AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

SCIENCE AND TECHNOLOGY LEADERSHIP IN A 21ST CENTURY GLOBAL ECONOMY

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

MARCH 13, 2007

Serial No. 110–10

Printed for the use of the Committee on Science and Technology

Available via the World Wide Web: http://www.house.gov/science

U.S. GOVERNMENT PRINTING OFFICE
33–801PS WASHINGTON : 2007

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2250 Mail: Stop SSOP, Washington, DC 20402–0001

COMMITTEE ON SCIENCE AND TECHNOLOGY

HON. BART GORDON, Tennessee, *Chairman*

JERRY F. COSTELLO, Illinois
EDDIE BERNICE JOHNSON, Texas
LYNN C. WOOLSEY, California
MARK UDALL, Colorado
DAVID WU, Oregon
BRIAN BAIRD, Washington
BRAD MILLER, North Carolina
DANIEL LIPINSKI, Illinois
NICK LAMPSON, Texas
GABRIELLE GIFFORDS, Arizona
JERRY MCNERNEY, California
PAUL KANJORSKI, Pennsylvania
DARLENE HOOLEY, Oregon
STEVEN R. ROTHMAN, New Jersey
MICHAEL M. HONDA, California
JIM MATHESON, Utah
MIKE ROSS, Arkansas
BEN CHANDLER, Kentucky
RUSS CARNAHAN, Missouri
CHARLIE MELANCON, Louisiana
BARON P. HILL, Indiana
HARRY E. MITCHELL, Arizona
CHARLES A. WILSON, Ohio

RALPH M. HALL, Texas
F. JAMES SENSENBRENNER JR., Wisconsin
LAMAR S. SMITH, Texas
DANA ROHRABACHER, California
KEN CALVERT, California
ROSCOE G. BARTLETT, Maryland
VERNON J. EHLERS, Michigan
FRANK D. LUCAS, Oklahoma
JUDY BIGGERT, Illinois
W. TODD AKIN, Missouri
JO BONNER, Alabama
TOM FEENEY, Florida
RANDY NEUGEBAUER, Texas
BOB INGLIS, South Carolina
MICHAEL T. MCCAUL, Texas
MARIO DIAZ-BALART, Florida
PHIL GINGREY, Georgia
BRIAN P. BILBRAY, California
ADRIAN SMITH, Nebraska
VACANCY

CONTENTS

March 13, 2007

	Page
Witness List	2
Hearing Charter	3

Opening Statements

Statement by Representative Bart Gordon, Chairman, Committee on Science and Technology, U.S. House of Representatives	18
Written Statement	19
Statement by Representative Ralph M. Hall, Minority Ranking Member, Committee on Science and Technology, U.S. House of Representatives	20
Written Statement	22
Prepared Statement by Representative Eddie Bernice Johnson, Member, Committee on Science and Technology, U.S. House of Representatives	23
Prepared Statement by Representative Russ Carnahan, Member, Committee on Science and Technology, U.S. House of Representatives	23
Prepared Statement by Representative Harry E. Mitchell, Member, Committee on Science and Technology, U.S. House of Representatives	25
Prepared Statement by Representative Vernon J. Ehlers, Member, Committee on Science and Technology, U.S. House of Representatives	26

Witnesses:

Mr. Norman R. Augustine, Chair, Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, Division on Policy and Global Affairs, the National Academies; Former Chairman and CEO, Lockheed Martin Corporation	
Oral Statement	26
Written Statement	28
Biography	32
Mr. Harold McGraw III, Chairman and CEO, The McGraw-Hill Companies; Chairman, Business Roundtable	
Oral Statement	33
Written Statement	35
Biography	40
Dr. Robert C. Dynes, Professor of Physics and Material Science; President, University of California	
Oral Statement	40
Written Statement	43
Biography	56
Dr. Craig R. Barrett, Chairman of the Board, Intel Corporation	
Oral Statement	57
Written Statement	59
Dr. Neal Lane, Malcolm Gillis University Professor, and Senior Fellow of the James A. Baker III Institute for Public Policy, Rice University	
Oral Statement	61
Written Statement	63
Biography	67
Ms. Deborah L. Wince-Smith, President, Council on Competitiveness	
Oral Statement	68
Written Statement	70

Page

Ms. Deborah L. Wince-Smith, President, Council on Competitiveness—Continued
Biography 78

Discussion 79

Appendix 1: Answers to Post-Hearing Questions

Mr. Norman R. Augustine, Chair, Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, Division on Policy and Global Affairs, the National Academies; Former Chairman and CEO, Lockheed Martin Corporation 106

Mr. Harold McGraw III, Chairman and CEO, The McGraw-Hill Companies; Chairman, Business Roundtable 110

Dr. Robert C. Dynes, Professor of Physics and Material Science; President, University of California 113

Dr. Craig R. Barrett, Chairman of the Board, Intel Corporation 115

Dr. Neal Lane, Malcolm Gillis University Professor, and Senior Fellow of the James A. Baker III Institute for Public Policy, Rice University 117

Ms. Deborah L. Wince-Smith, President, Council on Competitiveness 119

Appendix 2: Additional Material for the Record

Section-by-Section Summary of H.R. 362 122

Section-by-Section Summary of H.R. 363 124

SCIENCE AND TECHNOLOGY LEADERSHIP IN A 21ST CENTURY GLOBAL ECONOMY

TUESDAY, MARCH 13, 2007

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 1:05 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Bart Gordon [Chairman of the Committee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6375
TTY: (202) 226-4410
http://science.house.gov

Hearing on:

"Science and Technology Leadership in a 21st Century Global Economy"

2318 Rayburn House Office Building
Washington, DC

Tuesday, March 13, 2007
1:00 pm to 3:30 pm

WITNESS LIST

Mr. Norm Augustine
Chair of National Academy "Rising Above the Gathering Storm" Report Committee
Former Chairman and CEO, Lockheed Martin Corporation

Mr. Harold McGraw, III
Chairman and CEO
The McGraw-Hill Companies
Chairman
Business Roundtable

Dr. Robert Dynes
President
University of California

Dr. Craig Barrett
Chairman of the Board
Intel Corporation

Dr. Neal Lane
Malcolm Gills University Professor
Rice University

Ms. Deborah Wince-Smith
President
Council on Competitiveness

HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Science and Technology Leadership in a 21st Century Global Economy

TUESDAY, MARCH 13, 2007
1:00 P.M.–3:30 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Tuesday, March 13, 2007, the House Committee on Science and Technology will hold a hearing to receive testimony on the critical importance of science and technology to our nation's prosperity. The focus is on the provisions of the National Academy of Sciences report entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* Witnesses have been asked to address the reasoning behind the education and research recommendations enunciated in that report.

2. Witnesses

Mr. Norman R. Augustine, Retired Chairman and CEO of the Lockheed Martin Corporation. Mr. Augustine chaired the National Academy of Sciences (NAS) committee that wrote the *Gathering Storm* report.

Mr. Harold McGraw III, Chairman, President, and CEO of the McGraw Hill Companies. Mr. McGraw is the Chairman of the Business Roundtable.

Dr. Robert Dynes, President of the University of California. Dr. Dynes is Professor of Physics and Materials Science and a member of the National Academy of Sciences.

Dr. Craig Barrett, Chairman and CEO of Intel Corporation. Dr. Barrett served on the NAS committee that wrote the *Gathering Storm* report.

Dr. Neal Lane, Malcolm Gillis University Professor at Rice University and Senior Fellow at the James Baker III Institute for Public Policy. Dr. Lane was the Director of the National Science Foundation from 1993 to 1998 and Director of the White House Office of Science and Technology Policy from 1998 to 2001.

Ms. Deborah Wince-Smith, President of the Council on Competitiveness. Ms. Wince-Smith has held numerous positions in government as an expert on innovation policy.

3. Overarching Questions

- Why is the promotion of science and technology so critical to America's prosperity? Where do we stand today, and where do we need to be in the future?
- What should be the federal government's role in advancing the science and technology agenda? What should be the top priorities in science education and research? Do H.R. 362 and H.R. 363 address the most critical needs?

4. Brief Overview

Henry Luce, publisher of *Time Magazine,* coined the term "the American century" in 1941 to describe his vision of the 20th century. Indeed, after World War II, the U.S. economy grew substantially, and economists estimate that about half of U.S. economic growth was the result of technological innovation. Indeed, during the 20th century, the United States became a world leader in science and technology education and research and in innovation, and economic indicators demonstrated that the United States offered a high standard of living to its citizens.

In the 1990's however, during a period in which the United States was known as the world's lone "superpower," a number of indicators suggested that U.S. prosperity was diminishing. The United States trade surplus in high-technology products that was $54 billion in 1990 turned into a trade deficit of $50 billion in 2004. A number of iconic American companies moved assets, jobs, and ownership overseas. And

American students performed poorly in several international assessments of math and science achievement.

In May of 2005, Senators Lamar Alexander and Jeff Bingaman asked the National Academy of Sciences (NAS) to conduct a study of "the most urgent challenges the United States faces in maintaining leadership in key areas of science and technology." In June, Congressmen Sherwood Boehlert and Bart Gordon wrote to the NAS to endorse the Senate request for a study and to suggest some additional specific questions. The National Academy assembled a Committee on Prospering in the Global Economy of the 21st Century, and on October 12, 2005, that committee issued a report entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*

That report, whose title we abbreviate to *Gathering Storm,* offered four recommendations:

- Recommendation A: Increase America's talent pool by vastly improving K–12 science and mathematics education.
- Recommendation B: Sustain and strengthen the Nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.
- Recommendation C: Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.
- Recommendation D: Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs based on innovation by such actions as modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access.

Along with each recommendation, the report spelled out several specific action items to pursue in order to implement the recommendation.

On October 20, 2005, the Committee on Science of the 109th Congress held a hearing, entitled *"Science, Technology, and Global Economic Competitiveness."* The witnesses at that hearing were Norm Augustine, retired Chairman and CEO of Lockheed Martin Corporation and Chair of the NAS committee that wrote the *Gathering Storm* report; Roy Vagelos, retired Chairman and CEO of Merck & Co. and member of the NAS committee that wrote the report; and William Wulf, President of the National Academy of Engineering. In their testimony, these witnesses promoted the recommendations of the report and argued that the action items were critical and urgent.

The *Gathering Storm* report quickly became influential in promoting a national agenda on innovation and competitiveness. In the 109th Congress, the House Committee on Science reported two pieces of legislation implementing a number of the *Gathering Storm* action items. The first of these bills was H.R. 5356, the *Research for Competitiveness Act.* The second was H.R. 5358, the *Science and Mathematics Education for Competitiveness Act.* Together, these bills addressed many of the action items related to Recommendations A and B. The bills were never brought to the Floor of the House.

In the 110th Congress, Chairman Bart Gordon introduced three competitiveness bills, again attempting to implement the *Gathering Storm* recommendations that address science and technology. The first of these, H.R. 362, entitled *"10,000 Teachers, 10,000,000 Minds Science and Math Scholarship Act,"* parallels in large part H.R. 5358 from the 109th Congress. The second of these, H.R. 363, entitled *"Sowing the Seeds Through Science and Engineering Research Act,"* parallels in large part H.R. 4346 from the 109th Congress. (The third bill, H.R. 364, is to provide for an Advanced Research Projects Agency for Energy and is not the focus of the present hearing.)

On February 28, 2007, the Committee on Science and Technology marked up H.R. 363 and passed an amended version of the introduced bill. A summary of that bill, along with a summary of H.R. 362, appears below.

5. Specific Questions for the Witnesses

Each witness received a letter of invitation to testify at the hearing. In that letter, the witnesses were asked to address the overarching questions related to the hearing. In addition, each witness was asked to address an aspect of the hearing focus that relates to their realm of expertise.

Mr. Augustine was asked to describe the reasoning behind the priorities that resulted in the recommendations in *Gathering Storm* report. Dr. Barrett was asked the same question, and in addition was asked about his thoughts on what changes are needed in STEM education in order for the Nation to meet the future workforce needs of industry.

Mr. McGraw and Ms. Wince-Smith were asked what changes are needed in STEM education in order to meet the future workforce needs of business and industry. The Business Roundtable and the Council on Competitiveness both represent broad coalitions of business interests.

Dr. Dynes was asked to describe the California Teach program: how the Cal Teach model came into being; what the challenges are to putting it in place; what we are learning from the program about recruiting and preparing science, math, and engineering college majors to become STEM teachers; and what factors are important for emulating similar programs on a national scale.

Dr. Lane was asked to comment on the appropriateness of the proposed role of NSF in administering the STEM education programs contained in H.R. 362. In particular, Dr. Lane was asked to address how these NSF programs interact with STEM education activities at the Department of Education.

6. The Provisions of the Bills

H.R. 362—The "10,000 Teachers, 10 Million Minds" Science and Math Scholarships Act

The bill implements most of the K–12 science education recommendations of the *Gathering Storm* report. It establishes a teacher education program at the National Science Foundation (NSF) to encourage math, science and engineering faculty to work with education faculty to improve the education of science and math teachers and to provide scholarships to science, math and engineering students who commit to become science or math teachers at elementary and secondary schools; authorizes summer teacher training institutes at NSF and DOE to improve the content knowledge and pedagogical skills of in-service science and math teachers, including preparing them to teach Advanced Placement and International Baccalaureate courses in science and math; requires that NSF include support for Master's degree programs for in-service science and mathematics teachers within the NSF Math and Science Partnerships; and authorizes funding for the NSF STEM Talent Expansion program and expands the program to include centers for improving undergraduate STEM education.

Sectional Summary of Bill

Section 1 is the Table of Contents.

Section 2 reports findings on the role of NSF in K–12 and undergraduate STEM education.

Section 3 spells out definitions used in the bill.

Title I—Science Scholarships

Section 101 is the short title of the bill.

Section 102 reports findings relating the bill to the NAS report recommendations.

Section 103 describes the policy objective of the bill—to increase by 10,000 annually the number of capable K–12 science and math teachers.

Section 104 amends the NSF Noyce Scholarship program, established by the *NSF Authorization Act of 2002,* to create incentives for colleges and universities to improve the training of STEM teachers and increases the size and duration of the scholarships provided for science, math, and engineering majors who pursue teaching credentials:

- Provides competitive awards to institutions of higher education (or consortia of such institutions) that (1) establish cross-department faculty teams (science, math and engineering faculty along with education faculty) to develop courses of instruction leading to baccalaureate degrees in fields of science, math and/or engineering and also preparing graduates to become certified or licensed to teach in a K–12 classroom, and (2) administer scholarships for students during their sophomore through senior years and summer internships during their freshman years.
- Requires early field teaching experiences for student teachers in the program under the supervision of highly experienced and effective teachers.

- Requires awardees to provide professional development and mentoring support to scholarship recipients, after matriculation.
- Sets scholarship amounts at the cost of attendance at particular institutions, not to exceed $10,000 per year, and provides up to three years of scholarship support for any individual.
- Requires scholarship recipients to commit to teaching for up to six years following graduation (the period of teaching commitment is based on the number of years of scholarship support), reduces the commitment by one year for individuals who teach at high-need schools, and converts the scholarships to loans if the teaching commitment is not met.
- Authorizes the NSF to accept donations from the private sector to help support scholarships and internships.
- Authorizes $70 million for NSF for FY 2008, $101 million for FY 2009, $133 million for FY 2010, $164 million for FY 2011, and $196 million for FY 2012.

Title II—Mathematics and Science Education Improvement

Section 201 amends the NSF Math and Science Education Partnerships program established by the *NSF Authorization Act of 2002:*

- Specifies that priority for awards under the program be given to applications that include teacher training activities as a main focus.
- Authorizes teacher training activities to prepare teachers to teach Advanced Placement and International Baccalaureate science or math courses and provides for mentoring by professional scientists, mathematicians and engineers.
- Authorizes the development of master's degree programs for in-service science and math teachers.

Section 202 addresses teacher institute programs at NSF and DOE:

- NSF is directed to establish a grant program to support summer or academic year teacher institutes and authorizes summer teacher institutes as a component of the NSF 21st Century program. Such summer institutes are required to include teacher training activities to prepare teachers to teach Advanced Placement and International Baccalaureate science or math courses.
- Authorizes $32 million for NSF for FY 2008, $35.2 million for FY 2009, and $38.7 million for FY 2010, $42.6 million for FY 2011, and $46.8 million for FY 2012.
- The following amounts are authorized for the existing Laboratory Science Teacher Professional Development program at DOE: $3 million for FY 2008, $8 million for FY 2009, and $10 million for each year FY 2010 through FY 2012.

Section 203 requires NSF to ensure that, under the Math and Science Partnership program, Master's degree programs are developed and implemented for in-service math and science teachers, who attend on a part-time basis and who will be able to complete the degree requirements within two years. The programs have the following features:

- Provide stipends to defray the cost of attendance for teachers in the program.
- Allow for support for the development of the courses of instruction and related educational materials and equipment (offering of online learning is an option).
- Require the distribution of awards among institutions of different sizes and geographic locations.

Authorizes for this program $46 million for NSF for FY 2008, $50.6 million for FY 2009, $55.7 million for FY 2010, $61.2 million for FY 2011, and $67.3 million for FY 2012.

Section 204 establishes a national panel of experts to identify and collect K–12 science and mathematics teaching materials that have been demonstrated to be effective and to recommend the development of new materials in areas where effective materials do not exist; and directs NSF and the Department of Education to develop ways to disseminate effective materials and support efforts to develop new materials, in accordance with the recommendations of the national panel.

Section 205 amends the NSF STEM Talent Expansion program established under the *NSF Authorization Act of 2002* to create centers for improvement of undergraduate education in STEM fields, including:

- Development of undergraduate curriculum and teaching methods and training for faculty and teaching assistants in effective pedagogical practices.
- Assessment of the effectiveness of the centers and dissemination of information about materials and methods developed.

Authorizes $44 million for NSF for the STEM Talent Expansion program for FY 2008, of which $4 million is available for centers; $55 million for FY 2009, of which $10 million is available for centers; and $60 million for each year of FY 2010 through FY 2012, of which $10 million is available in each year for centers.

H.R. 363—Sowing the Seeds through Science and Engineering Research Act

The bill implements recommendations related to strengthening long-term basic research contained in the *Gathering Storm* report. It supports outstanding researchers in the early stages of their careers through grants at the National Science Foundation (NSF) and the Department of Energy (DOE) of $80,000 per year for five years; establishes a floor of 1.5 percent of research funding appropriated for NSF for an existing program supporting graduate students in multi-disciplinary fields of national importance; establishes a presidential innovation award to stimulate scientific and engineering advances in the national interest; establishes a national coordination office to identify and prioritize research infrastructure needs at universities and national laboratories and to help guide the investments of new infrastructure funds authorized for NSF and DOE; authorizes NSF to support research on innovation; directs the National Institute of Standards and Technology (NIST) and DOE to report on efforts to recruit and retain early-career scientists and engineers; and expresses the sense of Congress that a balanced science program at the National Aeronautics and Space Administration (NASA) contributes significantly to innovation and competitiveness.

Sectional Summary of Bill

Section 1 is the short title of the bill.

Section 2 authorizes NSF to carry out a grant program for awards to scientists and engineers at the early stage of their careers in academia or in nonprofit research organizations. The NSF's existing Faculty Early Career Development (CAREER) program may be designated as the mechanism for awarding these grants. The awards will go to outstanding researchers at the beginning of their careers and are intended for individuals from a variety of types of institutions, including minority serving institutions. The grants provide five years of research funding support at a minimum of $80,000 per year per award.

NSF is required to designate at least 3.5 percent of funds appropriated for Research and Related Activities to the grant program for each of FY 2008 through FY 2012.

Section 3 authorizes DOE to carry out a grant program for awards to scientists and engineers at the early stage of their careers in academia or in nonprofit research organizations to conduct research in fields relevant to the mission of DOE. The awards will go to outstanding researchers at the beginning of their careers and are intended for individuals from a variety of types of institutions, including minority serving institutions. The grants provide five years of research funding support at a minimum of $80,000 per year per award, and priority shall go to proposals involving collaborations with researchers at DOE national laboratories. The bill authorizes to DOE $25 million for each year for FY 2008 through FY 2012.

Section 4 directs NSF to allocate at least 1.5 percent of the amounts appropriated for Research and Related Activities to the Integrative Graduate Education and Research Traineeship (IGERT) program, which provides support for graduate students in fields relevant to national needs. It requires NSF to coordinate with other agencies to expand the interdisciplinary nature of the IGERT program and authorizes NSF to accept funds from other agencies to carry out the program.

Section 5 establishes the Presidential Innovation Award presented periodically, on the basis of recommendations from the Director of the Office of Science and Technology Policy, to citizens or permanent residents of the U.S. who develop unique scientific or engineering ideas judged to stimulate scientific and engineering advances in the national interest, to illustrate the linkage between science and engineering

and national needs, and to provide an example to excite the interest of students in science or engineering professions.

Section 6 establishes a National Coordination Office for Research Infrastructure under the Office of Science and Technology Policy to identify and prioritize deficiencies in research facilities and instrumentation in academic institutions and national laboratories and to make recommendations for use of funding authorized. The Office is directed to report to Congress annually at the time of the administration's budget proposal.

Section 7 authorizes NSF, in carrying out its research programs on science policy and the science of learning, to support research on the process of innovation and the teaching of inventiveness.

Section 8 directs NIST to transmit to the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation, not later than three months following enactment of the bill, a report on efforts to recruit and retain early-career scientists and engineers at NIST.

Section 9 expresses the sense of Congress that a balanced and robust program in science, aeronautics, exploration, and human space flight at NASA contributes significantly to national innovation and competitiveness. It also directs the NASA administrator to participate fully in interagency efforts to promote innovation and economic competitiveness through scientific research and development.

Appendix A:

Executive Summary of National Academy of Sciences Report, Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future

The United States takes deserved pride in the vitality of its economy, which forms the foundation of our high quality of life, our national security, and our hope that our children and grandchildren will inherit ever-greater opportunities. That vitality is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living. Economic studies conducted before the information-technology revolution have shown that even then as much as 85 percent of measured growth in U.S. income per capita is due to technological change.[1]

Today, Americans are feeling the gradual and subtle effects of globalization that challenge the economic and strategic leadership that the United States has enjoyed since World War II. A substantial portion of our workforce finds itself in direct competition for jobs with lower-wage workers around the globe, and leading-edge scientific and engineering work is being accomplished in many parts of the world. Thanks to globalization, driven by modern communications and other advances, workers in virtually every sector must now face competitors who live just a mouse-click away in Ireland, Finland, China, India, or dozens of other nations whose economies are growing.

CHARGE TO THE COMMITTEE

The National Academies was asked by Senator Lamar Alexander and Senator Jeff Bingaman of the Committee on Energy and Natural Resources, with endorsement by Representatives Sherwood Boehlert and Bart Gordon of the House Committee on Science, to respond to the following questions:

> What are the top 10 actions, in priority order, that federal policy-makers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st Century? What strategy, with several concrete steps, could be used to implement each of those actions?

The National Academies created the Committee on Prospering in the Global Economy of the 21st Century to respond to this request. The charge constitutes a challenge both daunting and exhilarating: to recommend to the Nation specific steps that can best strengthen the quality of life in America—our prosperity, our health, and our security. The committee has been cautious in its analysis of information. However, the available information is only partly adequate for the committee's needs. In addition, the time allotted to develop the report (10 weeks from the time of the committee's meeting to report release) limited the ability of the committee to conduct a thorough analysis. Even if unlimited time were available, definitive analyses on many issues are not possible given the uncertainties involved.

This report reflects the consensus views and judgment of the committee members. Although the committee includes leaders in academe, industry, and government—several current and former industry chief executive officers, university presidents, researchers (including three Nobel prize winners), and former presidential appointees—the array of topics and policies covered is so broad that it was not possible to assemble a committee of 20 members with direct expertise in each relevant area. Because of those limitations, the committee has relied heavily on the judgment of many experts in the study's focus groups, additional consultations via e-mail and telephone with other experts, and an unusually large panel of reviewers. Although other solutions are undoubtedly possible, the committee believes that its recommendations, if implemented, will help the United States achieve prosperity in the 21st century.

---

[1] For example, work by Robert Solow and Moses Abramovitz published in the middle 1950s demonstrated that as much as 85 percent of measured growth in U.S. income per capita during the 1890–1950 period could not be explained by increases in the capital stock or other measurable inputs. The big unexplained portion, referred to alternatively as the "residual" or "the measure of ignorance," has been widely attributed to the effects of technological change.

FINDINGS

Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength. We strongly believe that a worldwide strengthening will benefit the world's economy—particularly in the creation of jobs in countries that are far less well-off than the United States. But we are worried about the future prosperity of the United States. Although many people assume that United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost—and the difficulty of recovering a lead once lost, if indeed it can be regained at all.

This nation must prepare with great urgency to preserve its strategic and economic security. Because other nations have, and probably will continue to have, the competitive advantage of a low-wage structure, the United States must compete by optimizing its knowledge-based resources, particularly in science and technology, and by sustaining the most fertile environment for new and revitalized industries and the well-paying jobs they bring. We have already seen that capital, factories, and laboratories readily move wherever they are thought to have the greatest promise of return to investors.

RECOMMENDATIONS

The committee reviewed hundreds of detailed suggestions—including various calls for novel and untested mechanisms—from other committees, from its focus groups, and from its own members. The challenge is immense, and the actions needed to respond are immense as well.

The committee identified two key challenges that are tightly coupled to scientific and engineering prowess: creating high-quality jobs for Americans and responding to the Nation's need for clean, affordable, and reliable energy. To address those challenges, the committee structured its ideas according to four basic recommendations that focus on the human, financial, and knowledge capital necessary for U.S. prosperity.

The four recommendations focus on actions in K–12 education *(10,000 Teachers, 10 Million Minds),* research *(Sowing the Seeds),* higher education *(Best and Brightest),* and economic policy *(Incentives for Innovation)* that are set forth in the following sections. Also provided are a total of 20 implementation steps for reaching the goals set forth in the recommendations.

Some actions involve changes in the law. Others require financial support that would come from reallocation of existing funds or, if necessary, from new funds. Overall, the committee believes that the investments are modest relative to the magnitude of the return the Nation can expect in the creation of new high-quality jobs and in responding to its energy needs.

10,000 TEACHERS, 10 MILLION MINDS IN K–12 SCIENCE AND MATHEMATICS EDUCATION

Recommendation A: Increase America's talent pool by vastly improving K–12 science and mathematics education.

Implementation Actions

The highest priority should be assigned to the following actions and programs. All should be subjected to continuing evaluation and refinement as they are implemented:

Action A–1: Annually recruit 10,000 science and mathematics teachers by awarding four-year scholarships and thereby educating 10 million minds. Attract 10,000 of America's brightest students to the teaching profession every year, each of whom can have an impact on 1,000 students over the life of their careers. The program would award competitive four-year scholarships for students to obtain Bachelor's degrees in the physical or life sciences, engineering, or mathematics with concurrent certification as K–12 science and mathematics teachers. The merit-based scholarships would provide up to $20,000 a year for four years for qualified educational expenses, including tuition and fees, and require a commitment to five years of service in public K–12 schools. A $10,000 annual bonus would go to participating teachers in under-served schools in inner cities and rural areas. To provide the highest-quality education for undergraduates who want to become teachers, it would be important to award matching grants, perhaps $1 million a year for up to five years, to as many as 100 universities and colleges to encourage them to estab-

lish integrated four-year undergraduate programs leading to Bachelor's degrees in science, engineering, or mathematics with teacher certification.

