report describes how federal funding of solid-state physics, and ceramics and glass engineering in the late 1960s created the knowledge base for widespread development and use of fiber optic cable in the 1990s. It is also well known that much of this seminal work was performed by private industry as well.

[1] Losing the Competitive Advantage? The Challenge for Science and Technology in the United States; American Electronics Association, February 2005.

As you know Mr. Chairman, the timeframe in which these innovations developed has now collapsed in many fields, often to 20 months or less. The pace of scientific discovery and technological change has accelerated dramatically with the advent of more powerful and sophisticated tools, more robust computing and networking, and the relentless pressure of global competition. Creative disruption at the frontier and reduced lead-time between discovery and application are the principal drivers of global competition today.

In many fields, what was once viewed as a linear process from basic research, to application, to commercialization is now much more multidimensional, complex and parallel. Even the inquiries encountered in developing commercial products and services can generate ideas for frontier research. This give and take blurs the lines between the old categories, and makes innovation a much broader team sport.

What remains vital and constant, however, is a focus on frontier research and education. Transformational research and technological innovation converge on the frontier to produce truly revolutionary progress. Tinkering on the sidelines may be important, but it is not what drives cutting-edge innovation.

It is important to note that in our efforts to advance the frontier, we also aim to enhance development of the nation's talent pool by integrating research and education. This may be basic research's most profound, and lasting, impact. By providing students with significant research experiences throughout their schooling, the world-class scientists, technologists, engineers, and mathematicians trained in this way can transfer new scientific and engineering concepts from universities directly to the entrepreneurial sector as they enter the workforce. This capability is a strong suit in U.S. competitiveness, and one of NSF's greatest contributions to the nation's innovation system.

And although we are primarily a basic research agency, we are proud of our couplings with the private sector and industry that fosters innovation and competitiveness for the nation. NSF's research centers programs, such as our Engineering Research Centers and Science and Technology Centers, directly invite private sector partners to engage in and/or sponsor related cutting edge research that can lead to high-leverage innovations. The Foundation's Partnerships for Innovations program develop entrepreneurial pathways to couple new concepts developed in colleges and universities to early adopters in the form of new startup companies and innovation consortiums between private and public sector entities.

Furthermore, NSF couples investments in our Small Business Innovation Research and Small Business Technology Transfer programs with high-impact emerging technologies, such as nanotechnology, information technology, and biotechnology. We also co-fund cutting-edge, peer reviewed research in next-generation semiconductor technologies in partnership with the Semiconductor Research Corporation.

Mr. Chairman, I've only touched upon the variety and richness of the NSF portfolio. NSF research and education efforts contribute greatly to the nation's innovation economy and help keep America at the forefront of science and engineering. At the same time, NSF supported researchers produce leading edge discoveries that serve society and spark the public's curiosity and interest. Extraordinary discoveries coming from dozens of NSF programs and initiatives are enriching the entire science and engineering enterprise, and making education fun, exciting and achievement-oriented.

The President's American Competitiveness Initiative makes clear the larger rationale for investments in science and engineering. This is to put knowledge to work—to improve the quality of life and enhance the security and prosperity of every citizen. NSF is committed to cultivating a science and engineering enterprise that not only unlocks the mysteries of the universe but that addresses the challenges of America and the world.

Mr. Chairman and members of the Committee, I hope that this brief overview conveys to you the extent of NSF's commitment to advancing science and technology in the national interest. I look forward to working with you in months ahead, and would be happy to respond to any questions that you have.