Action A–2: Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in Master's programs, and Advanced Placement and International Baccalaureate (AP and IB) training programs and thus inspires students every day. Use proven models to strengthen the skills (and compensation, which is based on education and skill level) of 250,000 *current* K–12 teachers:

- *Summer institutes:* Provide matching grants to state and regional one- to two-week summer institutes to upgrade as many as 50,000 practicing teachers each summer. The material covered would allow teachers to keep current with recent developments in science, mathematics, and technology and allow for the exchange of best teaching practices. The Merck Institute for Science Education is a model for this recommendation.
- *Science and mathematics Master's programs:* Provide grants to universities to offer 50,000 current middle-school and high-school science, mathematics, and technology teachers (with or without undergraduate science, mathematics, or engineering degrees) two-year, part-time Master's degree programs that focus on rigorous science and mathematics content and pedagogy. The model for this recommendation is the University of Pennsylvania Science Teachers Institute.
- *AP, IB, and pre-AP or pre-IB training:* Train an additional 70,000 AP or IB and 80,000 pre-AP or pre-IB instructors to teach advanced courses in mathematics and science. Assuming satisfactory performance, teachers may receive incentive payments of up to $2,000 per year, as well as $100 for each student who passes an AP or IB exam in mathematics or science. There are two models for this program: the Advanced Placement Incentive Program and Laying the Foundation, a pre-AP program.
- *K–12 curriculum materials modeled on world-class standards.* Foster high-quality teaching with world-class curricula, standards, and assessments of student learning. Convene a national panel to collect, evaluate, and develop rigorous K–12 materials that would be available free of charge as a *voluntary* national curriculum. The model for this recommendation is the Project Lead the Way pre-engineering courseware.

Action A–3: Enlarge the pipeline by increasing the number of students who take AP and IB science and mathematics courses. Create opportunities and incentives for middle school and high school students to pursue advanced work in science and mathematics. By 2010, increase the number of students in AP and IB mathematics and science courses from 1.2 million to 4.5 million, and set a goal of tripling the number who pass those tests, to 700,000, by 2010. Student incentives for success would include 50 percent examination fee rebates and $100 mini-scholarships for each passing score on an AP or IB mathematics and science examination.

The committee proposes expansion of two additional approaches to improving K–12 science and mathematics education that are already in use:

- *Statewide specialty high schools.* Specialty secondary education can foster leaders in science, technology, and mathematics. Specialty schools immerse students in high-quality science, technology, and mathematics education; serve as a mechanism to test teaching materials; provide a training ground for K–12 teachers; and provide the resources and staff for summer programs that introduce students to science and mathematics.
- Inquiry-based learning. Summer internships and research opportunities provide especially valuable laboratory experience for both middle school and high school students.

SOWING THE SEEDS THROUGH SCIENCE AND ENGINEERING RESEARCH

Recommendation B: Sustain and strengthen the Nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life.

Implementation Actions

Action B–1: Increase the federal investment in long-term basic research by 10 percent a year over the next seven years, through reallocation of existing

funds[2] or if necessary through the investment of new funds. Special attention should go to the physical sciences, engineering, mathematics, and information sciences and to Department of Defense (DOD) basic research funding. This special attention does not mean that there should be a disinvestment in such important fields as the life sciences (which have seen growth in recent years) or the social sciences. A balanced research portfolio in all fields of science and engineering research is critical to U.S. prosperity. This investment should be evaluated regularly to realign the research portfolio—unsuccessful projects and venues of research should be replaced with emerging research projects and venues that have greater promise.

Action B–2: Provide new research grants of $500,000 each annually, payable over five years, to 200 of our most outstanding early-career researchers. The grants would be made through existing federal research agencies—the National Institutes of Health (NIH), the National Science Foundation (NSF), the Department of Energy (DOE), DOD, and the National Aeronautics and Space Administration—to underwrite new research opportunities at universities and government laboratories.

Action B–3: Institute a National Coordination Office for Research Infrastructure to manage a centralized research-infrastructure fund of $500 million per year over the next five years—through reallocation of existing funds or if necessary through the investment of new funds—to ensure that universities and government laboratories create and maintain the facilities and equipment needed for leading-edge scientific discovery and technological development. Universities and national laboratories would compete annually for these funds.

Action B–4: Allocate at least eight percent of the budgets of federal research agencies to discretionary funding that would be managed by technical program managers in the agencies and be focused on catalyzing high-risk, high-payoff research.

Action B–5: Create in the Department of Energy (DOE) an organization like the Defense Advanced Research Projects Agency (DARPA) called the Advanced Research Projects Agency-Energy (ARPA–E).[3] The Director of ARPA–E would report to the Under Secretary for Science and would be charged with sponsoring specific research and development programs to meet the Nation's long-term energy challenges. The new agency would support creative "out-of-the-box" transformational generic energy research that industry by itself cannot or will not support and in which risk may be high but success would provide dramatic benefits for the Nation. This would accelerate the process by which knowledge obtained through research is transformed to create jobs and address environmental, energy, and security issues. ARPA–E would be based on the historically successful DARPA model and would be designed as a lean and agile organization with a great deal of independence that can start and stop targeted programs on the basis of performance. The agency would itself perform no research or transitional effort but would fund such work conducted by universities, startups, established firms, and others. Its staff would turn over about every four years. Although the agency would be focused on specific energy issues, it is expected that its work (like that of DARPA or NIH) will have important spin-off benefits, including aiding in the education of the next generation of researchers. Funding for ARPA–E would start at $300 million the first year and increase to $1 billion per year over five to six years, at which point the program's effectiveness would be evaluated.

Action B–6: Institute a Presidential Innovation Award to stimulate scientific and engineering advances in the national interest. Existing presidential awards address lifetime achievements or promising young scholars, but the proposed new awards would identify and recognize persons who develop unique scientific and engineering innovations in the national interest at the time they occur.

BEST AND BRIGHTEST IN SCIENCE AND ENGINEERING HIGHER EDUCATION

Recommendation C: Make the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and

[2] The funds may come from anywhere in an agency, not just other research funds.

[3] One committee member, Lee Raymond, does not support this action item. He does not believe that ARPA–E is necessary as energy research is already well funded by the Federal Government, along with formidable funding of energy research by the private sector. Also, ARPA–E would put the Federal Government in the business of picking "winning energy technologies"—a role best left to the private sector.

retain the best and brightest students, scientists, and engineers from within the United States and throughout the world.

Implementation Actions

Action C–1: Increase the number and proportion of U.S. citizens who earn physical-sciences, life sciences, engineering, and mathematics Bachelor's degrees by providing 25,000 new four-year competitive undergraduate scholarships each year to U.S. citizens attending U.S. institutions. The Undergraduate Scholar Awards in Science, Technology, Engineering, and Mathematics (USA–STEM) would be distributed to states on the basis of the size of their congressional delegations and awarded on the basis of national examinations. An award would provide up to $20,000 annually for tuition and fees.

Action C–2: Increase the number of U.S. citizens pursuing graduate study in "areas of national need" by funding 5,000 new graduate fellowships each year. NSF should administer the program and draw on the advice of other federal research agencies to define national needs. The focus on national needs is important both to ensure an adequate supply of doctoral scientists and engineers and to ensure that there are appropriate employment opportunities for students once they receive their degrees. Portable fellowships would provide funds of up to $20,000 annually directly to students, who would choose where to pursue graduate studies instead of being required to follow faculty research grants.

Action C–3: Provide a federal tax credit to encourage employers to make continuing education available (either internally or though colleges and universities) to practicing scientists and engineers. These incentives would promote career-long learning to keep the workforce current in the face of rapidly evolving scientific and engineering discoveries and technological advances and would allow for retraining to meet new demands of the job market.

Action C–4: Continue to improve visa processing for international students and scholars to provide less complex procedures and continue to make improvements on such issues as visa categories and duration, travel for scientific meetings, the technology-alert list, reciprocity agreements, and changes in status.

Action C–5: Provide a one-year automatic visa extension to international students who receive doctorates or the equivalent in science, technology, engineering, mathematics, or other fields of national need at qualified U.S. institutions to remain in the United States to seek employment. If these students are offered jobs by United States-based employers and pass a security screening test, they should be provided automatic work permits and expedited residence status. If students are unable to obtain employment within one year, their visas would expire.

Action C–6: Institute a new skills-based, preferential immigration option. Doctoral-level education and science and engineering skills would substantially raise an applicant's chances and priority in obtaining U.S. citizenship. In the interim, the number of H–1B[4] visas should be increased by 10,000, and the additional visas should be available for industry to hire science and engineering applicants with doctorates from U.S. universities.

Action C–7: Reform the current system of "deemed exports."[5] The new system should provide international students and researchers engaged in fundamental research in the United States with access to information and research equipment in U.S. industrial, academic, and national laboratories comparable with the access provided to U.S. citizens and permanent residents in a similar status. It would, of course, exclude information and facilities restricted under national-security regula-

[4] The H–1B is a non-immigrant classification used by an alien who will be employed temporarily in a specialty occupation of distinguished merit and ability. A specialty occupation requires theoretical and practical application of a body of specialized knowledge and at least a Bachelor's degree or its equivalent. For example, architecture, engineering, mathematics, physical sciences, social sciences, medicine and health, education, business specialties, accounting, law, theology, and the arts are specialty occupations. See *http://uscis.gov/graphics/howdoi/h1b.htm*

[5] The controls governed by the Export Administration Act and its implementing regulations extend to the transfer of technology. *Technology* includes *"specific information* necessary for the 'development,' 'production,' or 'use' of a product" [emphasis added]. Providing information that is subject to export controls—for example, about some kinds of computer hardware—to a foreign national within the United States may be "deemed" an export, and that transfer requires an export license. The primary responsibility for administering controls on deemed exports lies with the Department of Commerce, but other agencies have regulatory authority as well.

tions. In addition, the effect of deemed-exports regulations on the education and fundamental research work of international students and scholars should be limited by removing all technology items (information and equipment) from the deemed-exports technology list that are available for purchase on the overseas open market from foreign or U.S. companies or that have manuals that are available in the public domain, in libraries, over the Internet, or from manufacturers.

INCENTIVES FOR INNOVATION AND THE INVESTMENT ENVIRONMENT

Recommendation D: Ensure that the United States is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs that are based on innovation by modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access.

Implementation Actions

Action D–1: Enhance intellectual-property protection for the 21st century global economy to ensure that systems for protecting patents and other forms of intellectual property underlie the emerging knowledge economy but allow research to enhance innovation. The patent system requires reform of four specific kinds:

- Provide the Patent and Trademark Office sufficient resources to make intellectual-property protection more timely, predictable, and effective.
- Reconfigure the U.S. patent system by switching to a "first-inventor-to-file" system and by instituting administrative review after a patent is granted. Those reforms would bring the U.S. system into alignment with patent systems in Europe and Japan.
- Shield research uses of patented inventions from infringement liability. One recent court decision could jeopardize the long-assumed ability of academic researchers to use patented inventions for research.
- Change intellectual-property laws that act as barriers to innovation in specific industries, such as those related to data exclusivity (in pharmaceuticals) and those which increase the volume and unpredictability of litigation (especially in information-technology industries).

Action D–2: Enact a stronger research and development tax credit to encourage private investment in innovation. The current Research and Experimentation Tax Credit goes to companies that increase their research and development spending above a base amount calculated from their spending in prior years. Congress and the Administration should make the credit permanent,[6] and it should be increased from 20 percent to 40 percent of the qualifying increase so that the U.S. tax credit is competitive with that of other countries. The credit should be extended to companies that have consistently spent large amounts on research and development so that they will not be subject to the current de facto penalties for previously investing in research and development.

Action D–3: Provide tax incentives for United States-based innovation. Many policies and programs affect innovation and the Nation's ability to profit from it. It was not possible for the committee to conduct an exhaustive examination, but alternatives to current economic policies should be examined and, if deemed beneficial to the United States, pursued. These alternatives could include changes in overall corporate tax rates, provision of incentives for the purchase of high-technology research and manufacturing equipment, treatment of capital gains, and incentives for long-term investments in innovation. The Council of Economic Advisers and the Congressional Budget Office should conduct a comprehensive analysis to examine how the United States compares with other nations as a location for innovation and related activities with a view to ensuring that the United States is one of the most attractive places in the world for long-term innovation-related investment. From a tax standpoint, that is not now the case.

Action D–4: Ensure ubiquitous broadband Internet access. Several nations are well ahead of the United States in providing broadband access for home, school, and business. That capability will do as much to drive innovation, the economy, and job creation in the 21st century as did access to the telephone, interstate highways, and air travel in the 20th century. Congress and the Administration should take

[6] The current R&D tax credit expires in December 2005.

action—mainly in the regulatory arena and in spectrum management—to ensure widespread affordable broadband access in the near future.

CONCLUSION

The committee believes that its recommendations and the actions proposed to implement them merit serious consideration if we are to ensure that our nation continues to enjoy the jobs, security, and high standard of living that this and previous generations worked so hard to create. Although the committee was asked only to recommend actions that can be taken by the Federal Government, it is clear that related actions at the State and local levels are equally important for U.S. prosperity, as are actions taken by each American family. The United States faces an enormous challenge because of the disadvantage it faces in labor cost. Science and technology provide the opportunity to overcome that disadvantage by creating scientists and engineers with the ability to create entire new industries—much as has been done in the past.

It is easy to be complacent about U.S. competitiveness and pre-eminence in science and technology. We have led the world for decades, and we continue to do so in many research fields today. But the world is changing rapidly, and our advantages are no longer unique. 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, and we are obliged to renew those commitments in education, research, and innovation policies to ensure that the American people continue to benefit from the remarkable opportunities provided by the rapid development of the global economy and its not inconsiderable underpinning in science and technology.

SOME WORRISOME INDICATORS

- When asked in spring 2005 what is the most attractive place in the world in which to "lead a good life," [1] respondents in only one of the 16 countries polled (India) indicated the United States.
- For the cost of one chemist or one engineer in the United States, a company can hire about five chemists in China or 11 engineers in India.[2]
- For the first time, the most capable high-energy particle accelerator on Earth will, beginning in 2007, reside outside the United States.[3]
- The United States is today a net importer of high-technology products. Its share of global high-technology exports has fallen in the last two decades from 30 percent to 17 percent, and its trade balance in high-technology manufactured goods shifted from plus $33 billion in 1990 to a negative $24 billion in 2004.[4]
- Chemical companies closed 70 facilities in the United States in 2004 and have tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of $1 billion or more, one is in the United States and 50 in China.[5]
- Fewer than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform basic mathematical computations.[6]
- U.S. 12th graders recently performed below the international average for 21 countries on a test of general knowledge in mathematics and science. In addition, an advanced mathematics assessment was administered to U.S. students who were taking or had taken precalculus, calculus, or Advanced Placement calculus and to students in 15 other countries who were taking or had taken advanced mathematics courses. Eleven nations outperformed the United States, and four countries had scores similar to the U.S. scores. No nation scored significantly below the United States.[7]
- In 1999, only 41 percent of U.S. 8th grade students received instruction from a mathematics teacher who specialized in mathematics, considerably lower than the international average of 71 percent.[8]
- In one recent period, low-wage employers, such as Wal-Mart (now the Nation's largest employer) and McDonald's, created 44 percent of the new jobs, while high-wage employers created only 29 percent of the new jobs.[9]
- In 2003, only three American companies ranked among the top 10 recipients of patents granted by the United States Patent and Trademark Office.[10]
- In Germany, 36 percent of undergraduates receive their degrees in science and engineering. In China, the figure is 59 percent, and in Japan 66 percent. In the United States, the corresponding figure is 32 percent.[11]

---

[1] Interview asked nearly 17,000 people the question: "Supposed a young person who wanted to leave this country asked you to recommend where to go to lead a good life—what country would you recommend ?" Except for respondents in India, Poland, and Canada, no more than one-tenth of the people in the other nations said they would recommend the United States. Canada and Australia won the popularity contest. Pew Global Attitudes Project, July 23, 2005.

[2] The Web site *http://www.payscale.com/about.asp* tracks and compares pay scales in many countries. Ron Hira, of Rochester Institute of Technology, calculates average salaries for engineers in the United States and India as $70,000 and $13,580, respectively.

[3] CERN, *http://public.web.cern.ch/Public/Welcome.html.*

[4] For 2004, the dollar value of high-technology imports was $560 billion; the value of high-technology exports was $511 billion. See Appendix Table 6–01 of National Science Board's Science and Engineering Indicators 2004.

[5] "No Longer The Lab Of The World: U.S. chemical plants are closing in droves as production heads abroad," *BusinessWeek* (May 2, 2005).

[6] National Center for Education Statistics, Trends in International Mathematics and Science Study, 2003, *http://nces.ed.gov/timss.*

[7] Data are from National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04–01). Arlington, VA: National Science Foundation. Chapter 1.

[8] Data are from National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04–01). Arlington, VA: National Science Foundation. Chapter 1.

[9] Roach, Steve. More Jobs, Worse Work. *New York Times.* July 22, 2004.

[10] U.S. Patent and Trademark Office, Preliminary list of top patenting organizations. 2003, *http://www.uspto.gov/web/offices/ac/ido/oeip/taf/top03cos.htm.*

[11] Data are from National Science Board. 2004. Science and Engineering Indicators 2004 (NSB 04–01). Arlington, VA: National Science Foundation, Appendix Table 2–33.

- The United States is said to have 10.5 million illegal immigrants, but under the law the number of visas set aside for "highly qualified foreign workers" dropped to 65, 000 a year from its 195,000 peak.[12]
- In 2004, China graduated over 600,000 engineers, India 350,000, and America about 70,000.[13]
- In 2001 (the most recent year for which data are available), U.S. industry spent more on tort litigation than on R&D.[14]

[12] Colvin, Geoffrey. 2005. "America isn't ready." *Fortune Magazine,* July 25. H–1B visas allow employers to have access to highly educated foreign professionals who have experience in specialized fields and who have at least a bachelor's degree or the equivalent. The cap does not apply to educational institutions. In November 2004, Congress created an exemption for 20,000 foreign nationals earning advanced degrees from U.S. universities. See *Immigration and Nationality Act* Section 101(a)(15)(h)(1)(b).

[13] Geoffrey Colvin. 2005. "America isn't ready." *Fortune Magazine,* July 25.

[14] U.S. research and development spending in 2001 was $273.6 billion, of which industry performed $194 billion, and funded about $184 billion. (National Science Board Science and Engineering Indicators 2004). One estimate of tort litigation costs in the United States was $205 billion in 2001. (Leonard, Jeremy A. 2003. *How Structural Costs Imposed on U.S. Manufacturers Harm Workers and Threaten Competitiveness.* Prepared for the Manufacturing Institute of the National Association of Manufacturers.) *http://www.nam.org/s_nam/bin.asp?CID=216&DID=227525&DOC=FILE.PDF.*

Chairman GORDON. Welcome to a hearing of the Science and Technology Committee on the critical importance of science and technology in the 21st century global economy, and I want to especially welcome our very distinguished panelists today.

I saw that you all had a chance to meet Mr. Hall. I hope you checked your billfold to make sure that as he passed through you, things are still all right.

Let me also say that we are being televised today, and I know that folks will be watching us from the office. The Democrats have an important caucus going on right now, so some of our folks are trying to break loose. I know that Vern Ehlers and others are in a variety of meetings, so folks will be coming in, but we are well represented by all their staff today also.

In 2005, I joined Senators Bingaman and Alexander and Congressman Sherry Boehlert in asking the National Academies of Science to study the urgent challenges facing the U.S. in maintaining global leadership in science and technology.

In response, the Academies formed an all-star committee and issued their report, entitled *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future."* I, for a long time, have had on my desk the preliminary copy. I am pleased today, and maybe your appearance here helped the printer get going, but we now have the final version that is out.

It is a very inspiring term, the title of the report, but it is also a very inspiring report, and we thank you for that. That committee was chaired by Mr. Augustine, and included Mr. Barrett, both of whom are here and witnesses today. It has become an enormously influential report, not only owing to the grave dangers it predicts if we are complacent, but also owing to 20 constructive action items it spells out that will lead to continued American leadership and prosperity.

I am an enthusiastic advocate of the report, and after studying its recommendation, I drafted legislation in the 109th Congress to implement each and every action item that fell within the Science Committee's jurisdiction. Sadly, little of the competitiveness agenda made it into law, but in the 110th Congress, that will change. There is a bipartisan consensus that investing in education and research along the lines of the *Gathering Storm* report is necessary.

That is why I am reintroducing H.R. 362 and H.R. 363 in the first days of this Congress. And I am pleased that Speaker Pelosi has made these two bills a major part of her competitiveness agenda. H.R. 362 is *"10,000 Teachers, 10 Million Minds" Science and Math Scholarship Act.* This bill addresses the critical shortage of certified science and math teachers in the U.S. It will produce a new corps of outstanding science and math teachers who are dedicated to and well prepared for teaching. And this is not an experiment. We know that the model works, and President Dynes, who is on our panel today, can discuss about the success of CalTeach Program which uses the same technique.

H.R. 362 also addresses the needs of the current science and math teachers through summer institutes and Master's degree programs, focused on content knowledge, that are targeted just for them. And we are not talking about the old-fashioned professional development programs, we are talking about sustained programs

focusing on disciplinary knowledge of teachers that will create a network of 50,000 teacher leaders across this country. H.R. 362 places these education programs at the National Science Foundation, and Dr. Lane on our panel today can explain why the National Science Foundation is the right agency for this job.

Leaders of the business community, such as Mr. McGraw, Ms. Wince-Smith, and Mr. Barrett, are on the panel today, will explain to us why the full breadth of the corporate sector takes an interest in pre-college math and science education.

In order to produce the most innovative scientists and engineers in the world, our children must be the highest achieving science and math students in the world, but the pathway that leads to innovation in the global economy doesn't end at the twelfth grade or with a college education. We also need to support the research and development enterprise in science and technology to maintain our world leadership in these areas.

That brings me to the second bill, H.R. 363, which the—which this committee reported unanimously, and should be before the full House next month. H.R. 363 is *Sowing the Seeds Through Science and Engineering Research Act.* Mr. Augustine, you might remember that term. I completely plagiarized your work, which I hope that you will find as a compliment. It was done so that it wouldn't be a Democratic or a Republican bill, but rather, a recommendation of this very well knowledged group.

This bill will strengthen long-term basic research in the physical sciences, mathematical sciences, and engineering. It directs funding toward graduate students and early career researchers in these areas. It also establishes a Presidential Innovation Award to stimulate scientific and engineering advances in the national interest.

Investing in science education and research along these lines is necessary if the U.S. is to maintain its position as a global leader in technology and innovation. Now, I don't claim these bills do everything. There are a variety of good ideas out there that address issues of national competitiveness, and this committee is going to be the committee of good ideas. So, even though these bills don't address every recommendation of the *Gathering Storm* report, they do address what seems to me to be the highest priorities concerning that, and that have bipartisan support, and you can be assured we will be building that bipartisan support for additional measures very soon.

Today, we have asked our distinguished panelists to address the reasons why the promotion of science and technology is so critical to America's prosperity, where we stand today, and where we need to be in the future. I look forward to hearing their expert testimony.

At this time, I recognize our distinguished Ranking Member, Mr. Hall, for his opening statement.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

It is my pleasure to welcome everyone this morning to this hearing of the Committee on Science and Technology on the critical importance of science and technology in the 21st century global economy. I want especially to welcome and to thank our distinguished panelists for taking the time to appear before us today.

In 2005, I joined Senators Bingaman and Alexander and Congressman Boehlert in asking the National Academy of Science to study the urgent challenges facing the United States in maintaining global leadership in science and technology.

In response, the Academy formed an all-star committee and issued their report entitled *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future."* That committee was chaired by Mr. Augustine and included Mr. Barrett, both of whom are here as witnesses today.

It has become an enormously influential report, not only owing to the grave dangers it predicts if we are complacent but also owing to 20 constructive action items it spells out that will lead to continued American leadership and prosperity.

I am an enthusiastic advocate of the report and, after studying its recommendations, I drafted legislation in the 109th Congress to implement each and every action item that fell within the Science Committee's jurisdiction.

Sadly, little of that competitiveness agenda made its way into law.

But in the 110th Congress that will change. There is a bipartisan consensus that investing in education and research along the lines of the *Gathering Storm* report is necessary. That is why I re-introduced H.R. 362 and H.R. 363 in the first days of this new Congress.

H.R. 362 is the *"10,000 Teachers, 10,000,000 Minds" Science and Math Scholarship Act.* This bill addresses the critical shortage of certified science and math teachers in the U.S. It will produce a new corps of outstanding science and math teachers who are dedicated to and well prepared for teaching.

This is not an experiment. We know the model works. President Dynes on our panel today can tell us about the successful "CalTeach" program, which uses the same approach.

H.R. 362 also addresses the needs of current science and math teachers, through summer institutes and Master's degree programs focusing on content knowledge that are targeted just for them. We're not talking about old-fashioned professional development programs. We are talking about sustained programs focusing on disciplinary knowledge of teachers that will create a network of 50,000 teacher leaders across the country.

H.R. 362 places these education programs at the National Science Foundation. Dr. Lane on our panel today can explain why the National Science Foundation is the right agency for this job.

Leaders of the business community, such as Mr. McGraw and Ms. Wince-Smith on today's panel, can explain to us why the full breadth of the corporate sector takes an interest in pre-college math and science education.

In order to produce the most innovative scientists and engineers in the world, our children must be the highest achieving science and math students in the world. But the pathway that leads to innovation in the global economy doesn't end at the 12th grade or with college graduation. We also need to support the research and development enterprise in science and technology to maintain our world leadership in these areas.

That brings me to the second bill, H.R. 363, which this committee reported unanimously and should be before the full House next month.

H.R. 363 is the *Sowing the Seeds Through Science and Engineering Research Act.* This bill will strengthen long-term basic research in physical sciences, mathematical sciences, and engineering.

It directs funding toward graduate students and early-career researchers in these critical areas. It also establishes a presidential innovation award to stimulate scientific and engineering advances in the national interest. Investing in scientific education and research along these lines is necessary if the United States is to maintain its position as a global leader in technology and innovation.

Now I don't claim that these bills do everything. There are all kinds of good ideas out there addressing issues of national competitiveness, and this committee is going to be the "committee of good ideas."

Even though these bills don't address every recommendation in the *Gathering Storm* report, they do address what seems to me to be the highest priority concerns that have bipartisan support.

Today, we've asked our distinguished panelists to address the reasons why the promotion of science and technology is so critical to America's prosperity; where we stand today; and where we need to be in the future. I look forward to hearing their expert testimony.

Mr. HALL. Thank you, Mr. Chairman, and I understand that you had a well attended press conference, and I am sorry I missed it. I always enjoy hearing what our leader says, and Mr. Augustine,

and Norm, nice to have you here again. You have been here many times, and I have quoted your statement that we can't be 911 to the whole world a lot of times. I always got good response on it.

And I say to Dr. Neal Lane that I might be your President if I had answered the letter correctly I received, that I was in the top ten in consideration to be President of Rice University. And I simply sent them back a copy of my transcript, and a press release that said that I had made four Fs and a D one time, and my dad punished me for spending too much time on one subject. So, I have got both those letters in my office up there. I have not heard back from them. So——

But I always—I am on the positive side. All of you who were there will be spared listening to my being repetitive. My message for this hearing is the same. If America is going to remain on top of the evolving world economy, we have to be dedicated to improving our workforce. We don't have time to stop for a breather, because countries like China and India are breathing down our necks, pumping out doctors and pumping out engineers, through great difference in numbers, probably not quality, but in numbers alone.

Today, we are—today's workers increasingly require a solid academic foundation in science and math, as well as technical know-how, in order to succeed in today's high-tech workplace. Despite these growing demands nationally, only one out of every fifty high school graduates will ever obtain an engineering or technical degree. Further, most American high school graduates are either not sufficiently prepared or not sufficiently motivated to pursue advanced study in science, math, engineering, or technology fields, and this is a real problem.

While there are no quick fixes, we can take steps now to reexamine and improve how teachers teach, and how students learn math and science, and I am pleased to see the Science Committee doing just that. Mr. Chairman, I salute you for that, and I thank you for that.

As a part of the H.R. 362, which I believe is on the agenda for today, I am particularly pleased to see that we are using University of Texas, UTeach, not UT, that would be University of Texas, or some say University of Tennessee, but UTeach is a program that they use as a basis for scholarship programs for the STEM students, who commit to teaching K–12 science and math classes after graduation. This program has been replicated and expanded to University of California, and I look forward to hearing more about it from Dr. Dynes.

Along with improving education, Congress should also work to promote competitiveness by increasing Federal R&D funding, while simultaneously stimulating private sector R&D. The Administration's American Competitiveness Initiative is working to do just that on the federal level, but there is still some room for creativity on how to increase private sector basic research. The government's role for the latter should be to create a system of incentives.

As the President said, and I quote, "The role of government is not to create wealth. The role of our government is to create an environment in which the entrepreneur can flourish, in which minds can expand, and in which technologies can reach new frontiers."

Encouraging private sector innovation through tax credits and other such programs will improve the American economy, make us more competitive globally, and also bring new products to the American people.

I have seen firsthand America's innovative capabilities, and I know we can do better. America's preeminence in the global economy depends on what all of us do today, each of us, all levels of government, industry, academia, parents and students, has an important role to play in keeping America competitive and ahead of the innovative curve.

I look forward to working closely with you, Mr. Chairman, on these competitiveness issues, and to hearing what our esteemed witnesses have to say on the subject.

And with that, I yield back my time, and I thank you, sir.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Thank you Mr. Chairman, and good afternoon. We just wrapped up a press conference to highlight the importance of innovation and the role that Congress and others can play in promoting American competitiveness. I have not changed my mind in the last few minutes, so I think I will stick with the same message. It's pretty simple.

If America is going to remain on top in the evolving world economy, we must be dedicated to improving our workforce. We don't have time to stop for a breather because countries like China and India are breathing down our necks, pumping out doctors and engineers.

Today's workers increasingly require a solid academic foundation in science and math, as well as technical know-how, in order to succeed in today's high-tech workplace. Despite these growing demands nationally, only one out of every 50 high school graduates will ever obtain an engineering or technical degree. Further, most American high school graduates are either not sufficiently prepared or not sufficiently motivated to pursue advanced study in science, math, engineering or technology fields.

This is a problem.

While there are no quick fixes, we can take steps now to re-examine and improve how teachers teach and students learn math and science, and I am pleased to see the Science Committee doing just that.

As a part of H.R. 362, which I believe is on the agenda for today, I am particularly pleased to see that we are using the University of Texas UTeach program as a basis for a scholarship program for STEM students who commit to teaching K–12 science and math classes after graduation. This program has been replicated and expanded at the University of California, and I look forward to hearing more about it from Dr. Dynes.

Along with improving education, Congress should also work to promote competitiveness by increasing Federal R&D funding, while simultaneously stimulating private sector R&D. The Administration's American Competitiveness Initiative is working to do just that on the federal level, but there is still room for creativity on how to increase private sector basic research. The government's role for the latter should be to create a system of incentives.

As the President said, *"The role of government is not to create wealth; the role of our government is to create an environment in which the entrepreneur can flourish, in which minds can expand, in which technologies can reach new frontiers."*[1] Encouraging private sector innovation through tax credits and other such programs will improve the American economy, make us more competitive globally, and also bring new products to the American people.

I have seen first-hand America's innovative capabilities, and I know we can do better. American preeminence in the global economy depends on what all of us do today. Each of us. . .all levels of government, industry, academia, parents and students. . .has an important role to play in keeping America competitive and ahead of the innovation curve.

[1] President George W. Bush, May 2001.

I look forward to working closely with you, Mr. Chairman, on these competitiveness issues and to hearing what our esteemed witnesses have to say on the subject.

Chairman GORDON. Thank you, Mr. Hall. I ask unanimous consent that all additional opening statements submitted by the Committee Members be included in the record. Without objection, so ordered.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman.

Multiple indicators tell us our nation is falling behind, when it comes to world competitiveness in science, technology, engineering and math.

I have seen a few examples in which a concerted effort by industry, or by a university, or even a scholarship program really makes a difference in student achievement.

Townview High School in Dallas comes to mind. Or the UTeach program at the University of Texas.

However, I have also seen many more schools struggle, with teachers feeling constrained with rigorous curricula but few resources to bring that curriculum to life for their students.

Despite the Federal Government's best efforts, young Americans are being "left behind." Many of these students are in high-need school districts, in poor urban and rural areas.

I appreciate the work that went into the report called *Rising Above the Gathering Storm.* I feel it is a definitive science policy guidebook.

However, the report isn't comprehensive. I feel that high-need schools are still getting left behind.

I also would like to see more attention given to encouraging women, Blacks and Hispanics to enter STEM fields and obtain advanced degrees. I'll be interested to hear your recommendations on this issue.

I welcome today's witnesses and appreciate your candid feedback on legislation we are developing in the Committee on Science and Technology.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman, thank you for hosting this hearing to address the importance of science and technology to the global competitiveness of our nation.

I share the concerns of many of you here today. Our nation's standing as the global leader in science and technology has slipped in recent years and I believe we need to counteract this worrying trend.

Last year I received a letter, from a mother in New Jersey whose 14-year-old daughter was not satisfied with her education. This girl wanted permission from her parents to move to Beijing for high school because she felt her counterparts in China were getting ahead. To me, this story underscores the need for our nation to strengthen its investment in education. In particular, America must commit to education in math, science and engineering to promote innovation and technological advancement. I request that this letter be submitted to the record.

I am pleased that the National Academy of Sciences has provided us with an excellent report, *Rising Above the Gathering Storm,* to focus on these crucial issues. I am similarly pleased that the Chairman has introduced legislation to implement the recommendations of the report. Last August, Mr. Gordon visited St. Louis for an outstanding panel discussion on innovation. Mr. Chairman, I can assure you that your visit sparked a conversation about competitiveness, STEM education and innovation that continues with enthusiasm in St. Louis. I look forward to working with the Committee and participating in the ongoing debate.

I want to thank all of the witnesses for being here today and I look forward to hearing the testimony.

[The information follows:]

Eva Lerner-Lam
47 Oxford Drive
Tenafly, NJ 07670

February 28, 2006

The Honorable Russ Carnahan
1232 Longworth House Office Building
Washington, DC 20515

Dear Congressman Carnahan:

RE: MY DAUGHTER'S EDUCATIONAL EXPERIENCE IN BEIJING, CHINA

We met at a breakfast function several months ago in Washington DC, and you asked that I write a brief letter to you describing my then-14-year-old daughter's educational experience in Beijing, China. Although I cannot say for certain that she will be successful in her endeavor, things so far seem to indicate that she made the right decision.

Born and raised in northern New Jersey, Katie's decision to uproot herself and move to Beijing, China came about in the spring of 2005 as a result of learning that I had been offered a Beijing-based job opportunity. She asked if she could come along with me and study all four years of high school there. Although I eventually turned the offer down, Katie was highly motivated to make the move anyway. In her words, "I want to learn Chinese, both the language and the culture. Anything that happens there, I want to experience in my own way, not filtered through the media." My husband and I tried to dissuade her from the notion of from moving to China until after college, when she would have her formal education behind her. Indeed, at that time in April 2005, she did not speak or read Chinese at all! She came right back at us, insisting that girls her age in China were quickly learning English and western ways of thinking and she already felt she, in America, was "behind" them, both in terms of basic educational content and in "thinking globally."

After great deliberation, my husband and I decided to support our daughter's initiative by having me move with her to Beijing in August for a six-month trial period. We were, of course, concerned about whether or not she would be able to grasp the language and catch up on all that was taught in earlier grades to her classmates. Even more important was the need to verify the educational standards that would be used; if we decided at any point in her high school career in Beijing to bring her back to New Jersey, just where would she be with respect to her academic qualifications? Indeed, even if she graduated with honors from a Beijing high school, would she be qualified for an American college education?

The results so far have been encouraging. The course materials at her public high school are standardized across the nation, and the testing is regular and rigorous. Katie's language skills have kept her in good stead in her classes (all her courses are taught entirely in Chinese). She studied very hard and did well on her first semester exams. We found that the math, physics, chemistry, biology, geography and history are taught very systematically and comprehensively, and despite the tediousness of having to look up almost every word of every homework problem in the dictionary for the first several months, Katie found the subject matter exceedingly well-presented and easy to learn. There is a heavy emphasis on science and math, and also a new move to have students think creatively and innovatively, to better prepare them for competition in the global marketplace. Katie likes her teachers, the subject matter and the intensity of the learning. We'll see how she does on her US-based Preliminary Scholastic Aptitude Tests (PSAT's) in her junior year of high school, but so far, so good.

Outside of the good education offered in the public school system here in Beijing, we are impressed by the emphasis that Chinese families give to education and its role in enabling China's growing global competitiveness. We have observed that most Chinese families view education as the most important factor in preparing their children to contribute to a global, not just Chinese, marketplace. Most Chinese families hire home tutors to ensure that their children understand the material and properly prepare for exams. Bookstores are crowded on weekends with parents buying extra study review workbooks. Computer stores sell inventory as quickly as stock comes in. Awareness of global culture is commonplace and sophisticated. With fiber optic rings around every major metropolitan area in the country, broadband access to the Internet is readily available and affordable, and government search engine and press controls are not an effective factor in limiting access to knowledge. Katie's peers are all online, blogging and downloading music and videos just like their American counterparts. It seems that everyone has a mobile phone. Most people abroad see Chinese exports, and skyscrapers, bridges and dams as signs of China's rise; we see all the ways that China's *people* are rising. Our daughter's initial observations are correct: one does need to see China unfiltered.

From our perspective, as long as our daughter can keep up with the rigorous academic requirements at her public high school in Beijing, we'll continue to support her efforts to succeed there. She will understand "the China Story" of the 21st century, and, we expect, will develop an internationalist viewpoint. We hope that she will continue to be happy there and that she will be able to use the education she is getting there to better prepare herself to compete globally.

Respectfully,

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

To remain competitive in the global economy, America needs technological innovation.

Today's hearing focuses on the education and research recommendations of the National Academy of Science's (NAS) report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*

The question is how to increase the number of innovators. We must encourage and inspire well-trained STEM educators—educators to inspire a new generation of scientists and engineers.

If the number of students studying science and technology continues to decrease, American competitiveness will also decline.

If we don't invest now and invest well, we will fall even further behind. Students today will be the innovators keeping American companies and their operations here tomorrow.

I yield back the balance of my time.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

It is wonderful to have such a distinguished panel with us today. Each of you is an expert in the relationship between our national economic competitiveness and science and technology. I am pleased that the Chairman has scheduled this hearing early in the 110th session and I appreciate his commitment to action on the recommendations of the *Gathering Storm* report.

As we work to ensure that our best and brightest students will be attracted to science, technology, engineering and math fields, we also must make sure we focus on improving math and science literacy for all of our students. I am pleased that H.R. 362 includes provisions supporting the training and retention of STEM teachers, and feel very strongly that teachers have a tremendous impact on student enthusiasm and interest in these subjects. Our system must foster a desire to explore the unknown, ask good questions, and equip our citizens with quantitative skills that will be useful in all parts of the workforce. There is no substitute for the inspiration provided by a teacher who has a passion for the subject they are teaching. Such passion is impossible without a solid foundation in pedagogy and content.

Finally, I would also like to note that one of the recommendations of the *Gathering Storm* report was to ensure that the United States is a hospitable location for innovative companies. While many of the recommended implementation steps to achieve this goal lie outside of the jurisdiction of this committee, I would note that the panel cited manufacturing and marketing as key activities related to innovation. The National Institute of Standards and Technology (NIST) works very closely with industry on programs to implement innovative technologies from the laboratory into the field. I want to make sure the Committee values NIST's important contribution to our national competitiveness, and look forward to working with my colleagues on an upcoming authorization bill for the agency.

Chairman GORDON. Now, I am pleased today to welcome this illustrious panel of academic, business, and government leaders to testify before the Committee.

First, Mr. Norm Augustine. As Mr. Hall has said, he has been before our committee many times, and we are the better off for it. He is the retired Chairman and CEO of Lockheed Martin. He is also a member of the Advisory Board to the Department of Homeland Security, and served for 16 years on the President's Council of Advisors on Science and Technology. In the 1970s, he served as Under Secretary, and then Acting Secretary of the Army. And Mr. Augustine chaired the National Academies committee that wrote the *Gathering Storm.* Mr. Augustine.

STATEMENT OF MR. NORMAN R. AUGUSTINE, CHAIR, COMMITTEE ON PROSPERING IN THE GLOBAL ECONOMY OF THE 21ST CENTURY, COMMITTEE ON SCIENCE, ENGINEERING, AND PUBLIC POLICY, DIVISION ON POLICY AND GLOBAL AFFAIRS, THE NATIONAL ACADEMIES; FORMER CHAIRMAN AND CEO, LOCKHEED MARTIN CORPORATION

Mr. AUGUSTINE. Mr. Chairman and Members of the Committee, thank you very much for this opportunity to speak with you about a topic that I deem to be one of the most important facing America today.

Mr. Chairman, with the Committee's permission, I would like to submit a formal statement for the record and briefly summarize it here. Thank you.

As you pointed out, it was my privilege to chair the National Academies committee that wrote the *Gathering Storm* report, and you were kind enough or polite enough not to mention that it was really because of your efforts and those of your colleagues that the Academies began this effort in the first place.

It was an effort that, of course, joined those of many other organizations, including the Council on Competitiveness. Our committee included 20 members who were nonpartisan. The membership was broad, and included CEOs of major corporations, presidents of universities, three Nobel laureates, a former state superintendent of schools, and a number of former Presidential appointees. Our findings were essentially unanimous, and I will briefly summarize them in a moment.

The underlying principle behind our work was what has been called the death of distance, which refers to the notion that many transactions that, in the past, required people to be in proximity to one another no longer do. And that means that, for example, when you have a CAT-scan to be read, it may be read by a physician in Australia; when you need software, it may be written by an engineer in Bangalore, and when you need your income tax prepared, it may be prepared by an accountant in Costa Rica.

Tom Friedman has said, in his marvelous book about the Earth being flat, that globalization has accidentally made Bangalore, Beijing, and Bethesda next-door neighbors, and when it comes to seeking jobs, that is certainly true. At the end of the Cold War, over three billion new would-be capitalists entered the world job market, and it is a world job market. Those three billion people are highly motivated, increasingly well educated, and willing to work for a fraction of what American workers at all levels are willing to work for, or at least have been accustomed to working for.

That suggests that we have a major competitiveness disadvantage that we have to find a way to offset. It has been the view of virtually every study with which I am familiar, certainly our recent National Academies study, that that offset will have to come from being the world's best innovators and first to market.

There are a number of indications that things are not going particularly well in that regard. Although our overall economy looks good in many respects, Americans, with five percent of the world's population, produce 28 percent of the world's goods and services. We have created two million net new jobs each year in recent years. Household net worth just passed $50 trillion, but there are a lot of worrisome signs, the gathering storm, if you will.

For example, of new R&D facilities that are to be built in the world, in the next few years, 77 percent are scheduled to be in India or China. You are all familiar with the fact that the world-renowned Bell Labs, I think unarguably, once the finest corporate research facility in the world was recently sold to the French, or what was left of that lab. The R&D investment in the physical sciences has been stagnant for 20 years in this country in real dollars. Of course, it is good things that others prosper, but the Na-

tional Academies' goal is to insure that America continues to prosper.

Our committee's findings were straightforward. The first was that our standard of living, and indeed, our security, in the years ahead, will depend on people having high-quality jobs in America. Second, to have high-quality jobs, we are going to have to be exceptional in science and technology, because those are the fields that underpin, to a very large degree, innovation, which is likely to be our primary competitive advantage.

Of recommendations we have made that have to do with science and technology, the first is that the federal investment in basic research be doubled in real dollars over the next seven years.

Second, a series of special grants should be set up for young researchers. Many of the great technical and scientific breakthroughs have been by young people, but because of the constraints on funding, and conservatism in grant funds, first grants, on the average, go to a person 42 years old.

Third, $500 million a year should be devoted to modernizing the instrumentation and equipment infrastructure of scientific research labs in this country.

Fourth, eight percent of the R&D budget should be set aside for discretionary application by the heads of local laboratories, the people who know best where the promise of future innovation lies, with a focus on high-risk high-payoff research.

Fifth, we proposed creating the equivalent of an Advanced Research Project Agency (ARPA) in the Department of Energy. ARPA was successful in most people's eyes, in helping the Department of Defense. Our hope is that ARPA–E can do the same thing in the Department of Energy.

Finally, we suggested, and you referred to this, Mr. Chairman, in your remarks, a National Award for Innovation.

The reaction of the media and the public to our recommendations has been astonishingly favorable. I have a collection of op-eds, several from each state in the union, almost all supporting our findings. Because of its length, I won't submit it for the record, but if the Members would like a copy, I would be happy to see that you get it.

And with that, Mr. Chairman, again, thank you for this opportunity to address your committee.

[The prepared statement of Mr. Augustine follows:]

PREPARED STATEMENT OF NORMAN R. AUGUSTINE

Can America Compete for Jobs?

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to participate in this hearing which addresses one of the most significant challenges facing America today: our nation's ability to preserve, and hopefully enhance, the standard of living and quality of life enjoyed by America's citizens. Unfortunately, because of absent decisive action on the part of our nation's leaders, there is a very real likelihood that today's adult generation will leave to its children, for the first time in our nation's history, a sustained, substantially lower standard of living than it enjoyed.

I would like to begin my testimony by thanking you, Mr. Chairman, for your courageous leadership in placing science and engineering on the Nation's agenda. I believe that there has been a broad awakening in America as to the impact of science

and technology and the consequences of its neglect. You and the Members of this committee were among the first to sound the alarm.

As you may be aware, it was my privilege to serve as Chair of the National Academies' assessment of our nation's future competitiveness. This committee, whose report became known as the *"Gathering Storm"* report, has completed its assigned task and, in keeping with the Academies' policies, been disbanded. Given that circumstance, the views I express today will be my own, speaking as a private citizen. However, I believe that my remarks are generally reflective of the views of my colleagues on the National Academies' committee. The committee's 20-person membership consisted of former presidential appointees, CEO's, Nobel Laureates, a State Superintendent of Schools, and several university presidents. . .one of whom has recently found new employment as Secretary of Defense. I should note that many other individuals and organizations have devoted enormous talent and energy to helping address the competitiveness challenges our nation faces, including the Council on Competitiveness, the Business Roundtable, the National Association of Manufacturers, the American Association of University Presidents, the Chamber of Commerce, the National Association of State Universities and Land-Grant Colleges, the American Physical Society, the American Association for the Advancement of Science, and numerous others.

It was through the encouragement of Members of the Senate and House of Representatives that the National Academies' project was initiated, and in particular Senators Alexander and Bingaman and Representatives Boehlert and you, Mr. Chairman, requested that an assessment be conducted. It would be difficult to cite a finer example of bipartisan cooperation in addressing a problem of critical importance to America's citizenry than that which took place following the release of the National Academies' *"Gathering Storm"* report and involving the White House and Cabinet Officers, the House of Representatives, and the Senate. The initial legislation to implement the Academies' recommendations had 70 co-sponsors in the Senate—35 Democrats and 35 Republicans. Similar support has been found in the House.

I have with me a collection of editorials and op/eds from newspapers in all 50 states. Virtually all indicate support for the Academies' findings and recommendations. I will, because of the document's length, not request that it be included in the record, but if any of the Members would like a copy I would be pleased to have one delivered to your office.

Having examined a great deal of evidence, the committee concluded that America's ability to compete for jobs in the years ahead will depend heavily upon our ability to maintain a strong position in the fields of science and engineering. It will be these fields that will underpin the innovation that in turn will create quality jobs for Americans. And to fill those jobs, *all* our citizens will need the basic tools required to function in a high-tech world. Eight different studies conducted in recent decades indicate that public investments in science and technology have produced societal returns that range from 20 to 67 percent per year. Various other studies have concluded that between 50 and 85 percent of the Nation's growth in GDP per capita during the last half-century can be attributed to science and engineering progress. In fact, one would be hard-pressed to find a better investment than research and education.

While a great deal has been accomplished, much remains to be done. The Academies' estimate of the incremental cost, at the federal level, of putting the Nation in a position to compete, will grow from $9B per year to $19B per year over the next five years. This is not a one-year competition in which we find ourselves—it is a seismic change, comparable to that the Nation underwent when it encountered a shift from 84 percent of its workers being involved in agriculture in the early 1800's to about one percent today. The transition to a globalized economy will, however, be markedly faster, with three billion would-be capitalists having entered the global job market in the past two decades alone and the number of nations actively participating in that market suddenly increasing from 25 to 66. These job candidates are highly motivated, willing to work for a fraction of the compensation U.S. workers receive, and are increasingly well educated. Furthermore, they span the employment spectrum from laborers and assembly workers to medical doctors, accountants and engineers.

It has been 17 months since the Academies' report was issued and while substantial preparatory work is now in place, including the FY07 continuing resolution, little impact of this effort has yet to be felt where it matters: in America's factories, schools, and research laboratories. The year ahead will be decisive in this regard, a period that one day may be looked back upon as a "tipping point"—one way or the other. The question is whether we have the staying-power to sustain the efforts which have now been initiated.

During the months since the Academies' report was issued, the world has, unfortunately, not been standing still waiting for us: An entire new generation of semiconductor integrated circuits, the mortar of the modern electronics revolution, has been introduced; Toyota now has eight times the market capitalization of General Motors and Ford, combined; the remnants of what was once the world's greatest industrial research lab, the legendary Bell Labs, the home of the transistor and the laser and numerous Nobel Laureates, has now been sold to a French firm; for the first time the most capable high-energy particle accelerator in the world does not reside in the United States; another $650 billion has been spent on our public schools which, according to recent standardized tests in science, was accompanied by a moderate improvement in performance in the lower grades and further deterioration in the 12th grade—suggesting that the longer our children are exposed to our schools, the worse they fare. In addition, U.S. investors put more new money into foreign stock funds than U.S. funds; 77 percent of the new research laboratories currently planned to be built in the world will reside in just two countries—neither of which is the United States; American firms once again spent more on litigation than on research and development; U.S. undergraduate engineering enrollment remained generally flat according to the latest data; nearly all the major Initial Public Offerings in the world during the period took place outside the United States; the German firm which not long ago purchased one of America's Big Three automakers, Chrysler, has now, upon closer inspection, decided it doesn't want it after all; the Academies' recommendation to add $9 billion to the federal budget was debated as U.S. citizens gambled $7 billion on the Super Bowl; our children continued to spend more time watching television than in the classroom; and the World Economic Forum in Geneva precipitously lowered its rating of U.S. competitiveness from first place to sixth.

A particularly troublesome aspect of the challenge we face is that there has been and will be no sudden wake-up call—no Sputnik, no 9/11, no Pearl Harbor—rather, the situation is much more analogous to the proverbial frog being slowly boiled. The economy is of course doing quite well, and it has to be considered a major positive that other nations are prospering. The challenge for America is to continue to be among those nations that prosper—and in this regard virtually all the warning trends are headed in the wrong direction.

As Tom Friedman concluded in *The World is Flat,* globalization has "accidentally made Beijing, Bangalore and Bethesda next door neighbors"—a neighborhood wherein able candidates for jobs which have traditionally resided in the United States are now just a mouse-click away.

It should be noted that while the Academies' committee focused on creating and sustaining jobs, the impact of the competitiveness race on our nation's physical security could be even more profound. Several years ago it was my privilege to serve on the bipartisan Hart-Rudman Commission on National Security, one of the two primary findings of the group being, ". . .the inadequacies of our system of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine." Indeed, the consequences of current trends are particularly acute for defense firms, which must rely upon U.S. citizens for much of their engineering force and cannot simply shift work overseas as does much of the commercial sector.

The National Academies' report offers four recommendations and 20 specific implementing actions to begin the process of assuring America's future competitiveness and security. The four recommendations address strengthening our K–12 public schools, significantly increasing the Nation's investment in basic research, encouraging more of the Nation's "best and brightest" to become engineers and scientists; and reconstituting the Nation's innovation ecosystem in such areas as patent policy, tax policy, litigation policy, and immigration policy. The Academies' report proposes undertaking these tasks within an overall framework that focuses upon reducing the Nation's energy dependence, since that is a task of the utmost importance and is closely coupled to the attainment of advancements in science and engineering.

The two highest priorities cited in the National Academies' report are, first, to increase the number of K–12 teachers with university degrees in the physical sciences, math or engineering, and, second, to substantially increase the basic research budget in math, engineering and the physical sciences while, at a very minimum, preserving the purchasing power of the Nation's on-going investment in the biosciences. The growth in recent years in funding of the health sciences is already paying significant dividends.

The Academies' specific recommendations with regard to science were presented in *"The Gathering Storm"* report under the heading, "Sowing the Seeds" and focused

on strengthening the Nation's traditional commitment to long-term *basic* research through:

- Increasing federal investment in research by 10 percent per year (real growth) over the next seven years, with primary attention devoted to the physical sciences, engineering, mathematics, and information sciences—without *dis*investing in the biological sciences.
- Providing research grants to early career researchers.
- Instituting a National Coordination Office for Research Infrastructure to oversee the investment of an additional $500M per year for five years for advanced research facilities and equipment.
- Allocating at least eight percent of the existing budgets of federal research agencies to discretionary funding under the control of local laboratory directors.
- Creating an Advanced Research Projects Agency-Energy (ARPA–E), modeled after DARPA in the Department of Defense, reporting to the Department of Energy Under Secretary for Science. The purpose of this entity would be to support on a competitive basis the conduct of long-term "out-of-the-box," transformational, generic, energy research by universities, industry and government laboratories.
- Establishing a Presidential *Innovation* Award to recognize and stimulate scientific and engineering advances in the national interest.

It is critical that we assure the existence of a long-term talent base to pursue the needed science and engineering activity, which together comprises the underpinning of much of America's innovation enterprise. Warranting particular emphasis is the matter of encouraging women and minorities, now widely under-represented in the science and engineering community, to pursue careers in these fields. America, already handicapped in this global competition by its wage scale, cannot afford to fail to avail itself of the talents of over half its citizenry. The committee recommended, under the heading, "Best and Brightest":

- Establishing 25,000 competitive science, mathematics, engineering, and technology undergraduate scholarships and 5,000 graduate fellowships in areas of national need for U.S. citizens pursuing study at U.S. universities.
- Providing a federal tax credit to employers to encourage their support of continuing education of their employees.
- Providing a one-year automatic visa extension to international students who receive a science or engineering doctorate at a U.S. university and meet normal security requirements, and providing automatic work permits and the opportunity for expedited residence status if these students are offered employment in the U.S.
- Instituting a skill-based, preferential immigration option.
- Reforming the current system of "deemed exports" so that international students and researchers have access to necessary non-classified information and research equipment while studying and working in the U.S.

Absent decisive steps, America's business base is almost certain to migrate to other, more competitive countries in the years ahead—in fact, it is already doing so. Under such a circumstance our nation could find itself with some of the world's richest investors living in a sea of unemployment. The consequences of this for stability and prosperity are evident.

Fortunately, it is not yet too late. . .but it *is* getting late. With the strong involvement of our nation's leaders, including the continuing support of the Members of this committee, we can assure that our science base remains vigorous, our K–12 educational system is rebuilt, our innovation infrastructure once again becomes the most attractive in the world—and our children are assured of an opportunity for a life even better than most of us have enjoyed.

Thank you again for permitting me to address this important topic. I would of course be pleased to answer any questions you might have.

NATIONAL ACADEMIES "GATHERING STORM" COMMITTEE BIOGRAPHIC INFORMATION

NORMAN R. AUGUSTINE [NAE*] (Chair) is the retired Chairman and CEO of the Lockheed Martin Corporation. He serves on the President's Council of Advisors on Science and Technology and has served as Under Secretary of the Army. He is a recipient of the National Medal of Technology.

CRAIG BARRETT [NAE] is Chairman of the Board of the Intel Corporation.

GAIL CASSELL [IOM*] is Vice President for Scientific Affairs and a Distinguished Lilly Research Scholar for Infectious Diseases at Eli Lilly and Company.GQ02

STEVEN CHU [NAS*] is the Director of the E.O. Lawrence Berkeley National Laboratory. He was a co-winner of the Nobel prize in physics in 1997.

ROBERT GATES is the President of Texas A&M University and served as Director of Central Intelligence.*

NANCY GRASMICK is the Maryland State Superintendent of Schools.

CHARLES HOLLIDAY JR. [NAE] is Chairman of the Board and CEO of DuPont.

SHIRLEY ANN JACKSON [NAE] is President of Rensselaer Polytechnic Institute. She is the immediate Past President of the American Association for the Advancement of Science and was Chairman of the U.S. Nuclear Regulatory Commission.

ANITA K. JONES [NAE] is the Lawrence R. Quarles Professor of Engineering and Applied Science at the University of Virginia. She served as Director of Defense Research and Engineering at the U.S. Department of Defense and was Vice-Chair of the National Science Board.

JOSHUA LEDERBERG [NAS/IOM] is the Sackler Foundation Scholar at Rockefeller University in New York. He was a co-winner of the Nobel Prize in physiology or medicine in 1958.

RICHARD LEVIN is President of Yale University and the Frederick William Beinecke Professor of Economics.

C.D. (DAN) MOTE JR. [NAE] is President of the University of Maryland and the Glenn L. Martin Institute Professor of Engineering.

CHERRY MURRAY [NAS/NAE] is the Deputy Director for science and technology at Lawrence Livermore National Laboratory. She was formerly the Senior Vice President at Bell Labs, Lucent Technologies.

PETER O'DONNELL JR. is President of the O'Donnell Foundation of Dallas, a private foundation that develops and funds model programs designed to strengthen engineering and science education and research.

LEE R. RAYMOND [NAE] is the Chairman of the Board and CEO of Exxon Mobil Corporation.

ROBERT C. RICHARDSON [NAS] is the F.R. Newman Professor of Physics and the Vice Provost for research at Cornell University. He was a co-winner of the Nobel Prize in physics in 1996.

P. ROY VAGELOS [NAS/IOM] is the retired Chairman and CEO of Merck & Co., Inc.

CHARLES M. VEST [NAE] is President Emeritus of MIT and a Professor of mechanical engineering. He serves on the President's Council of Advisors on Science and Technology and is the immediate Past Chair of the Association of American Universities.

GEORGE M. WHITESIDES [NAS/NAE] is the Woodford L. & Ann A. Flowers University Professor at Harvard University. He has served as an adviser for the National Science Foundation and the Defense Advanced Research Projects Agency.

RICHARD N. ZARE [NAS] is the Marguerite Blake Wilbur Professor of Natural Science at Stanford University. He was Chair of the National Science Board from 1996 to 1998.

* subsequently became Secretary of Defense

BIOGRAPHY FOR NORMAN R. AUGUSTINE

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 then 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 Mar-

tin Marietta Corporation in 1977, he served as Chairman and CEO from 1988 and 1987, respectively, until 1995, having previously been President and COO. He served as President of Lockheed Martin Corporation upon the formation of that firm in 1995, and became its CEO in January 1996, and later Chairman. Upon retiring from Lockheed Martin in August 1997, he joined the faculty of the Princeton University School of Engineering and Applied Science where he served as Lecturer with the Rank of Professor until July, 1999.

Mr. Augustine was Chairman and Principal Officer of the American Red Cross for nine years, Chairman 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 current or former member of the Board of Directors of ConocoPhillips, Black & Decker, Procter & Gamble, of which he is Presiding Director, and Lockheed Martin and is a member of the Board of Trustees of Colonial Williamsburg, a 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 to the Department of Homeland Security, was a member of the Hart/Rudman Commission on National Security, and has served for 16 years on the President's Council of Advisors on Science and Technology. He is a member of the American Philosophical Society and the Council on Foreign Affairs, 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 21 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 over 100 countries and stood on both the North and South Poles of the Earth.

Chairman GORDON. Thank you, Mr. Augustine, for your testimony, more importantly, your long-term commitment to our country.

Next, Mr. Harold Terry McGraw III is Chairman, President, and CEO of McGraw-Hill Companies. I guess when your name is on the front door, you can do whatever you want. He does it well, and is also the Chairman of the Business Roundtable, as well as the President of the Committee Encouraging Corporate Philanthropy.

Thank you, Mr. McGraw, for joining us today.

STATEMENT OF MR. HAROLD MCGRAW III, CHAIRMAN AND CEO, THE MCGRAW-HILL COMPANIES; CHAIRMAN, BUSINESS ROUNDTABLE

Mr. MCGRAW. Well, thank you, Mr. Chairman, and Ranking Member Hall, and Members of the Committee, and thank you for the leadership and the ideas that are embodied in H.R. 362 and H.R. 363. The CEOs of the Business Roundtable are very much in support of your work.

In 2005, the Business Roundtable and 14 other national business associations created the Tapping America's Potential campaign, with the goal of doubling the number of American science, technology, engineering, and mathematics graduates by 2015. We believe that expanding the talent pool is the critical element of the innovation agenda that America must pursue in order to remain competitive, and it is all about competitiveness.

America has a tremendous record of success and growth any way that you look at it, in economic terms, in technological terms, medical terms, any way. The United States has a $13.2 trillion economy, which is bigger than any other country by a wide margin. But

to keep moving ahead in our changing and increasingly very competitive world, everyone, young and old, needs a roadmap to find their way.

Business and government together need to help every American locate avenues to continually upgrade their skills and knowledge so that they can succeed. Education and lifelong learning are essential for a better life and a brighter future for America. Census data tells us that people with bachelor's degrees can earn more than twice as much as those with only a high school diploma, and three times more than a high school dropout.

Alliance for Excellent Education research shows that if the dropouts from the class of 2006 earned diplomas instead of dropping out, our economy would see an additional $309 billion in wages over those students' lifetimes. The economic impact of increasing our graduation rate is staggering to the individual and the economy as a whole. Johns Hopkins University research shows that half of our dropouts, half of our dropouts in this country come from 2,000 of our 14,000 high schools. We can get at half that problem if we just focus on those 2,000.

Your committee has been working on two important bills that would provide critical support for the foundation of America's innovation system. We endorse those bills, and let me tell you why. Our economy stands at a critical juncture. The United States is still, again, the world's economic leader, but that lead could slip. Powerful economic rivals have emerged, and these competitors are investing in innovation. Meanwhile, our federal support for research has declined, relative to the size of our economy.

In business, research is an investment pegged to sales or revenues, but federal funding for R&D has declined from 1.25 percent of GDP to 0.75 percent today. Imagine if a high-tech company invested in R&D at such a rate. Should we be investing in our children's future at a high-tech rate, or at least a greater rate than we do now, and if so, what should that rate be?

Also, demands of the workplace are increasing. The number of jobs requiring technical training is growing at five times the rate of non-technical jobs, but the U.S. education system is not keeping pace. More than half of the U.S. students entering college drop out before earning a degree, and the most recent data from the National Assessment of Educational Progress exams, NAEP, reveals that high school seniors' reading performance over the past decade actually declined, and according to NAEP, less than one quarter of seniors perform at their grade level or above in math.

The American people understand that the competitive landscape is changing. Today's challenge is about maintaining the higher standard of living Americans have come to expect. That means creating more high wage jobs in high value-added industries here in America. And it means preparing all of our citizens to compete and to succeed in the global economy. The key to our competitiveness challenge is innovation. Innovation drives productivity growth, creates new products, even whole new industries, and generates high wage employment and a higher standard of living for all Americans.

Productivity gains have created a new economic paradigm, enabling the Fed to maintain a generally accommodative interest rate

policy in the face of strong economic growth, without triggering inflation. It is time to implement the recommendations of the *Gathering Storm* report, and *Tapping America's Potential* report. We appreciate the work this committee is doing to press forward.

And finally, innovation is all about talent. In a world where natural resources, capital, and unskilled labor are all globally available, it is the well educated, skilled, and creative individual who will make the difference in economic performance. That is why the business community's innovation recommendations focus on education.

Today, American business and higher education leaders released the American Innovation Proclamation, urging Congress to double basic research at key federal science agencies, increase the funding of proven programs and incentives for math and science teacher recruitment and professional development, welcome highly educated foreign professionals, particularly those holding advanced science and technology degrees, especially from U.S. universities, by reforming our visa policies, and of course, our H–1B visa programs, and make permanent a strengthened R&D tax credit to encourage continued private sector innovation investment. And I am proud to be a signatory on this Proclamation, along with so many other business leaders who believe so much in what you are doing.

And in conclusion, it is worth noting that the forces driving economic integration and global competition were all invented here. America is in the best position to take advantage of the changing landscape and to continue to lead the world in these areas, so long as we recognize the challenges we face, we maintain the right focus on education, and invest where necessary to ensure that Americans succeed in the new environment.

Mr. Chairman, it is up to us to ensure that the 21st Century is the next American Century, and with your help and the Members of this committee, we will do just that.

Thank you.

[The prepared statement of Mr. McGraw follows:]

PREPARED STATEMENT OF HAROLD MCGRAW III

Mr. Chairman, Ranking Member Hall, Members of the Committee. Good afternoon. My name is Terry McGraw, Chairman, President, and CEO of The McGraw-Hill Companies.

I welcome the opportunity to appear before you today to address the vitally important issues of innovation and competitiveness not only on behalf of The McGraw-Hill Companies, but also as Chairman of Business Roundtable.

The McGraw-Hill Companies is a global information services provider headquartered in New York. We employ 20,000 people in 280 offices in 40 countries worldwide. You know us best through the McGraw-Hill imprint in education, Standard & Poor's, J.D. Power and Associates and *Business Week.*

Business Roundtable *(www.businessroundtable.org)* is an association of chief executive officers of leading U.S. companies with $4.5 trillion in annual revenues and more than 10 million employees. Member companies comprise nearly a third of the total value of the U.S. stock markets and represent over 40 percent of all corporate income taxes paid. Collectively, they returned $112 billion in dividends to shareholders and the economy in 2005.

Roundtable companies give more than $7 billion a year in combined charitable contributions, representing nearly 60 percent of total corporate giving. They are technology innovation leaders, with $90 billion in annual research and development spending—nearly half of the total private R&D spending in the U.S.

Both McGraw-Hill and Business Roundtable are passionate about innovation. In 2005, Business Roundtable, together with fourteen other national business associations, created the Tapping America's Potential campaign, or TAP, with the goal of

doubling the number of American science, technology, engineering and mathematics graduates with Bachelor's degrees by 2015. We believe that expanding the talent pool is a critical element—perhaps the critical element—of the innovation agenda that America must pursue in order to remain competitive in the 21st Century.

The McGraw-Hill Companies has a deep commitment to education and lifelong learning. In our rapidly changing and highly competitive world, every individual—young and old alike—needs a roadmap, a Global Positioning System if you will, to find their way. Not to find a location on a map or to provide driving directions, but to chart a course to succeed in our increasingly globalized society. Both business and government need to help every American locate avenues to continually upgrade their skills and knowledge. But it is a two-way street—every American also needs to recognize the importance of lifelong learning. For students it is particularly important to help them understand the important role that science, technology, engineering and math play in keeping routes open in their own global positioning system.

The McGraw-Hill Companies believe that education and lifelong learning are essential for a better life for all Americans. In the broader sense, education also is essential for a brighter future for America. U.S. Census data tells us that people with Bachelor's degrees have more than twice the average annual earnings of those with only a high school diploma and three times more than high school dropouts.

Business Roundtable endorses the Science and Technology Committee's bills, H.R. 362, *"10,000 Teachers, 10 Million Minds" Science and Math Scholarship Act,* and H.R. 363, *Sowing the Seeds Through Science and Engineering Research Act.* These bills, if enacted, would provide critical support for the foundations of America's innovation system. They represent essential components of a broader innovation and competitiveness agenda that Business Roundtable believes must be enacted this year. I commend the Committee for moving the legislation forward. Now, let me tell you why I think that is so important.

The U.S. economy stands at a critical juncture. While the United States is still the world's economic leader, that lead is slipping.

- Powerful global economic rivals have emerged, some of which were minor competitors only a decade ago.
- These competitors are investing in innovation. For example, China more than doubled its research and development spending as a percentage of gross domestic product (GDP) from 0.6 percent in 1995 to 1.4 percent today. This, during a time of very rapid GDP growth.
- Meanwhile, in the United States, federal support for research has declined relative to the size of the economy. In business, we think of research as an investment that should be pegged to sales or annual revenue, but federal funding for research and development has declined from 1.25 percent of GDP in 1985 to 0.75 percent today. Imagine if a high tech company, for example, invested in R&D at such a rate. Shouldn't we be investing in our children's future at a high tech rate, or at least at a greater rate than we do now?
- The demands of the workplace are increasing. The number of jobs requiring technical training is growing at *five times* the rate of non-technical occupations.
- But the U.S. educational system is not keeping pace. More than half of U.S. students entering college will drop out before earning a degree. The United States ranks 17th in the world in the proportion of the college-age population earning a science or engineering degree.
- And just a few weeks ago, the most recent data from the National Assessment of Educational Progress exams revealed that high school seniors' reading performance over the past decade actually declined. And according to the NAEP, less than one quarter of seniors perform at their grade level or above in math.

The American people understand that the competitive landscape is changing. A poll commissioned by Business Roundtable in late 2005 showed that Americans are confident about the competitive position of the United States today, but unlike a decade ago when they believed that the United States would continue to be the world's economic leader, Americans now think that the United States will lose its competitive advantage in the future.

Like the public at large, Business Roundtable CEOs do not take America's leadership position for granted. Because our companies' operations are global, we see firsthand how rapidly other countries are improving their competitive position. Business Roundtable is confident of America's ability to compete and win in global markets but we know that past success is no guarantee of future performance.

Today's competitiveness challenge is about maintaining the higher standard of living Americans have come to expect in a flatter world with more nimble competitors. That means creating more high-wage jobs in high-value-added industries here in America. And it means preparing all of our citizens to compete and succeed in the global economy.

The key to America's competitiveness challenge is innovation. Technological innovation drives productivity growth. It creates new products and processes—even whole new industries—thereby generating high-wage employment and a higher standard of living for all Americans. Productivity gains have enabled the U.S. economy to grow in recent years at rates that previously had been considered likely to trigger inflation. The recent strong growth, low inflation environment is attributable to the extraordinary gains in productivity that the U.S. economy has enjoyed since the mid 1990s.

Economists estimate that fifty percent of productivity growth comes from innovation. A study by economists Kevin Hassett and Robert Schapiro found that the value of ideas and innovation generated by the U.S. economy is more than $5 trillion a year—some 42 percent of our GDP.

The wellsprings of innovation require constant nurturing, and maintaining U.S. innovation leadership demands hard work and investment.

We can meet this challenge.

Frankly, as a nation we have been too complacent. It has been 18 months since the National Academies released the *Gathering Storm* report. In addition, nearly two years ago, Business Roundtable and 14 other national business associations issued the *Tapping America's Potential* report that contained recommendations to double federal investments in fundamental research, reform visa and green card policies to welcome the best and the brightest from around the world, and improve U.S. K–12 math and science education by focusing on recruiting and training a greater number of qualified teachers.

As I mentioned earlier in my testimony, the Tapping America's Potential campaign adopted one strategic and overarching goal: to double the number of science, technology, engineering and mathematics graduates with Bachelor's degrees by 2015.

It is time to pass legislation and start implementing the recommendations. We appreciate the good work this committee is doing to press forward.

Innovation is all about talent. In a world where natural resources, capital, and unskilled labor are all globally available, it is well-educated, skilled, and creative individuals who make the difference in economic performance. That is why Business Roundtable and our TAP campaign partners have focused on education as the first among equals of the key elements of the business community's innovation recommendations. More than any other aspect of our innovation system, education is the potential Achilles heel for future U.S. economic competitiveness.

Mr. Chairman, as you know, America's competitiveness challenge has galvanized the business community. Just this afternoon, a broad coalition of American business and higher education leaders released the *American Innovation Proclamation,* which calls upon Congress to enact an innovation agenda to:

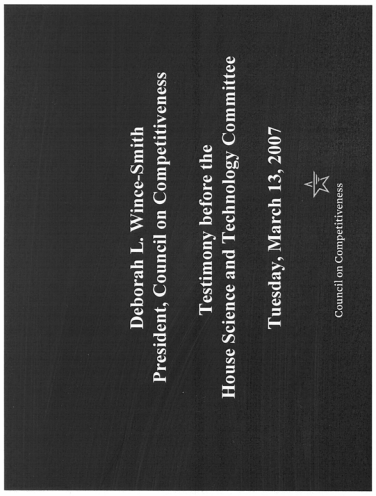
- One, renew America's commitment to discovery by doubling basic research at four key federal science agencies.
- Two, improve U.S. student achievement in math and science through increased funding of proven programs and incentives for math and science teacher recruitment and professional development.
- Three, welcome highly educated foreign professionals, particularly those holding advanced science, technology, engineering, or mathematics degrees, especially from U.S. universities, by reforming U.S. visa policies. We need to boost the number of H–1B visas beyond the very low level of only 65,000.
- And four, make permanent a strengthened R&D tax credit to encourage continued private-sector innovation investment.

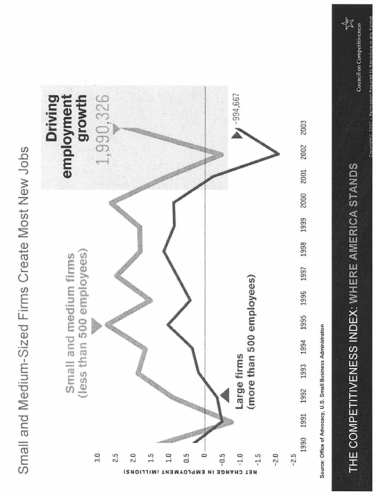
I am proud to be a signatory on this proclamation, along with some of my fellow panelists here. I believe that it embodies the right agenda for America. It is a positive agenda, which, if enacted, would open up new opportunities for America and her citizens. Of course, there are additional agenda items that Congress must address to ensure U.S. competitiveness. They include opening access to new markets, reducing health care costs, and reauthorizing a strengthened *No Child Left Behind Act,* among others. However, I will save that discussion for another day.

It is worth noting that the forces driving economic integration and global competition were all invented here. More than any other country, the United States created the conditions for global economic growth driven by accelerated technological inno-

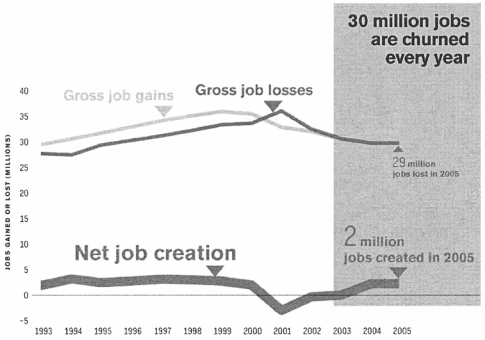
vation. America is in the best position to take advantage of the changing competitive landscape as long as we recognize the challenges we face and make the investments required to succeed in the new environment.

Mr. Chairman, it is up to us to ensure that the 21st Century is the next American Century. With your help, and the help of all of the Members of the Committee on Science and Technology, we will do just that.





The United States Has High Levels of Job Churn



Source: U.S. Bureau of Labor Statistics

THE COMPETITIVENESS INDEX: WHERE AMERICA STANDS

Council on Competitiveness

Copyright © 2007 – Permission Required to Reproduce in any Format

Council on Competitiveness

THE COMPETITIVENESS INDEX: WHERE AMERICA STANDS

Council on Competitiveness

Copyright © 2007 – Permission Required to Reproduce in any Format

BIOGRAPHY FOR HAROLD MCGRAW III

Harold McGraw III was elected Chairman of The McGraw-Hill Companies in December 1999; Chief Executive Officer in 1998; and President and Chief Operating Officer in 1993. He has been a member of The McGraw-Hill Companies' Board of Directors since 1987.

Mr. McGraw has led a transformation of the Corporation, consolidating 15 diverse units into three focused business segments, each one a market leader. In Financial Services, Standard & Poor's is the world's leading provider of financial analyses and risk assessments. In Education, McGraw-Hill Education is a leader in the U.S. K–12 education market as well as in the higher education and professional markets. And in Information & Media, the Corporation is a preeminent provider of essential news, information, analysis and solutions globally through *Business Week,* J.D. Power and Associates and leading portals for the energy, construction and aviation industries.

The McGraw-Hill Companies had sales of $6.3 billion in 2006. The Corporation has a strong history of growth. Over the last 10 years, it has outperformed the S&P 500, producing an annualized total return of 21.5 percent versus 8.4 percent for the S&P 500.

Mr. McGraw, 58, joined The McGraw-Hill Companies in 1980 and has held a number of positions with increasing responsibilities, including Vice President, Corporate Planning; publisher, *Aviation Week & Space Technology;* President, McGraw-Hill Publications Company; and President, McGraw-Hill Financial Services Company.

He serves on the Board of Directors of United Technologies and ConocoPhillips. He is Chairman of Business Roundtable, Chairman of the Emergency Committee for American Trade (SCAT) and a member of the Business Council. Mr. McGraw is a member of the State Department's Advisory Committee on Transformational Diplomacy and he also served as a member of President George W. Bush's Transition Advisory Committee on Trade.

Mr. McGraw is Chairman of the Committee Encouraging Corporate Philanthropy. He is also Co-Chair of Carnegie Hall's Corporate Leadership Committee and a member of its Board of Trustees. Additionally, Mr. McGraw serves on the boards of the National Council on Economic Education, New York Public Library, National Organization on Disability, National Academy Foundation, Partnership for New York City, and Prep for Prep.

Mr. McGraw received an M.B.A. from the Wharton School of the University of Pennsylvania in 1976 and a B.A. from Tufts University in 1972.

Chairman GORDON. Thank you, Mr. McGraw.

And now we have Dr. Robert Dynes, who is President of the University of California. Dr. Dynes is also Professor of Physics and Material Science at the University. And before coming to the University of California, he had a 22-year career at the AT&T Bell Laboratories and, in 1989, was elected to the National Academies of Science.

Thank you, Dr. Dynes.

STATEMENT OF DR. ROBERT C. DYNES, PROFESSOR OF PHYSICS AND MATERIAL SCIENCE; PRESIDENT, UNIVERSITY OF CALIFORNIA

Mr. DYNES. Good afternoon, Mr. Chairman. Mr. Chairman, Ranking Member Hall, and other Members of the Committee, thank you for the opportunity to testify on this important issue of science and technology leadership in the 21st Century.

I want to first specifically recognize Chairman Gordon and Norm Augustine for their leadership in bringing us to this point. It is an honor to be with these distinguished folks on the panel. My written testimony, which I have submitted for the record, outlines the University of California's vision for ensuring strong competitiveness in California and in the U.S. My job is to keep California competitive.

My vision rests on three planks. One, fueling innovation and boosting the Nation's economy by leading in RD&D, research, de-

velopment, and a second D: delivery, which is the delivery of the products of the university to society, and delivery of educated, motivated innovators to our society.

Two, forging strategic alliances with the best and brightest minds around the world to solve global problems that confront all societies for our benefit. Three, enhancing the quality of California's future workforce by tackling the crisis in K–12 education. This afternoon, I will provide a snapshot of a program at the University of California that speaks to the third plank.

This exciting program, which we call the Science and Math Initiative, or 1,000 Teachers, a Million Minds, is one of the models for your national program, the 10,000 Teachers, 10,000,000 Minds, which was outlined in the National Academies report and your legislation, H.R. 362.

My own motivation for this priority came from my many travels throughout California, where I encountered entire schools and entire school districts where there wasn't a single credentialed science and math teacher in the school.

Mr. Chairman, you have called upon us to recognize the challenges we face in research, and most especially, in education of our youth in mathematics and science. Your legislation creates an excellent model for research universities, and I say research universities, to implement that vision. And we at the University of California are stepping up to that plate to create a pipeline of math and science innovators for the Nation's future, and teachers for the Nation's future.

The Science and Math Initiative is one of my highest priorities as President of the University of California. It has personal significance for me, because I was a first generation college student, transformed by math and science education way back in the Sputnik era. The components of the University's initiative are described in more detail in my written testimony, but essentially, we must pay attention to three elements to develop good teachers.

One, recruit UC students who are majoring or considering majoring in science and math to be teachers. Two, provide these students with innovative curricula that rely on the expertise of our faculty in science, math, and education. Three, offer incentives to attract and retain these students as teachers, including a streamlined path to certification and financial incentives, such as loan forgiveness and paid summer internships. (We need to support these young people, even after they are in the teaching workforce.)

The University of California Deans who direct the Campus Science and Math Initiative, along with the faculty of science and mathematics departments and our departments of education are energized, are committed, and are working together. This may sound like a no-brainer to you, but it is quite novel to have the science faculty working with the School of Education on teacher training.

Attached to my written testimony is an example from UC–Berkeley of the new curriculum they are developing, which blends cutting-edge content knowledge in the sciences, including lab and field experiences, with distinctive new pedagogy, specifically suited to convey this knowledge to young students. We supplement the program with a field experience course. We actually put freshmen out

in teaching environments. These field experiences continue for four years, where students work in local schools, under the supervision of mentors or master teachers, and they meet regularly in small seminars to discuss the experiences, and learn from each other.

Our early research on this field-experience course has demonstrated that it has a profound effect on student aspirations. Many intensify their commitment to teaching, and many find that their interest deepens in various aspects of their own science and math, as they work with students. Teaching science motivates a deeper understanding of science, and everybody in the University knows that. Some of them also discover that teaching is not for them, which is important to learn as early as possible.

One of the strengths of the California Higher Education Master Plan is that many students transfer to UC from the community colleges, and this provides a rich source for future teachers. This academic year, as many as 100 community college freshmen are involved in the same field experiences as our UC freshmen. These parallel experiences allow them to transition smoothly when they transfer to UC later. We are now in the second year of the SMI program, developing our model simultaneously on all nine of our general campuses. Collectively, our campuses provide an excellent laboratory for testing different approaches to meet our program goals. We are inventing this as we go along, and by the year 2010, we are committed to producing 1,000 science and math teachers per year for the State of California.

While each of the campuses approaches this program differently, there are several common elements that we believe will lead to success, and those are described in my written testimony. We learn best practices from looking at all nine campuses.

At all the campuses, the students gain a deep grounding in their math and science majors, and every student has early field experience, and an expeditious pathway to teacher certification. To date, more than 600 students are enrolled in the SMI on our campuses, nearly 1,000 student placements have occurred in schools for field experiences, and we are involved with 467 teachers, 174 schools, and 41 districts across California. This is now the second year we are into it. It is growing rapidly.

I am also happy to report that the Science and Math Initiative has attracted enormous enthusiasm and support from both the public and the private sectors. The vigorous support of Governor Schwarzenegger and the state legislature has been instrumental in the program's strong start, and to date, corporate and foundation funding is over $4 million. I am especially grateful to several of our corporate major sponsors, including Intel, and I personally thank Craig Barrett for leading Intel to support us on this program.

I want to thank you for introducing H.R. 362, and I offer the University's support for your efforts. This bill will greatly assist programs like ours, and we look forward to working with your staff on a few modifications that we believe are necessary to make this as flexible as possible.

As a physicist, I look for things that are scalable. This program is scalable. It can work in school districts, it can work in the State, it can work in the Nation. H.R. 362 will allow expansion of the Science and Math Initiative concept from California to the Nation,

and also, focus more broadly on other elements essential to improving K–12 math and science education.

H.R. 362 is premised on students graduating with a science or math degree and teaching credential within four years. However, as we have developed down this path, many of our best students take a little longer to complete a science and math degree. The Science and Math Initiative streamlines the credentialing process, but because of varying teacher licensure requirements, especially in California, additional postgraduate training is often necessary.

We would like to see the legislation amended to allow flexibility in creating integrated programs that streamline the process to obtaining a Bachelor's or Master's degree and a teaching credential.

We look forward to working with you and your staff to enact this legislation. In addition, we need the Congress and the President to address federal resources in this endeavor. UC can, and I emphasize will, increase the number of science and math teachers who are trained, qualified, skilled, and equally importantly, passionate about science and mathematics. However, we need sustained, long-term commitment from our current partners and the Federal Government to realize our intended effects.

Finally, let me give you an example of the value of this program, and I share the words of one of our Science and Math Initiative students, who is out in the classroom. "After completing field work in the classroom, I knew teaching was for me. It made me realize the passion I had to help others, and at that point, I knew I wanted to make it a career."

Thank you.

[The prepared statement of Dr. Dynes follows:]

PREPARED STATEMENT OF ROBERT C. DYNES

UC's Missions as a Land-Grant University

Chairman Gordon, Ranking Member Hall, and other Members of the Committee, I am Robert C. Dynes, President of the University of California. I want to thank you for inviting me to testify, and I want to give special thanks to Chairman Gordon and Norm Augustine for their leadership and support in seeking to enhance U.S. competitiveness through targeted investments in university research and in science and mathematics education. I am pleased to have this opportunity to share the University of California's vision in this crucially important task.

Mr. Chairman, your invitation asked me to comment on your legislation that implements recommendations from the National Academy of Sciences' report *"Rising Above the Gathering Storm"* and also to describe the University of California's Science and Mathematics Initiative, which is one of the models for the recommendation to create a national program called "10,000 teachers, 10 million minds."

The report rightly and forcefully draws our attention to the challenges we face in research and most especially in the education of our youth in mathematics and science. In the past, America's colleges and universities have played a vital role in stimulating the innovation and creativity that drives economic development. This role of higher education in the future is likely to be even greater as the world becomes even more competitive.

As one of the Nation's most distinguished land-grant universities, the University of California has always had a tradition of employing its research and teaching capacity to address our state's and nation's economic and social challenges. In the 19th century, those challenges were in agriculture and mining (food and resources). Today, universities must build our nation's capacity for innovation, with greater urgency than ever before. Innovation in science and technology is the engine that will drive the 21st century economy, and the University of California is poised to play a major role in this effort.

Looking Ahead: Vision for Future of UC and California

My vision for how the University of California will do its part to keep the U.S. and California competitive in the new global knowledge-based economy builds on the land-grant research university's tripartite mission of research, education, and public service. A simple way to describe those three missions is:

- *Research:* Create new ideas.
- *Education:* Create new leaders and creators.
- *Public service:* Put these creations and people to work to benefit all citizens.

We believe that in carrying out these three missions—through research, education, and public service—the University must continue to contribute, as it has done to such great effect in the past, to California's ongoing achievement as one of the world's most creative laboratories for new ideas and better lives for the entire Nation.

At UC, we have been undertaking new efforts at long-range thinking and planning, trying to envision what the University should be in 2025 and what we need to do now to get there. That process has led to a number of initiatives within the University to build on the advantages we have as the Nation's largest research university with multiple campuses and a multitude of institutional and disciplinary strengths.

My own vision for the future of the University of California—and the State of California—focuses on three main efforts where we can harness the promise and power of our 10 campuses as *one* university most effectively. Those efforts are:

- *RD&D Innovation:* First, we will fuel innovation and ramp up the State's economy by leading the Nation in RD&D—research, development, and delivery of new products to end-users for society's benefit.
- *Strategic Global Alliances:* Second, we are forging strategic alliances with the best and brightest minds around the globe to solve problems that confront all societies. In the process, we will lure some of those best and brightest to the University so they can work for the benefit of California and the Nation.
- *Improving K–12 Education, especially in Science and Math:* Third, we will enhance the quality of California's and the Nation's future workforce by tackling the crisis in K–12 education—not just bemoaning it, but actually doing something about it.

The Science and Mathematics Initiative (SMI) or "Cal Teach" is an important piece of this last effort. We need many more science and mathematics majors to choose teaching in K–12 schools as their ultimate career. However, it is not the only piece. Public research universities must do more to transform math and science teaching in ways that will ensure future generations of Americans are offered educational opportunities that exceed those of past generations.

In this testimony, I will further describe these three initiatives, and I will point out which of the recommendations from The National Academy of Sciences' *"Rising Above the Gathering Storm"* report and the Chairman's legislation can help us in each of these efforts.

RD&D Innovation

We entered the era of research, development, and delivery on September 11, 2001, when we watched first responders trying—and failing—to communicate with each other at the World Trade Center. As a techie, I knew we had the communications technology. But the fire crews and the police and the rescue workers were never given that technology.

As UC President, I have vowed that this University will lead the Nation in RD&D advancements. That leadership is centered in our four California Institutes for Science and Innovation. They are changing the way universities operate, and they represent a new algorithm for university tech transfer.

Each Institute embodies "the promise and power of our 10 campuses" by linking two or more UC campuses with industry partners to focus on an area with vast RD&D potential, like nanotechnology, biotechnology, information technology, and telecommunications.

Each Institute is briefly described below.

- *The California Institute for Quantitative Biomedical Research (QB3):* UC–San Francisco leads this partnership with UC–Berkeley and UC–Santa Cruz. QB3 is developing new technologies and new areas of research for drug discovery and for the diagnosis and treatment of cancer, arthritis, and other diseases

through the convergence of mathematics, engineering, and physical sciences with biomedical and genome research.

- *The California NanoSystems Institute (CNSI):* UCLA leads this partnership with UC–Santa Barbara. CNSI is creating laboratories for research, education and technology development in the emerging field of nanoscience—the study and design of materials and functional machines at the level of individual molecules and atoms.
- *The California Institute for Telecommunications and Information Technology (Calit2):* UC–San Diego leads this partnership with UC–Irvine that has built effective inter-campus collaborations and new paradigms for performing multi-disciplinary research and education. Calit2 is defining worldwide and community-based networking scenarios to serve a broad spectrum of RD&D areas and global societal needs.
- *The Center for Information Technology Research in the Interest of Society (CITRIS):* UC–Berkeley leads this partnership with UC–Davis, UC–Santa Cruz, and UC–Merced. CITRIS is changing the way researchers collect, share, and utilize data, and it will transform decision-making in government and commerce by delivering new kinds of vital data for rapid analyses to save lives and dollars. The original focus of this research center was on six societal-scale applications of information technology—energy efficiency, transportation, earthquake preparedness, environmental monitoring, health care and education—but it was recently expanded to include special initiatives in Homeland Defense and Cultural Research.

In partnership with the State and with industry, including more than 400 companies, the four Institutes engage UC's world-class faculty directly with California companies in tackling large-scale issues critical to California's economy and to its citizens' quality of life. Information technology, telecommunications, nanotechnology, biology, health care, traffic congestion, environmental management, homeland security, and novel energy systems are among the areas of focus for new research within these Institutes. The Institutes are taking ideas beyond theory into practice, shortening the time to product development and job creation.

On December 27, our RD&D mission received a huge boost with the news of California Governor Arnold Schwarzenegger's Research and Innovation Initiative. Governor Schwarzenegger proposed nearly $95 million in the State budget—$25 million from the general fund and $70 million from lease revenue bonds—for the four Institutes and for other major UC projects that will boost our economy and preserve our environment through RD&D of new innovations.

Specifically, the Governor's Budget proposed $30 million in lease revenue bonds to the Helios Project, run by the University's Lawrence Berkeley National Laboratory to create sustainable, carbon-neutral sources of energy, including the next generation of super-efficient solar energy technology that will help reduce greenhouse gases and oil dependency.

It also included $40 million in lease revenue bonds for UC in the event that one of its campuses won the global competition for British Petroleum's $500 million grant to build and operate an Energy Biosciences Institute. The Institute will focus on converting biomass materials into fuels, converting fossil fuels to energy with less environmental damage, and maximizing oil extraction from existing wells in environmentally sensitive ways. February 1 brought more good news with the announcement that UC–Berkeley and the Lawrence Berkeley National Lab, in partnership with the University of Illinois at Urbana–Champaign, did win this global competition. Their new venture has the potential to revolutionize energy usage in this country.

I should emphasize here that, in all these undertakings, RD&D is being carried out by faculty AND students. UC students learn to be innovators by taking part in the creative process as students, both graduate students and undergraduates. That is the best kind of education you can give to a bright young person.

The National Academy of Sciences' "Rising Above the Gathering Storm" Report/H.R. 363 recommendations that will help research universities carry out RD&D:

I will not go into detail about each of the recommendations that is now in H.R. 363, but let me note here that implementation of that legislation would be of tremendous assistance in helping public research universities like ours. Annual 10 percent increases in federal support for peer-reviewed competitive research would help provide needed stability to plan future research endeavors.

In particular, the University strongly supports the provision that would designate a percentage of funding dedicated to high-risk, high-payoff research projects. While

undefined in the bill, the term "high-risk, high-payoff" is widely understood and supported in the scientific community. This approach generally refers to research that has the goal of exploring concepts that have the potential for huge impacts but that might also have a chance of failure.

Any successful enterprise that grows in size will tend to stick to proven methods. However, as global competition increases, we need to make sure the U.S. does not become overly complacent in how it funds research. Encouraging the federal research funding agencies to support cutting-edge research that pushes the boundaries of disciplines is a wise long-term strategy. Inevitably, there will be many examples where taking such chances does not pay off, but in the long run, just as high-tech industry depends on venture capital to progress, we need to create the resources for scientists to take risks that lead to major advances in science and technology.

Similarly, we need to take risks on promising individuals in the sciences. I strongly support the proposals to provide large awards to the most promising researchers. This will ensure that some of the best and brightest minds stay in academia long enough to make a difference in the overall enterprise.

And of course, we strongly support more federal support for research infrastructure—for facilities and specialized instrumentation.

Strategic Global Alliances

I believe we must view the progress of other nations as an opportunity for our own nation's development and not as a threat. We must harness the best minds from different societies to tackle common problems.

On the international front, the UC's push to forge strategic global alliances is driven in large part by leaders from industry and government who want California to maintain its competitive edge. You don't do that by building walls and staying in your own yard. You do that by being open to new ideas from people of diverse cultures and different perspectives.

The University of California is expanding its global presence as close as Canada and Mexico and as far away as China, India and Africa. Other societies grapple with the same problems we do in public health, energy and transportation, and the environment. Top universities in those societies are putting their best minds to work on these problems. Shouldn't we harness our best minds with theirs to tackle these problems and create innovative solutions?

This concept has taken me to China twice to launch a "10 + 10" alliance of our 10 UC campuses and China's top 10 universities. On both trips, I brought along at least two Chancellors and many campus representatives.

I just returned from India where I was developing a "UC–India Initiative" to expand research and educational collaboration with academic, government, and industrial partners. The tour included a special meeting with Indian President Abdul Kalam, who delivered the keynote speech via high bandwidth streaming video at last fall's UC–India Summit at Calit2 at UC–San Diego.

As with all our international alliances, the emphasis is on RD&D innovation that crosses the disciplines in areas of vital importance to both nations, areas like information technology, energy resources, and public health.

"Rising Above the Gathering Storm" recommendations related to strategic global alliances

Although not specifically addressed in Chairman Gordon's legislation, we also wish to express our support for recommendations in the National Academy of Science's report, *"Rising Above the Gathering Storm,"* that would facilitate entry of international students and scholars to the United States. There is a significant and ongoing need to facilitate institutions' efforts to attract and retain high-caliber U.S. and foreign students and researchers. With growing competition from other nations for international talent, the U.S. needs to make changes to the current visa system in order to compete. The current U.S. visa system increasingly prevents U.S. businesses, universities, medical institutions, and research centers from competing for needed talent.

Like many institutions around the country, UC has seen a decrease in international enrollments, which are crucial at the graduate level. In fall 2002, for example, UC enrolled 7,532 international graduate students. In fall 2005, that figure declined to 6,988—a drop of 7.2 percent.

Improving K–12 Education

The University is moving forward in addressing shortcomings in K–12 education. This task may hold the greatest potential for economic and societal impact, but in many ways, it may present our most difficult challenges. In my travels throughout California to meet with constituents, I have found this to be our most urgent prob-

lem by far. Mathematics and science achievement in California is lagging, and the ramifications for our state are alarming. Let me cite a few specifics:

- On the 2000 National Assessment of Educational Progress (NAEP), nearly half of California's eighth grade students scored "below basic" in science and math.
- National testing data (Trends in International Mathematics and Science Study) reveal that California's children are among the worst in the U.S. in their knowledge and abilities in both mathematics and science. U.S. children are falling further behind children of other countries in their knowledge of and abilities in mathematics and science.
- Statewide, 25 percent to 35 percent of California's science and mathematics teachers either have no credentials or are not qualified, i.e., they have neither a major nor minor in the subject area they are teaching. The situation is much worse in lower performing schools where as many as 80 percent of science and mathematics teachers are not qualified.
- The National Center for Education Statistics found in its 2002 report that at least 60 percent of high school science *classes* are taught by "out-of-field" teachers. In middle school, the problem is even more acute.
- At present, nearly 25,000 teachers in California are teaching with emergency credentials, meaning they do not meet the current requirements in the federal No Child Left Behind legislation.
- Projections indicate that more than 30 percent of California's teacher workforce will be eligible to retire in the next decade.
- For the first time in many years, California experienced a decrease in the number of credentialed teachers entering its workforce in 2005–06.
- This year, California has a shortage of more than 2,000 mathematics teachers, 1,000 life science teachers, and 1,000 physical science teachers.
- Little or no science is being taught in many of California's K–5 classrooms.

The one experience that really brought this home to me in my travels up and down the state was visiting entire schools and even school districts that did not have a single qualified mathematics or science teacher.

Having been in the sciences my whole career, I know first-hand that great K–12 teachers are indispensable to the future scientific interest and success of students.

Without any doubt, some of these problems are due to the shortage of teachers with deep content knowledge in mathematics and science. California's supply of mathematics and science teachers falls far below the number needed. The state barely produces half of the necessary credentialed teachers to cover the demand.

In May 2004, UC and California State University (CSU) entered into a compact with Governor Schwarzenegger that offered us stability in State funding in exchange for meeting certain state accountability goals and addressing state needs. The compact called for a new UC initiative to address the shortage of trained K–12 teachers in science and math.

In May 2005, in consultation with Governor Schwarzenegger and Chancellor Charles Reed of the CSU system, we launched a bold program. UC made a commitment to quadruple the number of students trained to be science and math teachers from 250 per year to 1,000 a year. We called the program "Cal Teach" or the UC Science and Mathematics Initiative (SMI). CSU committed to 1,500 science and math teachers a year for a combined total of 2,500.

The basic elements of SMI as we envisioned it were:

- Recruiting UC students to be math and science teachers from students who are majoring or considering majoring in those fields.
- Providing these students the training they need by drawing on the expertise of our faculty in those fields, both in the disciplines and in advances in pedagogy specific to science and math education.
- Offering financial incentives to retain these students as teachers.

As this process has developed, two interesting things have happened on the campuses. First, the SMI campus directors are deans in the sciences, so they carry a lot of clout. They are committed to the success of this program, and they are energized about it.

Second, we are seeing faculty in science and mathematics departments team up with faculty in education departments. Now they are collaborating on entirely new curricula for preparing science and math undergraduates to be master teachers. Included with this testimony is an example from UC–Berkeley of this new curricula,

blending cutting-edge content knowledge in the sciences, including field and lab experiences, with distinctive new pedagogy specifically suited to conveying this knowledge.

As the campuses develop these new curricula, and as they come back together to pool their ideas, I predict we are going to see real magic happen. Because your committee is considering a similar program for the Nation, I want to include a significant amount of detail in the rest of this testimony on what we have done to date.

As we provide this detail about our program, I think it is important to remember that we need flexibility in implementation. SMI at each of our campuses will look different to account for local campus and regional circumstances.

UC's Unique Resources for Addressing the Teacher Deficit

As the Nation's largest public research university, the University of California has an extraordinary array of intellectual and other resources for addressing issues such as the achievement gap in K–12 education. I believe that no issue so commands the application of those resources as does improvement in the achievement of our youth. Let me add that I believe we must do everything we can to identify and encourage K–12 student talent to study and work in the fields of science, technology, engineering, and mathematics (STEM).

So what can a research university like UC bring to this issue?

- The University produces almost half of all the students earning baccalaureate degrees in science and math in California. Research universities tend to have higher concentrations of students in the science and math disciplines.
- UC students constitute our state's highest achievers, and they have the potential to make enormous contributions as science and math teachers, as well as in all other fields.
- UC has a faculty unmatched in the depth and breadth of their expertise in science and math. We can apply this expertise in advancing the subject matter mastery of these students as well as the skills and content knowledge of teachers already in the field.
- Yet, in the past, the University and most other top research universities have not tapped their potential for attracting science and math students into the teaching force. Addressing that issue energetically and effectively may be the very best way that UC and peer institutions can contribute to the improvement of public schools and their students.

So how are we proposing to organize these resources to address this urgent problem?

SMI Model—The University

UC's response, working in partnership with K–12 schools, CSU Chancellor Reed, Governor Schwarzenegger, the California Legislature, and California industry leaders, has been to launch the SMI in Spring 2006 at the nine UC general campuses. The goal of the program is the goal the Governor and I agreed to the year before—to quadruple the number of math and science teachers the University produces from 250 in 2005–2006 to 1,000 by 2010–2011, as CSU doubles its output to 1,500 by 2010–2011. This is a bold challenge to our faculty, staff, and students. But the crisis is real, and we must take dramatic action to address it.

Quantity and Quality in the Teaching Force

Of course, quantity is only one of the goals of SMI. We also are committed to improving the preparation of teachers in ways that will result in superior teaching and learning, and that will attract some of our most talented and high-achieving science and math majors into a teaching career. Specifically, SMI is developing better methods for preparing these students as science and math teachers so that they have an extraordinary command of their discipline *and* more refined pedagogical skills in their fields. UC will attract to the teaching force more of its undergraduate majors in science, math or engineering, and we are creating curricula that focus on newly developed teaching techniques specifically geared to science or math learning.

UC is developing the SMI program in consultation with a broad spectrum of stakeholders: faculty members, inter-segmental education partners, industry leaders, foundations, and state and national organizations specializing in science, math, engineering, technology and teaching. We are building upon the Community Teaching Fellowships in Mathematics and Science program, which began at UC–Berkeley over 20 years ago, as well as a model pioneered in 1997 at the University of Texas, Austin, which has prepared hundreds of new math and science teachers since its inception, in response to the same pressures we feel in California today.

Program Growth and Development—First Steps

SMI is now in its second year of operation. UC campuses began by establishing Resource Centers in their schools of sciences and mathematics for advising, as well as for placement, student recruitment, and coordination with schools. Making math and science departments the locus of the program emphasizes the centrality of subject matter mastery, and in the preparation of new teachers, it more directly involves those faculty most attuned to the scientific ideas and knowledge that our citizens should master. Concurrently, UC education faculty are collaborating with scientists and mathematicians in new ways to identify pedagogies appropriate to various disciplines and students.

A second benefit of locating SMI in math and science units is that this promotes student recruitment and clearly demonstrates the interdisciplinary aspects of the program—learning science/math and teaching techniques as a blended effort. Having the program in the science and math departments demonstrates this is clearly right in the place where the students "live."

We supplement the program recruitment with a "field experience" course, beginning at the freshman level, called CaT1 courses, where students work in local schools under the supervision of mentor teachers and meet regularly in small seminar groups to discuss experiences and learn from one another. These courses bring potential teachers into direct contact with schools and students *immediately* so they can experience the exhilaration of guiding students in their field while they experience the challenges of teaching and test their own capacities. These CaT courses extend throughout the student's undergraduate experience.

Our early research on the outcomes of this field experience course has demonstrated that it has a pronounced effect on student aspirations. Many intensify their commitment to teaching, and many find that their interest deepens in various aspects of their own science and math learning as they work with their students' learning patterns. And some discover that teaching is not for them, which we know is important.

Community College Component

During this past year, UC has also expanded SMI to the California Community Colleges. Students who transfer from community college campuses comprise about 30 percent of UC graduates and about two-thirds of CSU graduates. Community college students who intend to transfer to UC or CSU represent a rich source of future teachers for California's schools since many return to their home communities after completing undergraduate degrees.

The University began its SMI community college work with the Foothill–De Anza Community College district, extending its first- and second-year SMI courses to students who plan to transfer. This project has since expanded to include 16 community colleges (five in southern California, three in the Santa Barbara region, five in the Silicon Valley area, and three in the Santa Cruz/Monterey Bay region). This academic year, as many as 100 community college freshmen are participating in a field experience at a local school accompanied by a follow-up seminar at their home community college.

SMI-Second Year-Current Program Components and Organization

We are now well into our second year of operation, and the model is still evolving. At Texas, UTeach originated on just one campus. At UC, to help address the enormous needs of California, the program is being developed simultaneously on all nine of our general campuses. Each UC campus has a distinctive curriculum and a different set of local schools and educational issues, so our various campuses provide an excellent laboratory for testing different approaches to the goal of increased teacher numbers and improvements in preparation. Some campuses have developed education minors with a math or science emphasis, and faculty from across the disciplines have collaborated to develop math and science education courses. Common elements of the model include:

- Development of new curricula, which combines cutting-edge content knowledge in the sciences, including field and lab experiences, with distinctive new pedagogy specifically suited to conveying this knowledge.
- Student recruitment, focusing on freshmen and community college transfers, but providing student entry at all levels of the undergraduate program.
- Lower-division academic program elements that combine field experiences (CaT 1, 2, and 3) with seminar participation and "Master Teacher" supervision, encompassing as subject matter California's standards-based instruction, learning assessment tools, classroom management, diversity, and learning theory.

- Upper-division program elements that form a bridge to the credential program by building upon the early field experiences and math and science subject matter preparation to connect with the University or district internships.
- Alignment of subject matter preparation with educational course work to assure prompt and timely completion of an undergraduate degree, a preliminary teaching credential, and a Master's degree in five years.
- Summer STEM institutes to develop distinctive pedagogy for teaching math, biology, physics, chemistry, and geosciences.
- Financial incentives for student participation.

There are a number of "paths to teacher certification," and I am including illustrations from two of our campuses, UC–Irvine and UC–Santa Barbara, to display the wide variety of ways in which students will earn certificates and the many different paths that students may follow when they enter the SMI program—whether as a freshman, a transfer, or a junior or senior at a UC campus.

These two patterns also illustrate graphically:

- the capacity for students to gain deep grounding in the knowledge and methodology characteristic of a major in math or science gained at a research university level;
- early field experience in the classroom, combined with seminars for reflection and analysis of the field experience; and,
- multiple entry points to the "pathway" at different times in a student's academic career, and expeditious progress to gaining teacher certification via a number of different routes.

University of California Santa Barbara: CAL TEACH PROGRAM

Science Math Initiative Leading to Teacher Certification

Recruiting Summers

Invitation from Math, Science and Education; orientation sessions; contact info

If student begins as a	Freshman Year	Sophomore Year	Summer Institute	Junior Year	Summer Institute	Senior Year	Post graduate Requirements
Freshman (Start here)	CAT 1	CAT 2 Instructional Technology and Design	Education minor	school placement Special Ed	Content pedagogy Education minor CSET test prep (if needed) Literacy	ELD/SDAIE school placement content & literacy supervision	One semester of student teaching OR One semester paid internship with university supervision (opt 2nd sem supervision) Content/professional issues seminar & PACT
Sophomore (Start here)		CAT 1 CAT 2	Education minor	Computers for Teachers school placement Special Ed	Content pedagogy CSET test prep (if needed) Literacy	ELD/SDAIE school placement content & literacy supervision	One semester of student teaching OR One semester paid internship with university supervision (opt 2nd sem supervision) Content-professional issues seminar & PACT
Junior (Start here)			Education minor	CAT 1 and 2 (if not taken in CC) Instructional Technology and Design (if not taken at CC) and/or Special ED	Content pedagogy CSET test prep (if needed) Literacy	ELD/SDAIE More extensive school placement content & literacy supervision Special Ed (if not taken earlier)	One semester of student teaching OR One semester paid semester internship with university supervision Content-professional issues seminar & PACT OR planned year-long internship program
Senior (Start here)						CAT 1 Test prep & Ed Minor courses to ease credential or intern year load	UCSB 5th year OR planned year-long internship program
Post graduate							UCSB 5th year program

Courses to be taken as General Ed courses: U.S. Constitution, Technology, Equity & Diversity

State tests: CBEST taken any time. CSET-sub tests taken after courses or any time during program. CSET test prep in summer before Senior year if needed

Program assessments: Teaching Portfolio developed throughout program. Used to develop induction year plan. Built upon for M.Ed.

UCI SMI students have the following post-baccalaureate credential program options:

(1) Early Start: Intern Credential Program

Starts: Spring of undergraduate senior year

Duration: 5 quarters of coursework and teaching experience extends into a post-bac year.

Unique benefits: Intern candidates are hired by a school district as the teacher of record and paid a salary from fall through spring.

(2) Early Start: Student Teaching Credential Program

Starts: Spring of undergraduate senior year

Duration: 3–4 quarters of coursework and teaching experience extends into a post-bac year.

Unique benefits: By getting a spring start, student teaching candidates can finish the credential by the end of winter quarter in their post-baccalaureate year and be hired as a credentialed teacher for winter semester.

(3) Traditional Student Teaching Credential Program

Starts: Fall of post-bac year

Duration: 3 quarters of coursework and teaching experience in a post-bac year

Unique benefits: This pathway is a good choice for late decision makers as well as students who feel that they can benefit from the more gradual acceptance of teaching responsibility as a student teacher.

(4) Earn a Master of Arts in Teaching (M.A.T.) and a Teaching Credential

Starts: Summer of post-bac year

Duration: Two added summers (6 courses) in addition to the credential program curriculum.

Unique benefits: Students with an M.A.T. are often more competitive in the job market, they become future leaders in their departments, and their additional post-bac units will increase their starting placement on a district's pay scale.

(5) Earn an M.S. from one of the UCI Physical Sciences Departments and a Teaching Credential

Starts: Fall of post-bac year

Duration: Three or more academic quarters to finish the M.S, followed by three or more academic quarters in a credential program (6 or more quarters total).

Unique benefits: Students with an M.S. degree are often more competitive in the job market, they become future leaders in their departments, and their additional post-bac units will increase their starting placement on a district's pay scale.

The combined M.S. and credential is offered by the departments in the School of Physical Sciences in partnership with the Department of Education.

Enrollment in SMI

Initial student interest in SMI has been very enthusiastic. Campuses made initial projections of enrollment in the CaT (seminar), and in some cases, interest has considerably surpassed the estimates. At the UC–Berkeley campus, the number of students enrolled in the program far exceeded projections and greatly increased the number previously headed for math/science teaching careers. Based on experience to date, campus SMI directors anticipate an enrollment of 1,184 students in the second CaT (seminar), and they project that science and math teachers matriculating from UC programs will reach 800 by 2010.

We are exploring many avenues to raise that figure to our goal of 1,000. To that end, we are focusing on the issues of recruitment and retention. Possible strategies include:

- Increasing recruitment of community college freshman students who plan to major in STEM fields and who will transfer into UC STEM credentialing programs. These students represent a rich vein of potential candidates.
- Creating pathways for "career changers."
- Developing on-line materials to enable non-STEM credentialed teachers to prepare and pass subject-specific exams in STEM fields.
- Integrating, where appropriate, the California Subject Matter Projects (CSMP) in math and science, ISME, the California State Summer School for Mathematics and Science (COSMOS), Teacher Fellow program, and other STEM professional development experiences to help prepare and retain STEM teachers.

SMI STUDENT CHARACTERISTICS—2005-6

Gender	Students	Percentage
Female	397	67%
Male	198	33%
TOTAL	595	

Academic Level	Students	Percentage
Freshmen	207	35%
Sophomore	171	29%
Junior	132	22%
Senior	85	14%
TOTAL	595	

Major	Students	Percentage
Mathematics	196	33%
Science: Biology	186	31%
Science: Chemistry	58	10%
Science: Physics	27	5%
Engineering	33	6%
Other*	95	16%
TOTAL	595	

*"Other" includes undeclared or undecided

Student enrollment in SMI shows a roughly 2-to-1 ratio of women to men, a welcome story for young women excelling in math and science. The ethnicity of students participating in this program conforms very closely to the ethnic distribution of UC's undergraduate population. Our premise that students would enter the program at all academic levels is proven true. The number of SMI students majoring in mathematics and biology far exceed numbers in other majors. Demand for physics teachers is somewhat lower than in other fields. Larger numbers of future teachers of chemistry would be valuable.

Participating Schools

To date, nearly 1,000 student placements have occurred in schools for field experiences. This process has involved 467 teachers and 174 schools in 41 districts. We believe this will have positive outcomes for all who are participating. We are tracking the socioeconomic characteristics and academic performance of schools where students are placed, and to date, they represent a wide spectrum. And, because students bring observations back to their university classes for discussion, they are able to compare and contrast different experiences from different sites.

What the University Has Learned Thus Far and How It Will Respond to Evidence Collected as Program Develops—Research and Learning Via SMI

SMI leadership consists of a consortium of campus SMI officials headed by Dr. Fred Eiserling, Associate Science Dean and Professor of Microbiology at UCLA. The group meets via teleconference once a month, and members are in regular contact by e-mail. Campus Faculty Program Directors and Academic Coordinators also confer by teleconference biweekly and are actively sharing information on program progress.

SMI is being implemented at our nine general campuses as a system-wide program, one that provides flexibility for each individual campus to grow the program within its own unique environment and curriculum. This is a highly unusual opportunity to test the program's basic tenets in diverse settings. Similar teaching programs have been developed at other universities, but none has encompassed the number and type of institutions involved in this effort. Outcomes will provide a rich source of insights for future work in this area.

As this work develops, implementation is being approached deliberately as a project for study.

Data Collection and Research

UC is collecting data systematically on each step of the program, including student interviews and close monitoring of each participant. For this tracking, UC has developed an on-line "My California Teach" portal. The system:

- tracks all student participants, including hours in the classroom and other activities;
- provides students the opportunity to assess the usefulness of their own activities in class;
- provides students an on-line journal to write about their experiences and to begin developing their teacher professional portfolio;
- provides programmatic information and on-line advice to students;
- tracks all K–12 teacher participation; and,
- pays students and teachers for in-class work.

This extensive data base will allow the University to track and study a large number of teachers as they move through the pipeline over a period of five years. Data will provide information to allow better testing of hypotheses about teaching and teacher preparation, including the effect of various types of field experiences and course work that are newly developed for this effort.

In particular, UC will study the effects and effectiveness of field experiences and the patterns of course work being offered via SMI. Questions that will be studied include how field experiences impact teacher preparation and how particular courses in major fields of math and science and also in education affect the quality and number of teacher aspirants and graduates.

Funding

SMI has attracted financial support from the public and private sectors. Governor Schwarzenegger and the California Legislature are now funding the program at both UC and CSU. In 2005–06, the State provided UC with $750,000, which was matched by $750,000 in University funds, to support the initial infrastructure needed to implement the new initiative. In 2006–07, the State provided an additional $375,000, again matched by University funds, for a total of $2.25 million for the program. These funds are being used to develop resource centers on UC campuses to operate the program. Using a combination of State and University funds, each campus resource center has at least $250,000 for program operations.

In addition, The Regents of the University of California initially secured pledges totaling $4,024,850 from 19 foundations and corporations toward SMI.

The bulk of those funds came from two major underwriters: the Intel Corporation, which pledged $2 million over four years in $500,000 increments, and SBC (now AT&T), which pledged $1 million over five years. Since those original commitments, other funds have been pledged to other campus sites, the largest being an endowed chair for over $2 million at UC–Irvine.

Private funding agents have expressed great interest in providing support that will help attract and retain student engagement in the program. They also are interested in supporting teachers who either directly mentor these students or who serve as master teachers.

The University will need to secure support for intern-credentialed teachers from states, school districts and other sources. UC also will need to secure ongoing funding, public and private, to make the program affordable for under-served populations. Working with a variety of partners will be crucial to the program's ultimate success.

The Governor's budget also proposes funding 600 assumable loans for SMI students, loans that would be forgiven in exchange for a teaching commitment.

H.R. 362 would greatly assist programs such as SMI

The University supports federal legislation such as H.R. 362, which would boost funding for federal competitive grant programs that support higher education efforts to improve the development of K–12 math and science teachers, as well as undergraduate STEM programs. H.R. 362 would seek to expand the SMI concept from California across the Nation, and also to focus more broadly on other elements essential to improving U.S. math and science education.

H.R. 362 is modeled on our original idea of having students graduate in a science and math discipline and receive their credential within four years. However, we are finding that this stipulation runs counter to the goal of increasing the number of highly-qualified teachers in science and math. Even many of our best students take slightly more than four years to complete a science or math degree. SMI does integrate education courses long before completion of the Bachelor's degree and stream-

lines the credentialing process. However, varying teacher licensure requirements, especially in California, mean that additional post-Bachelor of Science degree training will be needed.

We would like to see the legislation amended to delete reference to a four-year completion period under the Robert Noyce Scholarship Program. Instead, we hope for flexibility in creating integrated programs that result in a Bachelor's or even a Master's degree *and* a teaching credential or license. We want to reduce the time to obtain both the degree and the license, but we need the flexibility because of the varying teacher licensure requirements within and across each of the 50 states.

Two UC campuses, Irvine and Los Angeles, are current recipients of Noyce Scholarship Program funding, and at least two other campuses, Riverside and Santa Cruz, are preparing to respond to the latest request for proposals. Our campuses are collaborating with local school districts and community colleges to provide support for future math and science teachers. Continued access to these funds would help us implement SMI and achieve our goal of 1,000 teachers by 2010.

In the Noyce Scholarship program, in years where appropriations fall below $70 million, no more than 15 percent of appropriations may be used for capacity-building activities. These include academic courses, early field teaching experiences, and stipend programs. Our campuses have indicated that this 15 percent cap hinders program effectiveness, and we therefore request that the cap be removed from the program.

Conclusion

Let me conclude by reiterating my gratitude to Chairman Gordon and the Members of this committee for addressing an issue that is so crucial to the future of the Nation. The University strongly supports the recommendations of the National Academy of Science's report, *"Rising Above the Gathering Storm."* I feel certain that we need to take bold action. As this testimony has charted, we have taken bold action with SMI. In California, we were willing to take the necessary steps to address the shortage of science and math teachers. As we build SMI, we will find better ways to do this. As we refine this program, we urge you to make sure that legislation provides the necessary flexibility for national implementation, because conditions will vary in different states and localities within states.

And we must recognize that one initiative is not enough. We need more engagement across the board between our research universities and our K–12 public schools. We need partnerships with community colleges, state universities, private universities, business, and industry, as well as State and Federal Government. The University of California has the capacity to take a leadership role in improving K–12 student learning and achievement. It is my belief that, as a land grant university, we have the responsibility to do that. Our campuses have the expertise to unlock the reasons why so many young people—the future workforce and the future hope of this country—are not being prepared to participate fully in the economic and civic life of our country. I believe we can change that. I know you share my belief. I thank you again for this opportunity to speak with you.

ATTACHMENT #1

BERKELEY CAL TEACH SUMMER INTENSIVE INSTITUTE IN PARTNERSHIP WITH BERKELEY LAB

Berkeley Lab has offered to provide a summer institute for Cal Teach students the summer following their Junior Year.

The Berkeley Cal Teach Program goals for the summer institute are to:

- Deepen student's content knowledge
- Develop student's pedagogical skills to transfer the summer experience into the classroom.

Berkeley Lab developed and implemented a ten week summer undergraduate Preservice Teacher Intensive Research Institute in 2002 to 2005. The first of the ten weeks included orientation to the lab, safety training, a course on journal writing and tours of research facilities. The core experience of the institute consisted of four two-week consecutive sessions. Each session consisted of a small group of five to six students preparing for an experiment, collecting and analyzing data, developing a science presentation and creating a lesson translating the experience to the classroom. A lead Berkeley Lab scientist typically taught the students scientific principles needed for the experiment in the morning. An experienced teacher joined the students as a coach. Afternoons were spent in the lab setting with the lead scientist and his or her group. Examples of two week sessions include, micro fingerprint analysis at the ALS Infrared beam line, A neutron activation analysis with irradiation at a nuclear reactor, building and testing a cosmic ray coincidence detector, and gamma ray analysis of terrestrial radio activities as related to anti-terrorism. The final week students prepared for their final presentations and reports. Students received a stipend of $400/week and were expected to work 40 hours each week.

Students all participated in:

- Weekly Friday afternoon seminar on translating experience to the classroom
- Subject matter knowledge self assessment
- Job Hazards Questionnaire and Safety Training
- Journal/Research notebook
- Short scientific paper writing assignment with peer review
- Weekly one on one meeting with a Master Teacher(s)
- Weekly "Summer Lecture Series" at noon and Lab tours

Weekly seminars were held on Friday afternoon. Topics included:

- Favorite lessons from in-service teachers
- Vernier probe-ware workshop
- Model inquiry based lessons and instructional materials design (Lawrence Hall of Science)
- National Board Certification requirements presented by a NBC teacher
- Issues for New Teachers
- Scientific Inquiry and Inquiry Based Teaching and Learning
- Professional Recognition and Grant Opportunities

Outline for Berkeley Cal Teach Summer Intensive Research Institute

Design Criteria

- 50 students per summer
- eight- to ten-week program
- Exposure to scientists and engineers at UCB and Berkeley Lab
- Access to and use of scientific resources of the UCB and Berkeley Lab
- Small group learning opportunities (5 students per group)

Goals

- Deepen content knowledge for each student in four areas—Earth, life, physical science and engineering (prepare for breadth on the CSET Test)
- Transfer content knowledge to classroom setting

- Develop understanding of scientific inquiry and engineering design and construction
- Encourage Understanding of the interconnection and relationship between science disciplines
- Introduce frontier science and technology topics
- Instill view of science teaching as integral to the scientific and engineering enterprise

Strategies (experiences common to all students)

- Orientation to research, safety, journaling and course requirements.
- Four two-week research activities, one in earth, life, physical science and engineering (72 hours for each two-week session)
- Weekly seminars (four hours/wk) with master teacher and in-service teachers on translating the research experience to the classroom.
- Daily mentoring by scientist and resource teacher with expertise in subject area (e.g., an experienced physical science teacher would participate with the students in the two week research experience led by scientist or engineer as content coach.)
- Berkeley Cal Teach student subject matter knowledge assessments based on high school student standards and expectations.
- Science short paper to show understanding of research programs.
- Power Point presentation to teacher and scientists colleagues based on summer experience.
- Standards-based science lesson based on summer experience.

Supporting Structures

- Program administrator responsible for organizing, monitoring, documenting and evaluating the summer intensive research institute.
- A master teacher for each strand, earth, life, physical science and engineering.
- A teacher coach for each group of 10 students.
- Four lead research investigators each willing to dedicate two weeks in the summer to teach and lead students in research for each group of five students (one in Earth, life, physical science and engineering for each group of five students).
- $4,000 of stipend funds for each student.
- Program administrative funds.
- Advanced workshops for lead investigators to assist them in developing learning objectives and resource materials.

Feasibility and cost.

With 50 students it is possible that in any one week 10 groups of five students would be working with a lead investigator. We expect that the program coordinator could find five of these investigators at Berkeley Lab and five on campus.

The total annual cost of the program would be about $350K. Of this amount $200K for Berkeley Cal Teach Student Stipends and $100K for 10 in-service teacher coaches. $25K for the Teacher Coordinator salary, $12K for the Master Teacher and $13K for materials, supplies and other expenses.

BIOGRAPHY FOR ROBERT C. DYNES

Robert C. Dynes is the 18th President of the University of California, a post he has held since October 2, 2003. A first-generation college graduate and a distinguished physicist, President Dynes served as the sixth Chancellor of UC's San Diego campus from 1996 to 2003. He came to UC–San Diego in 1990 after a 22-year career at AT&T Bell Laboratories, where he served as Department Head of semiconductor and material physics research and Director of chemical physics research. His numerous scientific honors include the 1990 Fritz London Award in Low Temperature Physics and his election to the National Academy of Sciences in 1989.

Robert C. Dynes also is a Professor of physics at UC–Berkeley, where he directs a laboratory that focuses on superconductivity and incorporates postdoctoral and graduate students in physics and materials science as well as undergraduates. As a Professor of physics at UC–San Diego, he founded an interdisciplinary laboratory where chemists, electrical engineers, and private industry researchers investigated

the properties of metals, semiconductors, and superconductors. He subsequently became Chairman of the Physics Department and then Senior Vice Chancellor for Academic Affairs.

President Dynes is active in the national scientific arena. He is a fellow of the American Physical Society, the Canadian Institute for Advanced Research, and the American Academy of Arts and Sciences. He serves on the Executive Committee of the U.S. Council on Competitiveness. He is a Fellow of the California Council on Science and Technology and as a member of the Business-Higher Education Forum. He serves on the California Commission for Jobs and Economic Growth and the Governor's Nurse Education Initiative Task Force, and is a member of the Oakland CEO Council.

A native of London, Ontario, Canada, and a naturalized United States citizen, Robert C. Dynes holds a Bachelor's degree in mathematics and physics and an honorary doctor of laws degree from the University of Western Ontario and Master's and doctorate degrees in physics and an honorary doctor of science degree from McMaster University. He also holds an honorary doctorate from L'Université de Montréal.

Chairman GORDON. Thank you, Dr. Dynes. We are going to be marking this bill, H.R. 362, in two weeks, so we would very much like to hear your recommendations during that period, so that if we can perfect this, we certainly want to.

Mr. DYNES. Thank you.

Chairman GORDON. Now, our next witness is Craig Barrett. He is Chairman of the Board of Intel Corporation. He also served on the National Academies committee that wrote the *Gathering Storm* report. Before joining Intel, Mr. Barrett, or Dr. Barrett served on the Stanford University faculty, and is currently the Chairman of the National Academies of Engineering.

Thank you, Dr. Barrett.

STATEMENT OF DR. CRAIG R. BARRETT, CHAIRMAN OF THE BOARD, INTEL CORPORATION

Mr. BARRETT. Mr. Chairman, Mr. Hall, other Members of the Committee, I would like to first say that I am in violent agreement with the three commentaries from my right, even though Dr. Dynes represents the University of California, and I am a Stanford graduate. That shows what cooperative spirit can do.

I applaud the recognition by the Science Committee of the challenges the United States faces, and the introduction of H.R. 362 and H.R. 363, to promote higher quality and quantity of math and science teachers in K–12, and to promote increased federal support of basic research and our research universities, I think are critical to U.S. competitiveness going forward.

I noticed that in H.R. 362, one aspect of that bill is, in fact, to strengthen the Noyce Scholarship Program, which was authorized under the *NSF Authorization Act of 2002,* and named after Bob Noyce, who is a founder of Intel Corporation. I had the opportunity to work closely with Bob through most of my professional career at Intel, and I think he is, perhaps, emblematic of what the committee is pondering, and what the witnesses before you are talking about today.

Bob Noyce was an exceptional man, and when he was an undergraduate at Grinnell University, his interest in technology was really sparked by a physics professor, who was very engaging, but also had contacts with Bell Laboratories, and was able to get a few of the first transistors that Bill Shockley and his group produced,

bringing those back to Grinnell and working with Bob Noyce, the physics professor was able to get Bob intrigued in this topic.

Bob subsequently left Grinnell, went to MIT, received his doctorate, emigrated to the West, went to work at Shockley Transistor initially, but left there, founded Fairchild Semiconductor, left there, and founded Intel Corporation in 1968. Parenthetically, Bob would have been a Nobel recipient, aside from his unfortunate death in 1990, before Jack Kilby at TI, co-inventor of the transistor with Bob, was awarded the Nobel laureate.

I think Bob's career is emblematic. An engaged student, an engaged professor, probing the edge of technology in association with a topflight research laboratory, also probing the edge of technology. Combining those three things together really is what promotes U.S. competitiveness and innovation. It is the sort of thing we have taken for granted years and years, which is now becoming challenged as the world becomes a much smaller place, and other countries are copying our leadership activities.

By the way, if you want to see some wonderful examples of innovation, I might invite any of you who are interested to the Intel Science Talent Search finals, which are here in Washington at the Reagan Building tonight. You will see 40 of the brightest high school kids in the world, all of their research projects makes my Ph.D. dissertation look like child's play.

But there are wonderful examples of innovation still in the United States. There are wonderful research universities still in the United States, but we need to do more. *Rising Above the Gathering Storm* was published about 18 months ago. Since then, not much has happened, although we have increased the R&D budget in some of the basic research activities this year, and we are grateful, and we think that is a great first step. H.R. 362 and H.R. 363 have the opportunity to take that much further.

We have been advocating, both at Intel and the high-tech community, for some time, the things necessary to be competitive in today's knowledge-based world: a wonderful K–12 education system, especially in mathematics and science; a university system that prepares the talent for the next generation; federal support of basic research, which is really the seed corn for the ideas for the next generation of products, goods, and services, and companies; a patent system which is fair, and promotes invention in the United States; a tax system which promotes investment in innovation in the United States. All of these things are necessary for us to succeed. The two bills we are talking about today are a good first start in this particular area.

I would leave you with one other thought. I have heard people comment sometimes that this is just another sky is falling routine. In the 1980s, many of us complained about Japanese companies, and the potential competition from Japan. If you recall, Japan emphasized quality and manufacturing, and required the entire United States manufacturing industry to accommodate those two trends in order to compete effectively with Japan. We did so. Since that time, the rest of the world has recognized that it is not a manufacturing future, it is an innovation future. And they have seen what we have done well, and they are copying that.

And the challenge for us is to recognize that they are copying what we did well for the last several decades. Our challenge is to do what is necessary to be successful for the next several decades. H.R. 362 and H.R. 363 are a good first step in that direction, and should be applauded.

Thank you.

[The prepared statement of Dr. Barrett follows:]

PREPARED STATEMENT OF CRAIG R. BARRETT

Mr. Chairman, I appreciate the opportunity to appear today before the Committee to discuss the broad challenges facing the U.S. economy from the new dynamics of global competition. I am pleased to add my voice in support for your initiatives, H.R. 362 and H.R. 363, which build upon prior work done in this Committee in the vital areas of K–12 teacher preparation in math and science (H.R. 362), and increased funding for basic research in the physical sciences conducted through the programs of the National Science Foundation, the Department of Energy, NASA, NIST, and the Department of Defense (H.R. 363).

I note that one of the key components of H.R. 362 is strengthening the impact of the Noyce scholarship program, established by the *NSF Authorization Act of 2002,* to create incentives for colleges and universities to improve the training of STEM teachers and increase scholarships provided for science, math and engineering majors who pursue teaching credentials.

I worked closely with Bob Noyce for many years and want to reflect briefly upon his life and experience, and his contributions to innovation in America, which are emblematic of what it is all of us here on this panel are trying to communicate in the strongest possible terms.

Bob Noyce thrived in the environment of learning created by a superb and dedicated Physics Professor at his alma mater, Grinnell College in Iowa. That professor had obtained two of the very first transistors produced by William Shockley and his team at Bell Labs through his relationship with the President of Bell Labs. Noyce became enthusiastic about this new field of research, and furthered his education at MIT, emigrated to California, and went to work for Shockley Semiconductors. Later of course, he went on to be one of the founders of Fairchild Semiconductor and Intel Corporation, and acknowledged as one of the co-inventors of the integrated circuit along with Jack Kilby of TI.

Here's the point: **a good teacher, a research lab, an engaged student—**the resources that are critical to innovation, the creation of new technologies, and new industries. America has always taken for granted that these foundations of innovation will be there, providing the basis for American economic success.

But we can no longer take those things for granted, which is why the Innovation Agenda announced by the new Democrat leadership in the House, the President's American Competitiveness Initiative, and your legislation, are so important.

The *Gathering Storm* report has now been out for about 18 months. The proclamation we released just before this hearing is another attempt to focus the Congress on the **need for action.** We've had enough reports—perhaps now that elections have passed, Congress can get down to business. Your bills are important first steps, in education and research. The recently approved, substantial FY '07 funding increases for NSF, NIST, and DOE represent a critical down payment on the need for expanded research in the physical sciences, and I thank our Democrat leadership in Congress, particularly Speaker Pelosi, for making that happen.

Intel has been pushing hard for these things for many years, long before the *Gathering Storm* report. All the pieces of the innovation system have to work right together—

- K–12 education, with good teachers well prepared in math, science, and engineering
- University research and teaching programs that build talent for the future
- Government-funded basic research that provides seed corn for new technologies
- Ability to hire and retain the highly talented foreign students who study in the U.S.
- a strong, balanced patent system that produces quality patents and fair results in the courts
- A tax system that fosters investment in applied research, and creation of new manufacturing capabilities in America.

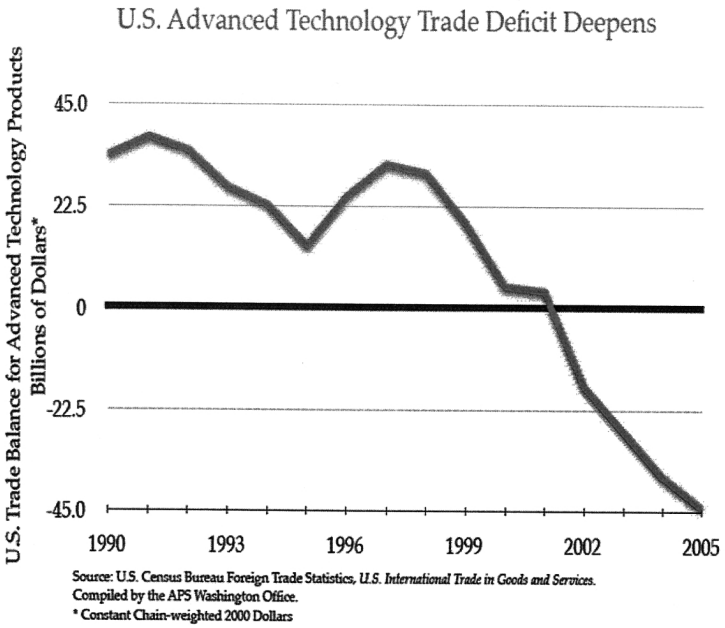
Those are the keys to long-term American economic success. And it is, I think, indisputable that we have allowed these important foundations of innovation to erode.

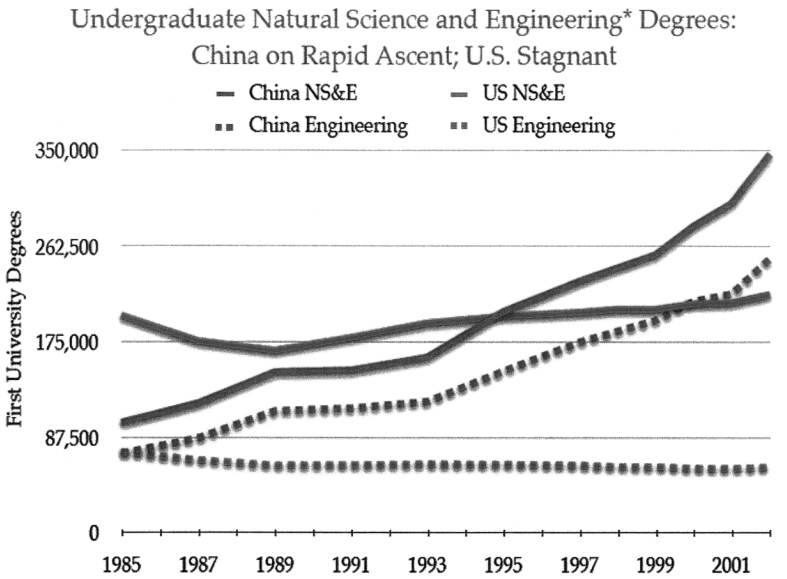
- We have come close to having critical research facilities—such as the Brookhaven heavy ion collider—close.
- We have had close calls on funding for the Focus Center Research Program, which is key to expanding the frontiers of knowledge in semiconductor manufacturing.
- And university graduate programs are threatened for lack of research funds and U.S. students.

Some say "we've heard this before—Japan was going to overtake us in the 80's." And this is the most important point, one I hope all Members of the Committee will take away from this hearing.

In the 80's, the challenge was quality in *manufacturing*. We rose to that challenge in the decades of the 80's and 90's. **Today, however, the challenge is knowledge creation—**and which countries will be the leaders in discovery and speeding discoveries into the marketplace. The rest of the world has caught on to our strengths—and is imitating what we have done right for the past century.

The real question before us today is, will we do it right in the next century?





* NS&E degrees include natural (physical, biological, earth, atmospheric, and ocean sciences), agricultural, and computer sciences, mathematics and engineering. Missing U.S. 1999 data approximated by 1998 data.
Compiled by the APS Washington Office.
Source: *2004* and *2006 Science and Engineering Indicators*, National Science Foundation

Chairman GORDON. Thank you very much, Dr. Barrett.

Next, we have Dr. Neal Lane, a Malcolm Gillis University Professor at Rice University, and Senior Fellow at the James Baker Institute for Public Policy. Dr. Lane is a former Director of the National Science Foundation and Director of the White House Office of Science and Technology Policy. Dr. Lane also chaperoned a two week trip that former Chairman Jim Sensenbrenner and I took to the South Pole. I sometimes wonder whether that was a science experiment, just having us together for two weeks, but I am—and we are glad you are here.

So, thank you, Dr. Lane.

STATEMENT OF DR. NEAL LANE, MALCOLM GILLIS UNIVERSITY PROFESSOR, AND SENIOR FELLOW OF THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY, RICE UNIVERSITY

Mr. LANE. Thank you very much, Mr. Chairman, and Ranking Member and fellow Texan, Ralph Hall, Members of the Committee.

I also want to thank you for your support, in the effort the NSF was making at that time to secure the funds to rebuild the South Pole Research Station, which I think has happily come to pass. It takes a while to build things at the South Pole. We greatly appreciate that. That was very important for science and for the Nation.

Thank you, also, for inviting me to join this very distinguished panel to address a matter of considerable urgency, as the *Gath-*

ering Storm report, I think, made quite clear. And that report put forward some bold, and I think very reasonable specific actions, and I applaud you, Mr. Chairman, and your fellow co-sponsors, for legislation, House Bill 362 and 363, which will move much of that bipartisan agenda along.

And I say that not on behalf of the science community, but rather, out of concern for my four grandchildren, aged four to sixteen, and their happiness and their well-being in the Nation that they will inherit. Our generation, happily, has enjoyed the fruits of six decades of considerable public and private investment in research, much of it carried out in our universities, which produce cutting edge science discovery, path-breaking technologies, and a science and engineering workforce second to none, including many talented men and women who have come here from other parts of the world. Thank God we invited them to come.

But in recent years, the U.S. has been reluctant to make the kind of long-term investments necessary to secure a bright future for Americans. We seem to have other priorities. My grandchildren and their generation will inherit a different America, and they think, perhaps, a bit worn-out or used-up America, and that doesn't seem fair, somehow.

I was privileged to work for President Bill Clinton, who was fond of saying there is nothing wrong with America that cannot be cured by what is right with America, and indeed, there are things that we can do, and we can do them now, to assure our young people the future they deserve. We should not fail them.

So, Mr. Chairman, that then brings me to the specific legislation you have put forward to address some of these matters. In H.R. 363, you authorize substantial increases for basic research in the physical and mathematical sciences and engineering for the National Science Foundation, Department of Energy's Office of Science, NIST, NASA, and the Department of Defense. These agencies have supported excellent research, much of it in universities. Increasing funding for their research programs will pay big dividends in the future, as it has done in the past.

NSF has the broadest mission of these agencies, to promote progress in all areas of science, mathematics, and engineering; and studies in social, behavioral, and economic sciences can be just as relevant as the physical sciences to the process of innovation and American industrial competitiveness, by helping us understand people and organizations. NSF should be given the flexibility to set its priorities among all its directorates and programs.

In addition to these agencies, I believe your bill should also include NOAA, which in a fundamental way, is also relevant to innovation and competitiveness. NOAA supports much of the research on weather and climate change, and its National Weather Service applies the latest science and observations, including data and weather satellites, to make weather forecasts. Accurate forecasts can save lives, and they can save money. Katrina cost us well over $120 billion and immeasurable human costs. These costs are likely to be higher in the future.

Funding for NOAA should be increased, and its planned cutbacks in university support should be reversed. The same is true for NASA. Furthermore, NASA, the agency with the capability to de-

sign and launch satellites, should not be allowed to define away its responsibility by dropping Earth observations from its mission statement.

Now, turning to your second bill, H.R. 362. I want to commend the committee and you, Mr. Chairman, for your leadership in moving forward to address the serious problem of K–12 science education and math education. We will not be able to address the workforce need without improving our schools and teaching in those schools.

In your letter, Mr. Chairman, you asked me specifically to address the appropriateness of the proposed role of the National Science Foundation in administering the science, technology, engineering, and mathematics programs contained in H.R. 362. So, let me give you three reasons, Mr. Chairman, why I consider NSF to be the right agency for this important task.

First, NSF has decades of experience working with school districts and teachers, for example, through the much-heralded Summer Institutes, such as the ones you propose. Department of Energy is also in a good position to organize excellent teacher institutes. Second, NSF has funded much of the pedagogical research that has been done in this country, and can, I believe, best connect the products of that research with the teachers and the classrooms. Third, NSF has a close relationship with most of the Nation's researchers in the physical sciences and engineering, and colleges and universities where our science and math teachers get their education, and can best influence the quality of teacher education. And I should add a fourth, namely, that the NSF program uses competitive peer review to select only the most meritorious proposals for funding.

Mr. Chairman, this committee has long been a bipartisan voice of reason, for advocacy for high standards in research and education, and in the defense of integrity of science, and I thank you for that, all of you, and I congratulate you for moving forward with this important legislation.

I have one last request, Mr. Chairman, something I would like to see the committee put on its future agenda, and that is to study how the whole federal science and technology apparatus works, and how government-wide research priorities are actually set in science, engineering, and education. And the NIH, that has seen flat budgets for four years running, should be a part of that discussion. And I recognize this committee has an oversight responsibility for many agencies, including NIH. I would like the Committee to address the question, in our current system, is the whole really greater than the parts? I personally believe America can do better, our grandkids deserve better, and given the urgent tone of the *Gathering Storm* report, we may not have all that much time.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Lane follows:]

PREPARED STATEMENT OF NEAL LANE

Chairman Gordon, Ranking Member (and fellow Texan) Ralph Hall, Members of the Committee:

Thank you for inviting me to testify today in this important hearing *"Science and Technology Leadership in the 21st Century Global Economy,"* which deals with a matter of considerable urgency.

This committee has long been a champion for U.S. science and technology and research and education. It has been a bipartisan "voice of reason" in Washington. I particularly appreciated the guidance and support this committee gave me when I was NSF Director and during my time as Director of OSTP. It is always a pleasure to appear before you.

I also feel very honored to be part of today's distinguished panel.

Norm Augustine, who chaired the committee that wrote the National Academies' report, *"Rising Above the Gathering Storm,"* has been ringing alarm bells throughout this town and the Nation about the enormous challenges our country faces in this century. The findings in that report are frightening and the recommendations are both bold and compelling. I join many others who believe that there is great urgency in putting those recommendations into action.

And I applaud you, Mr. Chairman, and your fellow co-sponsors of legislation (H.R. 362 and H.R. 363) to move much of that agenda along by authorizing significant growth in the research budgets of several agencies and funding for several innovative programs to improve the teaching of science, technology, engineering and mathematics (STEM) in this country.

I might also mention that the *"Gathering Storm"* report has gotten the attention of many in my state of Texas. The Academy of Medicine, Engineering, and Science of Texas (TAMEST) has, with the encouragement of Senator Kay Bailey Hutchinson, taken on the task of determining how the education recommendations of the report might be implemented at the State level. I suspect other states are doing the same.

Earlier, I used the word "urgency." So, let me tell you why I believe the Congress should waste no time in moving this and other relevant legislation along. And, I ask your indulgence to let me personalize my testimony. Since the Chairman has talked about his five-year-old daughter, expressing some concerns similar to my own, I hope you will indulge me as I talk about my four grandchildren, Jessica, Matthew, Allia, and Alex, ages four to 17.

Over the past 60 years, my generation—and the baby boomers who came behind us—have enjoyed the fruits of considerable public and private investment in research, much of it in universities, where millions of bright young men and women have learned how to think, how to discover and invent—how to turn knowledge into wealth, jobs, and a standard of living for Americans that is the envy of the world.

No less important, as a part of this success, were the thousands of men and women who came to America from other parts of the globe to obtain their education in our universities. And many of them stayed and became a critical component of the most highly skilled science, engineering and technical workforce in the world. Thank God we welcomed them to our communities.

Well, the baby-boomer scientists and engineers are beginning to retire; and the pipeline does not have sufficient numbers to replace them. Furthermore, fewer of the brightest young people from other parts of the world are choosing to study and make their careers in America. They are finding excellent opportunities elsewhere.

These past six decades have been a golden age for America, in part due to our leadership in science and technology. But, looking to the future, things do not look so golden. Much has changed in recent decades. And many, if not most, of the factors that enabled the United States to be so successful no longer apply.

The *"Gathering Storm"* report presents frightening statistics and logical implications that should be a "wake up" call to all Americans.

My *grandchildren,* and your grandchildren and children, are wondering how their lives will compare to the lives we have enjoyed. I think they are concluding that they may not have it so good.

Their generations are looking at a very different world than the one I saw as a naïve physics student in the 1960's.

When I was a teenager, we didn't worry about the energy supply. It seemed to be endless. Well, today, we realize that it is not.

When I was a teenager, we couldn't imagine that humans could be changing the climate, and along with it, the weather for future generations. Well, today we realize that the energy we use and the fuel we burn *are* changing the climate. And our concerns grow more serious with each passing day.

When I was a teenager, it seemed that the United States would always be the unrivaled economic power on the globe. Well, today, we realize that we could well lose that position. In many ways, the handwriting is on the Great Wall.

And I think it would never have occurred to us that our performance in school would rank well down the list of nations, by almost any measure you could name.

So, my grandchildren face enormous challenges. But, the news is not all bad. There are things we can do right now to help—and it would be irresponsible not to do them.

The reality, of course, is that there is no simple solution, no magic bullet, as the *"Gathering Storm"* report points out. Progress will require a number of difficult strategic decisions and investments of taxpayers' money. It will take vision, political leadership, perhaps even courage. My hunch, however, is that the American people know that we're in big trouble, and they are willing to do their part, provided their government tells them the truth and puts forward sensible plans.

Fortunately—and it is a big plus—we have the strong institutions needed to implement the recommendations in that report and contained in your proposed legislation.

We have outstanding state and private colleges and universities all across the country that collectively make up what is by far the strongest system of higher education in the world. And one of the principal reasons for this success is decades of federal investment in research and higher education. I do not believe that these institutions can remain strong if that investment is allowed to continue to slide downward.

And we have many outstanding federal agencies, which, given the resources, flexibility and effective leadership can do their part.

So, Mr. Chairman, that brings me to the specific legislation you have put forward to address some of these matters. In H.R. 363, you authorize increases of 10 percent per year (for five years) for *basic research* in the physical and mathematical sciences and engineering for NSF, DOE's Office of Science, NIST, NASA and DOD with special emphasis given to: early career development, integration of research and education, interdisciplinary research, and infrastructure enhancement. In the case of NSF, you also authorize increased funding to promote research on the process of innovation and teaching inventiveness, which would involve NSF's social sciences and educational research programs.

I want to state unequivocally that if this bill passes and funds are appropriated for these important efforts, and provided the agencies are given flexibility in implementing them, America's future competitive position in the world will look much brighter than it does today. Our grandkids should be pleased.

Let me comment, specifically, on NSF, DOE/OS and NIST. What do these three agencies have in common? In a word "excellence":

- Excellence, in the research they support (all have garnered Nobel Prizes);
- Excellence in the quality of their programs and staff; and
- Excellence in their contributions to advancing the Nation's position of leadership in science and technology over the past half century.

In the case of DOE, the agency has the mission and wherewithal to connect the research results of the researchers it supports with the future carbon-free energy and fuel needs, as well as the security, of our country.

In the case of NIST, the agency has the mission and wherewithal to provide U.S. industry: (a) with appropriate support to bring high-risk emerging technologies closer to market and (b) well researched and tested industrial standards that reflect the results of excellent research and the latest technological innovations.

In the case of the NSF, the agency has the relationship with our institutions of higher education to effectively integrate research and education to deliver new knowledge at the frontiers of science and engineering and tomorrow's technically trained workforce so vital for the future of the Nation.

Your bill also addresses DOD and NASA. I believe it should also include NOAA.

DOD has, in the past, been a prime investor in basic research. Indeed defense agencies invented the process of competitive peer review that is the hallmark of excellence in research. In recent times, however, defense priorities have shifted to short-term mission-specific goals. Your legislation sends a strong signal that this situation should be reversed.

NASA has made extraordinary contributions to science in such fields as astronomy, astrophysics, space, planetary, and Earth science, including satellite observations of the Earth's atmosphere, land and sea. The recent shift in NASA priorities has placed science well down the list in order to make room for an aggressive drive to go back to the Moon, and perhaps beyond. Whether returning to the Moon is a good idea or not, sacrificing critically important science to do it clearly is unwise.

That brings me to one more issue I would like the Committee to consider—how one understands and frames innovation and competitiveness. It is in this context that I mention NOAA.

One of the major costs of doing business is weather and weather-related events—storms (hurricanes and tornadoes), blizzards, floods, droughts, and other disruptive acts of nature. We already suffer billions of dollars a year in losses due to weather events. Hurricane Katrina cost well over $120 billion and immeasurable human

loss. These financial and human costs could be considerably reduced with more accurate and timely forecasts. The management of Jet Blue could probably attest to that need based on the problems they and their customers suffered during the ice storms of Valentine's Day last month.

Furthermore, global warming and climate change will alter the patterns of the past and may lead to more frequent and more disastrous events. We need the research to improve our understanding of climate and weather, provide better forecasts, as well as invent the technologies to cope with the impacts.

In addition to the research supported by NSF and DOE's Office of Science, the work of NOAA and NASA are central to our understanding of climate and weather. NOAA, in particular, the National Weather Service, has the responsibility to produce official forecasts, and NOAA experts need the observational data and computer modeling capability to this well.

NASA is the agency with the capability to design and launch the satellites that provide much of that observational data. It is incomprehensible to me that NASA would remove "Earth observations" from its mission statement at a time when we are facing staggering future weather-related costs and when our weather satellites are aging and the plans to replace them are not going well.

It is also disturbing that both NASA and NOAA are cutting back on their extramural research support, where the competitive process of peer review can be used to select the most meritorious and promising ideas. Moreover, the kind of research these agencies support (for example, the geosciences, or climate science) in universities involves students in complex problem solving that trains them to work in interdisciplinary teams. This is precisely the kind of technical workforce industry says they need. Cutting back on university support in these disciplines does not bode well for the future.

The recently released National Academies' report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* raised alarm bells about our deteriorating system of weather and climate observations and ability to protect our nation's citizens and businesses from natural disasters. The report has received an enormous amount of attention.

Both NOAA and NASA's science and Earth observation programs will need your support for the additional funding required to meet these critical societal needs, as well as your continued protection of those agencies from earmarks that in the past have made it hard for them to do their jobs.

Before I leave the topic of federal support for research, I would be remiss if I did not mention that many federal agencies have important research programs that deserve attention and increased support. Even though NIH is not strictly under the jurisdiction of this committee, it is important to note that its budget has been essentially flat for four years running. That can't be good public policy.

Now, turning to your second bill (H.R. 362), I want to commend the Committee—and you, Mr. Chairman for your leadership—in moving forward to address the serious problem this country has in K–12 education.

Your bill, H.R. 362, addresses the critical need to improve the quality of the teaching of science, technology, engineering and mathematics (STEM) in our schools, colleges and universities. The programs you authorize with this legislation are important steps to take as the Nation deals with this enormous educational challenge. The bill should be strongly supported by all Members of Congress.

Mr, Chairman, in your letter you asked me to specifically address the appropriateness of the proposed role of the National Science Foundation in administering the science, technology, engineering and mathematics education programs contained in H.R. 362.

Let me give three reasons why I consider that to be the right decision:

- First, NSF has decades of experience working with school districts and teachers, for example, through much heralded summer institutes such as the ones you propose. (I cannot count the number of occasions when teachers came up to me and said the most important thing that happened to them during their early teaching years was the NSF summer science institutes.)
- Second, over the years, NSF has funded much of the pedagogical research that has been done in this country. Only by getting the researchers, themselves, into contact with the schools and teachers will it be possible to apply what has been learned to improve teaching and learning.
- Third, NFS (and DOE's science program) have a close relationship with most of the researchers in the physical sciences and engineering in colleges and universities where our science and math teachers get their education. Given the green light and the funding, these agencies, working with universities and

colleges, can dramatically improve the education (and re-training) of future math and science teachers.

- And, I should add a fourth: namely, that the NSF and DOE's science program use a process of competitive peer review to select only the most meritorious proposals for funding. They keep the standards high. And I want to emphasize that I am not criticizing the Department of Education, which has an excellent staff and a hard job to do. But it is a different job. They have neither the experience nor the staff to take on the role of NSF and DOE's Office of Science.

In summary, I congratulate the Committee for moving forward with this important legislation and want to express my appreciation for holding this hearing and allowing me to share my views.

Thank you, Mr. Chairman.

BIOGRAPHY FOR NEAL LANE

Dr. Neal Lane is the Malcolm Gillis University Professor at Rice University. He also holds appointments as Senior Fellow of the James A. Baker III Institute for Public Policy, where he is engaged in matters of science and technology policy, and in the Department of Physics and Astronomy.

Prior to returning to Rice University, Dr. Lane served in the Federal Government as Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy, from August 1998 to January 2001, and as Director of the National Science Foundation (NSF) and member (ex officio) of the National Science Board, from October 1993 to August 1998.

Before becoming the NSF Director, Dr. Lane was Provost and Professor of Physics at Rice University in Houston, Texas, a position he had held since 1986. He first came to Rice in 1966, when he joined the Department of Physics as an assistant professor. In 1972, he became Professor of Physics and Space Physics and Astronomy. He left Rice from mid-1984 to 1986 to serve as Chancellor of the University of Colorado at Colorado Springs. In addition, from 1979 to 1980, while on leave from Rice, he worked at the NSF as Director of the Division of Physics.

Widely regarded as a distinguished scientist and educator, Dr. Lane's many writings and presentations include topics in theoretical atomic and molecular physics and science and technology policy. Early in his career he received the W. Alton Jones Graduate Fellowship and held an NSF Doctoral Fellowship (University of Oklahoma), an NSF Post-Doctoral Fellowship (while in residence at Queen's University, Belfast, Northern Ireland) and an Alfred P. Sloan Foundation Fellowship (at Rice University and on research leave at Oxford University). He earned Phi Beta Kappa honors in 1960 and was inducted into Sigma Xi National Research Society in 1964, serving as its National President in 1993. He served as Visiting Fellow at the Joint Institute for Laboratory Astrophysics in 1965–66 and 1975–76. While a Professor at Rice, he was two-time recipient of the University's George R. Brown Prize for Superior Teaching. Dr. Lane has received numerous prizes, awards, including the AAAS Philip Hauge Abelson Award, the AAAS William D. Carey Award, the American Society of Mechanical Engineers President's Award, the American Chemical Society Public Service Award, the American Astronomical Society /American Mathematical Society/American Physical Society Public Service Award, and many honorary degrees.

Through his work with scientific and professional organizations and his participation on review and advisory committees for federal and State agencies, Dr. Lane has contributed to public service throughout his career. He is a fellow of the American Physical Society, the American Academy of Arts and Sciences (member of its governing council), the American Association for Advancement of Science, the Association for Women in Science and a member of the American Association of Physics Teachers. He serves on several boards and advisory committees.

Born in Oklahoma City in 1938, Dr. Lane earned his B.S., M.S., and Ph.D. degrees in physics from the University of Oklahoma. He is married to Joni Sue Lane and has two children, Christy Saydjari and John Lane, and four grandchildren, Allia and Alex Saydjari, and Matthew and Jessica Lane.

Chairman GORDON. Thank you very much, Dr. Lane.

Interesting that you mentioned that. We are in a period of scarce resources or limited resources, and I have been concerned, whether it is the National Labs, or different agencies that are maybe trying to do the same thing, are we really focusing our money best? And

I think that does need to be an area of review. I don't want to micromanage, but we do want to get our best bang for the buck, and I think we need to find out where we can get our best synergy. And we will be having that oversight hearing in the future.

Now, we have Ms. Deborah Wince-Smith, who is President of the Council of Competitiveness. She was the former Assistant Secretary of Technology Policy in the Department of Commerce, and served as an Assistant Director at the Office of Science and Technology Policy.

Welcome, Ms. Wince-Smith.

STATEMENT OF MS. DEBORAH L. WINCE-SMITH, PRESIDENT, COUNCIL ON COMPETITIVENESS

Ms. WINCE-SMITH. Mr. Chairman, Ranking Member Hall, Members of the Committee, thank you so much for the opportunity to appear before you today on the critical issues of U.S. competitiveness, the skills of all Americans, and ensuring that our nation continues to invest in R&D at the forefront of knowledge.

Since the Council on Competitiveness issued its report, Innovate America, in December 2004, there has been a drumbeat for action on a national innovation and competitiveness agenda, with the National Academies' *Gathering Storm* report and the work of the Business Roundtable as an example. We talk about innovation being multi-disciplinary, and I will say that all of these reports really have taken the best ideas, and come together, really, in a very coordinated way now, to push this through as a very important national priority.

I might just mention that this morning, I attended Secretary Paulson's summit that he has underway on competitiveness of capital markets, and Warren Buffett and Jeff Immelt, and Chairman Greenspan were all talking about the importance of having U.S. leadership in capital markets, access to liquidity, everything that fuels our innovation. And what was very interesting as the discussion unfolded; the three issues that came to the top of the agenda were the importance of our math and science education, the need for systemic immigration reform, and the importance of investing in R&D at the frontier.

Mr. Chairman, I would like to really thank you and the Members of this committee for keeping the pressure on Congress to really look at competitiveness legislation as a whole. And I know that while the private sector is doing many, many important things at the end of the day, Congress and the Administration must act as if we are going to continue to ensure that our children have a legacy of prosperity in the years to come.

And the Council is very much in favor of H.R. 362 and H.R. 363. I have submitted a written statement for the record, and what I really wanted to do this afternoon is just very briefly focus your attention on four very powerful data points from the Council's recently released *Competitiveness Index: Where America Stands.* This is a quantitative and qualitative look at the state of the U.S. economy vis-à-vis our global competition, and the trends in the future.

[Chart]

The first chart that I want to show you is the importance of small and medium-sized businesses. These are our job drivers, our

job creators for the future. This really shows that over the last two decades, 80 percent of the total net new jobs in this country have come from small and medium-sized firms. The entrepreneurial engine is what is going to drive our future. We know that our large global corporations are global enterprises, they are optimizing their investments, their search for talent, their R&D, all in global supply chains. And this adds tremendous value to the U.S. economy, but in terms of job creation, it is the entrepreneurial economy that will drive our future, and they will be the game changing innovators, just as Bob Noyce some years ago exemplified the entrepreneur creating a global enterprise such as Intel. So, clearly, STEM education and increased investment in basic research are the key drivers for entrepreneurial business development. These will be the assets on which our entrepreneurs will build the businesses of the future.

Access to risk capital, seamless technology transfer, and accelerated deployment, and enhancing our collaboration between business, academia, and our National Laboratories, are really the essential building blocks that also have to be improved if we are going to capitalize on these investments in basic science, and the people that will make all of this happen.

[Chart]

The second chart I want to show you is how higher order skills are the skills of the future. The investments that we are talking about through these two pieces of legislation are really going to be the investments to develop the skills that are going to be important as we go forward in this 21st Century economy. Routine manual and cognitive skills, any job that can be digitized, those jobs have declined in importance, and it is going to be complex communication, expert thinking, judgment, intuition, and idea generation capacity that will create the innovation future for America. And again, STEM education is at the heart of all the jobs in the American economy.

And I will also mention that it is these types of skills and higher order thinking that are going to be instrumental in increasing the intangible assets on which our economy also depends. Our work has shown that the value of intangible assets now is about $1 trillion, equaling that of tangible investment, and again, that relates to STEM education, and investment in R&D.

[Chart]

This next chart on high wage, fast growth occupations clearly shows that again, we have to have higher levels of education, and we have to have education that combines STEM education, literacy and engineering skills, with language, humanities, and social sciences, so that Americans will have the skills that drive creativity. The thing that is really important on this chart is to look at the big blue circles, because the big blue circles are showing high value, high skill jobs with high value income for American citizens.

So, these three charts really paint a very powerful picture on why the legislation before this committee is so important, and why we must focus on the skills America needs to fuel our entrepreneurial economy.

[Chart]

And let me conclude with one last chart. This may seem a conundrum, but it is actually very, very interesting, that in the United States we have tremendous job churn. It highlights that our economy destroys nearly as many jobs as it creates each year, about 30 million. That is right, 30 million jobs are destroyed each year and about the same are created. This is creative destruction, and it is a fact of life in the American economy. It is a testament to the incredible ability of our country to destroy and create jobs at an amazing pace, as innovation permeates throughout the economy.

Other countries find themselves locked and saddled with rigid, inflexible labor markets and high unemployment. Now, this job churn also is a source of tremendous anxiety, as each lost job represents an individual who is faced with uncertainty for his or her future, regarding health care benefits, and pension. But what it shows is the likelihood of this person getting another job, and that likelihood is high, but it is only going to be high in the future if they have the skills, and the skills, again, depend on our STEM education, our investments in R&D, accelerating our entrepreneurship, and ensuring that we have a society that has high performance correlation learning.

So, Mr. Chairman and Members of the Committee, I urge you to take action on these bills and others in the panoply of competitiveness legislation. And I commend you for your leadership. And I am pleased to answer any questions.

[The prepared statement of Ms. Wince-Smith follows:]

PREPARED STATEMENT OF DEBORAH L. WINCE-SMITH

Good afternoon, I'm Deborah Wince-Smith, the President of the Council on Competitiveness. Thank you, Chairman Gordon, Congressman Hall, and the Members of the Committee, for this opportunity to present testimony on the importance of implementing a national competitiveness agenda, and, in particular, increasing funding for long-term basic research, supporting America's high performance computing capability, and enhancing science, technology, engineering and mathematics (STEM) education.

The Council on Competitiveness is the only group of corporate CEOs, university presidents and labor leaders committed to the future prosperity of all Americans and enhanced U.S. competitiveness in the global economy through the creation of high-value economic activity in the United States. Starting at the top with our Chairman, Chad Holliday, the CEO of DuPont, our members recognize that the world has changed and America's current place as an economic superpower is not guaranteed. In this new conceptual economy, ideas and technological development will not be enough to ensure our continued success. We must find innovative ways to apply new knowledge, work across disciplines and add high value jobs. We cannot and should not seek to compete for low wage, low cost opportunities—that time has passed us by. An underpinning of strong STEM education will be critical across a myriad of occupations if Americans are going to thrive in this new economy. Yet despite spending more per student than almost any other country, American students perform poorly in relation to their international peers in math and science.

Since the Council on Competitiveness issued its private sector call for action, *Innovate America,* in December 2004, there has been a steady drum beat for action on U.S. competitiveness, punctuated by similar proposals from the National Academies, congressional leadership, the Administration and the Nation's governors. All of these efforts have benefited from broad support by the private sector, including the personal involvement of many of the country's top CEOs and university presidents, as evidenced by the panel here today. At a similar hearing last year, I commented that I believed there was a critical confluence of support for action on competitiveness, if only policy-makers would take advantage and act. Some important progress has been made, but there remains much to be done. We are at a critical juncture as a nation and as a people. A scatter shot approach to innovation and competitiveness risks accomplishing little, while a comprehensive innovation agenda can set the country on a foundation for long-term success that will help ensure the

next generation looks back with pride—as we do to the men and women on whose backs and minds our current prosperity rests.

THE CONCEPTUAL ECONOMY

At the beginning of the 21st century, America stands at the dawn of a conceptual economy in which insight, imagination and ingenuity determine competitive advantage and value creation. To succeed in this hyper-competitive, fast-paced global economy, we cannot, nor should we want to, compete on low wages, commodity products, standard services, and routine science and technology development. As other nations build sophisticated technical capabilities, excellence in science and technology alone will not ensure success.

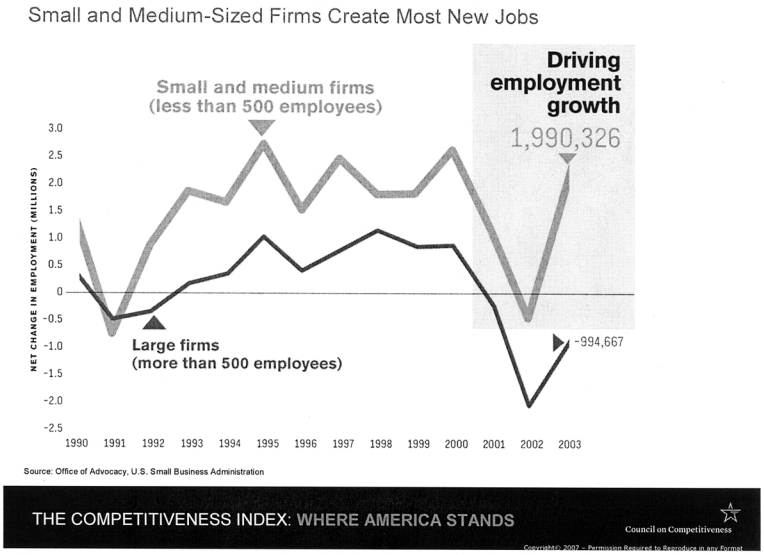
The United States must focus on its strengths—on what it means to be American. We must innovate and embrace the opportunities of the rapidly emerging, high-value conceptual economy. It is increasingly clear that the most important competition is being fought in the arena of ideas, learning, and delivering new kinds of value to the marketplace. Looking back at the tremendous growth of America's gross domestic product over the past half century, information and ideas have been equally, if not more, important than materials and manpower to sustaining America's economy.

In the conceptual economy, our success will be measured by our ability to transform industries, reshape markets old and new, stay on the leading-edge of technology creation, and fuse diverse knowledge, information and technology. This new global economy will be much different than the industrial economy of the 20th century, or even the information economy of the past two decades. The conceptual economy will favor nations that reach globally for markets, and those who embrace different cultures and absorb their diversity of ideas into the innovation process. It will be fueled by the fusion of different technical and creative fields, and thrive on scholarship, creativity, artistry, and leading edge thinking. The investments, infrastructure and talent necessary for Americans to succeed in this new global paradigm require public and private sector action. We cannot assume our past success will guarantee future prosperity.

As my colleagues with me at the table know well, the private sector can and will continue to look inward to how it can best compete in today's global economy. We also can sound the alarm—and we have tried to do that to the best of our ability—but it is Congress and the Administration that must act if Americans are going to continue to see a rising standard of living in the 21st century.

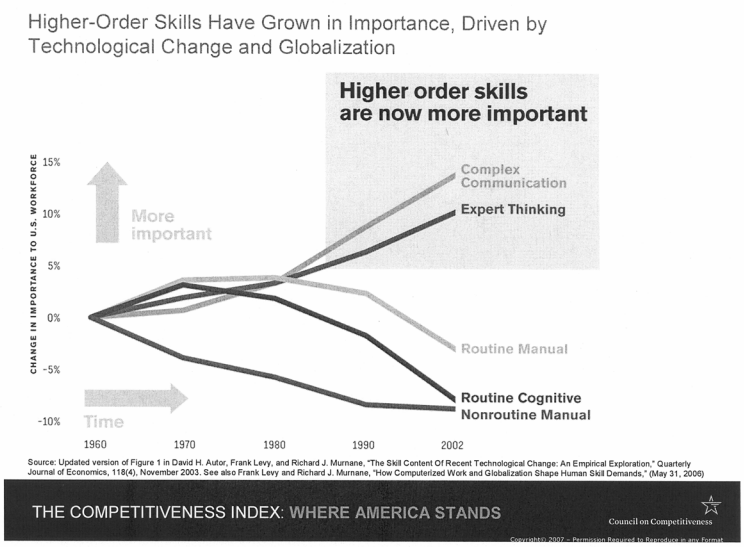
I want to call your attention to four data points from the Council's recently released *Competitiveness Index: Where America Stands,* which is a comprehensive look at the state of the U.S. economy vis-à-vis our international competition.

CHART 1



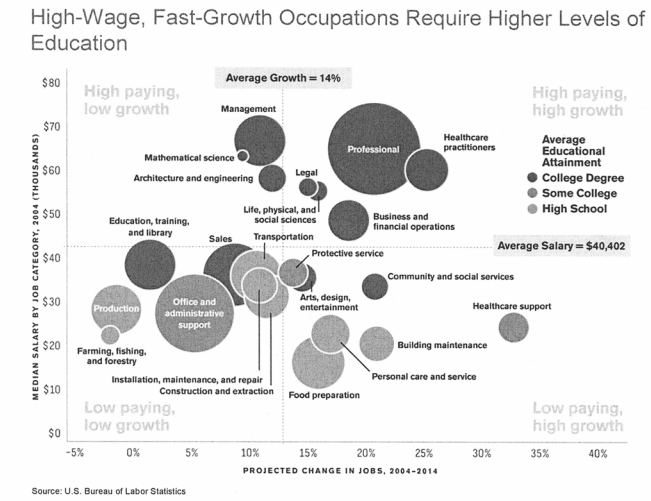
This first chart highlights the importance of small and medium-sized businesses as job creators in the United States. This is not to say that large corporations do not generate value to the U.S. economy—they unquestionably do—but job creation is coming from smaller enterprises and the power of entrepreneurship. Central to the ongoing success of these smaller firms is to leverage and accelerate the entrepreneurial spirit that so defines the American way of life; and that has been so central to our country's history of discovery, creativity and transformational value. Clearly enhanced STEM education and increased investment in basic science research are key drivers of small business development and key assets for entrepreneurs, but they must be supported by an innovation infrastructure that enables value and job creation and market penetration. Access to capital, seamless technology transfer, mentoring and strategic business/academic collaboration are essential building blocks that must be constantly improved to take full advantage of our nation's investments in science and people this committee is considering.

CHART 2



And make no mistake; those investments are exactly what is needed, as this next chart demonstrates. Routine manual and cognitive skills have declined in importance since the late seventies, while complex communication and expert thinking have increased markedly. Again, the importance of STEM education as a grounding for so many jobs in the American economy is emphasized by this data. This chart is a visual representation of the challenges policy-makers face in helping to prepare Americans for the jobs that employers are seeking to fill over the next two, five or 10 years. The skills that are valued are not those of the 20th century assembly line or the commoditized textile factory and that is not where the comparative advantage or opportunity lies either.

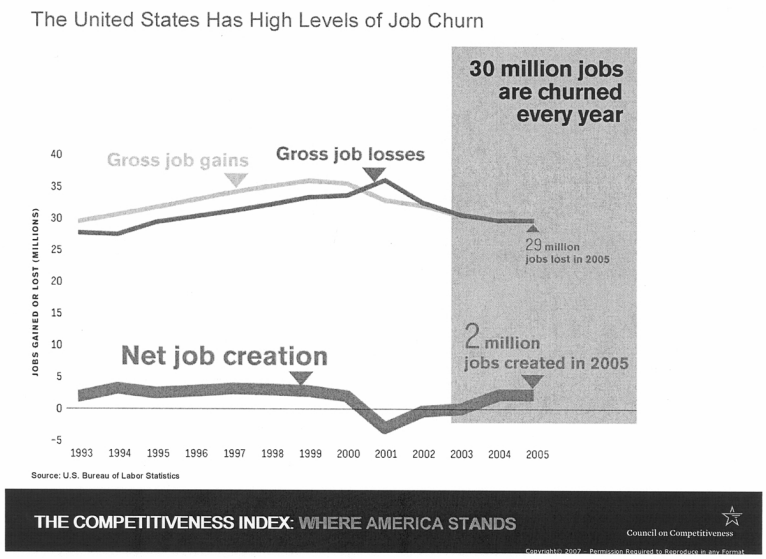
CHART 3



The blue circles in the upper right hand corner of this chart are the circles that matter, as they represent high wage, high growth jobs. Here is why what this committee is working on is so important and why I and my colleagues at the table are so committed to leading this imperative. High wage, high growth jobs require higher skills! That's STEM education. That's language skills and humanities and social sciences. That's entrepreneurship. The orange circles are yesterday's economy. Will those jobs disappear or become irrelevant to our day-to-day lives? No. But we do a disservice to the American people if we spend our time fighting for the orange circles, when a world of opportunity is within our grasp if we harness the potential of innovation to power our future.

Taken together, these three charts paint a very clear picture as to why this committee and the Congress in general must focus on U.S. competitiveness and the skills Americans will need to compete and prosper.

CHART 4



The job churn chart highlights that the U.S. economy destroys nearly as many jobs as it creates each year—about 30 million. Talk about creative destruction. Churn is a fact of life in the American economy. It is healthy. It is a testament to the incredible ability of our country to destroy and create jobs at an amazing pace as innovation permeates throughout the economy. Other countries are saddled with rigid, inflexible labor markets and high unemployment.

But, job churn also is the source of tremendous anxiety as each lost job represents an individual who is now faced with uncertainty for his or her future. Uncertainty regarding health care benefits, and retirement. The chart shows that the likelihood of this person getting another job is very high, but it does not say how long it might take and whether it will pay as well. This again should reinforce the Committee's focus on STEM education as critically important, because it recognizes that the American people will be better prepared to handle these transitions, if they have the foundation to engage in lifelong learning and higher order skills necessary for the jobs of the future.

THE INNOVATION ECOSYSTEM

The Innovation Agenda outlined in the Council's Innovate America report and echoed by the *Rising Above the Gathering Storm* report, the President's *American Competitiveness Initiative,* the Democratic Innovation Agenda, and many other important initiatives, recognized that there are three foundational platforms or building blocks to innovation—Talent, Investment and Infrastructure. This comprehensive, or ecosystem, approach to innovation best ensures a return on investment for the American people in the form of jobs, social benefits and wealth creation.

Talent addresses our human capital needs including building the base of scientists and engineers by enhancing K–16 STEM education, pioneering an extensive portable graduate fellowship program and attracting the best and the brightest students and workers from around the world by reforming our immigration system. We also must empower workers to succeed in the global economy by reforming federal job training programs to enable them to have the flexibility to target the skills needed for the jobs of the 21st century.

Investment in innovation addresses the balance between risk and reward and the incentives—or disincentives—for people and institutions to invest in innovation. Pri-

orities here should be to revitalize frontier and multi-disciplinary research by increasing federal funding of basic research, making the R&D Tax credit permanent and seeking to catalyze Innovation Hot Spots™ at regional locations across the United States through public-private partnerships explicitly focused on supporting regional innovation.

Investing in innovation also demands adherence to two fundamental principles: a willingness to accept risk and a willingness to wait for the return on investment. Although America's entrepreneurial economy understands and embraces these principles, the much larger financial mainstream may be now moving in the opposite direction. Investment time horizons are getting shorter. Long-term innovation strategies remain under-valued. And business executives in publicly held companies now face a regulatory climate that is blurring the line between business risk and legal risk. Intangible assets, which represent an increasingly large percentage of the value of corporations, still don't show up on the balance sheet, reducing incentives to invest in creating more value. How we measure innovation remains a challenge without a solution.

Innovation infrastructure covers not only the physical infrastructure that supports innovation but also the political, regulatory and legal infrastructure that facilitates innovative behavior. We must create a 21st century intellectual property regime, strengthen America's advanced manufacturing capacity and put in place a national, coordinated innovation policy with representatives from the public and private sector.

It is with great optimism that as I testify here today that a tremendous amount of progress has been made in the past two years, but we are still far from the finish line.

A GOOD BEGINNING

The Council—under the leadership of its Chairman, Chad Holliday, its Vice Chairmen, Wayne Clough, President of Georgia Tech and Doug McCarron, President of the United Brotherhood of Carpenters and Joiners; and with the support of Craig Barrett, Intel Chairman, and William Brody, President of Johns Hopkins, who head our National Innovation Leadership Council—have invested substantial time and energy to ensure that the recommendations of *Innovate America* and subsequent reports do not gather dust on the shelf. Thanks to the strong leadership of Members of Congress and many people in the Administration we can look back today at several encouraging steps that have been taken to better position the United States to compete in the 21st century global economy.

- With the passage of the FY2007 Continuing Resolution in February 2007, agencies including the National Science Foundation (NSF), the National Institutes of Standards and Technology (NIST) and the Department of Energy's Office of Science received significant funding increases for long-term basic research—a critical underpinning of an innovation economy. The FY 2008 budget request continues this important trend, though attention must be paid to other key research agencies, including the National Institutes of Health and the Department of Defense. Research has become inherently multi-disciplinary, so while an argument can be made that the physical sciences have been under funded over the past several years, any "catch-up" funding should not come at the expense of the life sciences.
- Late in 2006, the Congress passed and the President signed another extension of the R&D Tax credit that included various enhancements to the credit. This important step, particularly the enhancement, which updated the credit to better reflect marketplace realities, should be built upon in 2007 and the credit should be extended permanently.
- Both in the House and Senate, a number of bills have been introduced that would implement various pieces of the innovation/competitiveness agenda. Many of these bills have received strong bipartisan support and this committee has already acted on a number of them.
- Consistent with the call in *Innovate America* for better integration between workforce and economic development programs, in early 2006, the Department of Labor awarded $195 million in grants to thirteen regions across the country through its Workforce Innovation in Regional Economic Development (WIRED) program. The WIRED program embraces the Council's focus on innovation as the key to regional economic development and will foster much needed coordination among regional workforces and economic development programs. The WIRED program has already expanded beyond the original thirteen regions and is becoming a model for regional economic development

and coordination. The Council serves as a technical advisor to the Department on this program.

- Just last week, the Patent Office announced that it is "starting a pilot project that will not only post patent applications on the Web and invite comments but also use a community rating system designed to push the most respected comments to the top of the file, for serious consideration by the agency's examiners. A first for the Federal Government, the system resembles the one used by Wikipedia, the popular user-created online encyclopedia." The Council's report called for the patent system to be a resource for innovation and while time will tell how successful it might be, this announcement is an important first step in opening up the process to greater transparency and collaboration.
- Enhancing U.S. competitiveness is not solely a federal issue and states play a pivotal role. They are better positioned to integrate strategies and respond to many of the challenges facing Americans. In July of 2006, Governor Janet Napolitano, the Chair of the National Governors Association (NGA), announced that the NGA would make innovation in the states its priority for her term as Chair. This recognition that states and regions are the cauldrons of creativity in the United States has laid the groundwork for important policy and regulatory changes to be put in place that will catalyze collaboration, enhance STEM education and better align workforce training with workforce opportunity. The Council is pleased to be a partner in this effort.

THE ROAD AHEAD

Now is no time to rest on the laurels of past accomplishments—many of which require continued action or even the short-term benefit could be lost. There is clearly broad private sector support for a comprehensive innovation package as evidenced by the Innovation Proclamation delivered to the Hill today with over 270 organizations represented. In addition to those actions detailed above that must be taken to maintain the progress made to date, Congress must address the following areas:

- A central focus of this hearing is the importance of enhancing STEM education in the United States and a cornucopia of proposals have been put forward to address this critical issue. Without delving into the details of any specific proposal, it is a top priority of the Council's 180 private sector leaders that action be taken in this area by federal, State and local leaders. Enhancing STEM education is critical to the ability of our citizens to compete globally and to fuel the creativity that will drive American competitiveness in the future. Solutions must include improving teacher quality through better training and performance-based incentives.
- Entrepreneurship and risk taking are the bedrocks of American creativity and small business development. Policy-makers must take into consideration the impact regulations, tax policy and liability concerns have on innovation and the creative process. Anecdotally, we are seeing foreign capital markets attracting interest for new IPOs. Liability, health care and exorbitant tort costs that now exceed our national investment in research and development continue to be a concern for many small- and medium-sized businesses, as the costs to them are disproportionably higher. And in parallel, we place significant costs burdens on U.S. global enterprises conducting high value commercial activity, thereby impacting decision-making regarding investing in next generation manufacturing facilities and operations in the U.S.
- While federal programs like WIRED are making strides in coordinating workforce and economic development priorities, much remains to be done in aligning federal and State resources with the 21st century needs of the American worker. Workforce resources are sub optimized and not addressing regional realities. Proposals to provide greater flexibility and focus in the various workforce programs have been put forward by the Administration, Members in the House and Senate and by the National Governors Association, but to date, no final action has been taken.
- While most of the attention on immigration reform has been placed on the issue of what to do with illegal immigrants, there are several critically important provisions under consideration that would encourage more legal immigrants with advanced degrees in science and engineering to stay and work in America. We often say that America attracts the best and brightest to study and work here, but that assumption is being tested around the world as research parks spring up in China and top-notch universities open in India. Once the appropriate background checks are completed, we should staple a

green card to the diplomas of those immigrants who acquire advanced degrees in STEM disciplines and commit to work in America for a significant period of time.

- Lastly, the Committee's continued support of high-performance computing is critical to American competitiveness and I encourage you to ensure that our National Labs have these critical tools. Supercomputing is an important ingredient in our nation's innovation infrastructure and a linchpin to the country's competitiveness. It reduces time to discovery and accelerates the innovation process, and has become essential to the business survival of many of our most competitive companies. Unfortunately, Council research has shown that we lack the talent we need to take full advantage of these innovation accelerating tools. . .both within our national labs and within the private sector. Advancing the math and science capabilities of today's students will be vital to ensuring that we, as a nation, are able to take full advantage of these nationals assets.

In conclusion, I want to urge the Committee and the Congress to take action this year on a comprehensive competitiveness agenda that at a minimum includes increased research funding, enhanced STEM education, high skilled immigration reform and permanent tax incentives for investment in research and development. State and local governments and leaders in the private sector must do their part as well, but setting the agenda for the Nation lies with the Congress and the Administration. One path takes us down the road of opportunity and continued global economic leadership while the other is a path down which we follow rather than lead and opportunity passes us by.

Thank you.

BIOGRAPHY FOR DEBORAH L. WINCE-SMITH

Deborah L. Wince-Smith is the innovative force behind a premiere group of CEOs, university presidents and labor leaders committed to driving U.S. competitiveness. Most notably, she has spearheaded a national campaign that made innovation a top-tier national policy issue. She is recognized in the global business community as a "go to" person for strategic counsel, as exemplified by her recent appointment to the Board of Directors of the NASDAQ Stock Market.

As President of the Council on Competitiveness, Wince-Smith's expertise in technology policy, economic development and global competition is frequently sought after by government, industry and news media.

She has more than 20 years of experience as a senior government official, including as Assistant Secretary for Technology Policy in the Department of Commerce during the first Bush administration. Most recently, she was appointed by President George W. Bush and confirmed by the U.S. Senate to serve as a member of the Oversight Board of the Internal Revenue Service. During the course of her career, she has testified before several committees of the U.S. House and Senate. She also serves on or chairs four Cabinet-level advisory groups, including a task force on nuclear energy for the Secretary of Energy.

Following her government tenure, Wince-Smith became active in governance of various national scientific labs. She sits on the Board of Governors for Argonne National Laboratory and the University of California President's Council for Los Alamos and Lawrence Livermore National Laboratories. Wince-Smith was also a consultant for several Fortune 100 companies. Her practice focused on global competitiveness, R&D partnerships and international development agreements.

She has appeared on several international broadcast networks, including CNN, MSNBC, C–SPAN, and Canada's Report on Business Television. She is regularly interviewed by major newspapers like *The Washington Post* and *Wall Street Journal* as an expert on economic, science and technology policy. Her opinion pieces have appeared in publications such as *The Hill,* a leading newspaper that covers Congress, and she is a regular contributor to *Innovation Magazine.*

Throughout her career she has been in the vanguard of the global competitiveness debate. During the Reagan Administration, Wince-Smith served as the Assistant Director for International Affairs and Competitiveness in the White House Office of Science and Technology Policy. She designed and negotiated the landmark 1988 Head of Government Science Technology Agreement with Japan and developed President Reagan's 1988 Competitiveness Initiative. She later directed President George H.W. Bush's National Technology Initiative. She began her career as a Program Director for the National Science Foundation from 1976–1984 where she managed U.S. research programs with Eastern European countries and U.S. universities.

Wince-Smith earned a degree in classical archaeology and graduated Magna cum Laude and Phi Beta Kappa from Vassar College. She earned her Master's degree from King's College, Cambridge University. In December 2006 she received an honorary Doctor of Humanities degree from Michigan State University. She volunteers her time on the Board of Directors of the University of Pennsylvania Museum of Archaeology and Anthropology and is a trustee of the National Inventors Hall of Fame.

DISCUSSION

Chairman GORDON. Thank you so much, Ms. Wince-Smith, and thank all of the panelists for a very informative hearing here.

As I told you earlier, when I introduced H.R. 362 and H.R. 363, it wasn't a Democratic bill or a Republican bill. I wanted to make it a reflection of *Rising Above the Gathering Storm,* because I wanted to get something done.

So, I have a couple of questions that I don't want you to think of in a partisan context, but we are at a time now of limited resources, so we have got to get this right. It is going to be hard to come back next year and say we want some more money. And I am very pleased that, with Sherry Boehlert and Vern Ehlers, they have really prodded the Administration to come forth with the President's American Competitiveness agenda, and I am glad that he has.

But there are a couple of differences, and I just want to explore those today. First, in my bills, I put the emphasis on teacher education, trying to improve the capabilities of the new and in-service math teachers. The President has put 70 percent of his money in K–12 math curriculum. Now, again, I am not really—I don't want to put you in an awkward position of taking sides, and I hope there are not really sides here. We are all trying to get to the same place, but I would like to hear from Dr. Barrett and Mr. Augustine on why, in your report, you put such an emphasis on teacher math/science education.

Mr. AUGUSTINE. I will begin, and Dr. Barrett can correct me. The National Academies study made 20 specific recommendations with regard to actions to be taken, as you know.

Our number one priority was to produce more teachers with degrees in mathematics and science. The reason for our emphasis on math and science teachers was fairly straightforward. Math and science teachers are where the leverage is. Every one of them affects a large number of students every year, and during the course of a career, there is a multiplier effect.

We all have experience in which a teacher has changed our lives. It certainly was true of me. So, our basic emphasis was on teaching, and we think there is great room for improvement, because today, the chance that a child will have a teacher with a degree or certificate in math and science is very small. We take a physical education teacher, and tell them to teach physics. They are intimidated by it, they don't enjoy it. That is very contagious to the children.

Furthermore, anecdotal evidence shows that young people who are turned off by math and science are turned off by the fourth grade, and so, the early teachers are critically important, as well as the ones along the way. That is why we rated it as number one on our list.

Mr. BARRETT. People have been teaching mathematics for centuries. When it is done well, it is done well with a good teacher. It is as simple as that. A qualified, accredited teacher who is motivated can motivate young children to succeed. Organizations like the National Science Foundation have many studies in place on the pedagogy of how to do this. There are all sorts of studies on how to do this.

The fundamental thing is, unless you have a good, qualified teacher, it doesn't work, so the National Academies, I think, recognize that, and I think all of us have recognized that in our past. We have all, somewhere in our educational process, been impacted by a good teacher, who has driven us to exceed our own personal expectations on what we can accomplish. That is what we want for every child in the area of mathematics and science.

Good teachers come first. They are the magic in the classroom.

Chairman GORDON. Thank you, Dr. Barrett. You know, I was stunned the other day to learn that over 50 percent of the math teachers in this country have neither a major nor a certification to teach math, and over 90 percent of the physical science teachers have neither a certification nor a major.

Now, I am going to abbreviate my, I am going to stop here. Let me tell you what is going on, members, if you would just hold your horses just a moment. We are getting ready to have the last votes, I think there are going to be three votes, the last votes of the day. I am sure some of the old-timers on our committee have unfortunately run into this before. What I would like to do is stop my questioning, let Ranking Member Hall have an opportunity to ask a question, because we have 15 minutes.

After that, if the panel members that can stay, if you would adjourn to our cloakroom, there is some, I think some sandwiches that could hold you over, and all of the members that can come back, we would appreciate you coming back.

Mr. Hall, you are recognized.

Mr. HALL. For one minute.

Chairman GORDON. Thank you, Mr. Hall.

Mr. HALL. My time is up. I want to extend the Chairman's questions about capabilities and who ought to teach it, and what area you should begin in, and I surely agree with your answers there.

I will ask all of you, I will ask Mrs. Wince-Smith, so much of what we are talking about today boils down just to simple need to strengthen education, and put an emphasis on math and science. But the solution doesn't seem to be as easy as producing more people with math and science degrees because we know in countries like China and in countries like India, they are meeting world demand with probably equally well educated, but a lot of lower cost workers.

How do we compete with this, and what can our workforce offer in terms of added value to offset skilled but lower cost foreign workers, because that is a major problem. It is a major problem to pricing our goods, after we have taught them how to use the goods or produce the goods.

Mrs. Wince-Smith, do you have a comment on that? And I will ask it to anyone.

Ms. WINCE-SMITH. Well, my comment would be that we aren't going to be able to compete on commoditized work, and the extent to which we will succeed is when we can build higher value around products and services, that can command a premium globally. And that is why we have to really get a handle on it ensuring that all of our children, no matter what fields they go into, have quantitative skills, and have the math and science that is infusing virtually all activities. It is not necessarily that they will be research scientists, but in order to perform in any area, you have to have these quantitative skills.

And one issue that I would say that I think needs to be out on the table, and perhaps at another hearing, I might recommend inviting the very dynamic new head of the American Federation of Teachers Union, Mr. McElroy, because getting some of the reform and innovation in that system is going to be really critical for pay for performance to attract these teachers that have the commitment to teach our young people.

Mr. HALL. Well, I guess I was hoping I would hear, when you read about the statistics of the number of engineers that China produces, it dwarfs our engineers, or even India. I would like to hear that well, they are not producing the type of engineers, they are not the grade, they are not the quality engineers, they are not complete engineers as we are.

I haven't heard that. I would like to hear it, and Dr. Barrett, maybe you are going to tell me that.

Mr. BARRETT. I think you have been—we have been perhaps not articulating this as clearly as we might. The basic strength the United States has is today certainly is not the K–12 education system. Our unassailable strength today is in our research universities, and the quality of the education, the combination of research and education, and the product that they put out, both the student as a product, and the research as a product.

It is critical to build upon that. It is critical to build upon it with increased funding of those research universities, to make them the most, keep them the most competitive in the world. All of the dialogue about K–12 education is to promote a greater capability in our inherent workforce, and also, to provide a greater feedstock, if you will, to our universities and children, who are knowledgeable and capable and interested in math and science.

We will never compete on quantity alone, and should not expect that. We have to compete on quality. We have the best universities in the world. It is a national treasure. We ought to do everything to support them.

Mr. DYNES. If I could add to that, I am glad that Dr. Barrett said it, rather than me. But in my travels around the world, in countries like India and China, and compare them with the research universities here in the United States, the strength that we have here is that we integrate education and research, so that we are actually teaching young people how to be innovative. We are teaching them to take risks, and that is something that doesn't happen in the rest of the world.

All the discussion of science and math teaching training is to continue that pipeline, so that when new companies are created from the innovative people that come out of the research univer-

sities, those companies have a workforce that can speak the language. But our real strength is our ability to take risks.

Mr. HALL. I think my time is probably up, but I am hoping that I hear that the huge numbers of people in China and in India would dwarf our numbers, and we can have an expectation that they would have more in numbers, but hopefully not in quality, and I—the Chairman is hitting my knee here just now, I think my time is up, and I yield. If it is not up, I want to yield back to you, Mr. Chairman.

Chairman GORDON. Thank you, Mr. Hall, you are 29 over, but it was a good 29. Mr. Baird, would you like to try to work in before we go?

Mr. BAIRD. Very quickly. First of all, what a distinguished panel we have here today. We are humbled at your presence, and grateful for your leadership in working on this.

It seems one element that we haven't talked much about that just seems so important is sort of a cultural change in our society. If you talk to the average parent of young people and say we want them to study more math and science, they will probably say that is a good idea. But if those kids come home, and say mom or dad, can you help me with my quadratic equations, they will run screaming from the room and turn on a videogame as a distraction.

I don't know how we address that, but I would be very interested in your thoughts about that, trying to change the culture, and especially help parents, empower parents to help their kids, as the kids take on more difficult subjects than the parents took. That would be part one.

Part two would be: We hear a great deal from industry about the need to expand H–1B visas and limit the cap. I understand the logic for that, but I would also be interested myself in finding some way to link that to an increased responsibility on the part of businesses seeking H–1Bs to participate in the endeavor to train our own domestic workforce, so we need to rely less on H–1Bs. I fully understand the need for more H–1Bs, but it seems to perpetuate the problem if the businesses don't also invest in educating our workforce.

And I would welcome any response to that.

Mr. BARRETT. Let me try very quickly on both. The most significant thing, in my opinion, to get young children interested in mathematics and science, and the knowledge base they will need for the 21st Century, is to have teachers who are engaged, knowledgeable, and can enthuse the children with the wonders of the universe. A PE coach teaching physics is not going to hack it. Someone who is teaching mathematics and doesn't understanding mathematics is not going to hack it. You need good teachers in the classroom.

The second comment is on the H–1B visa issue. One of the beauties of our university system is that it is the best in the world. It attracts people from all around the world, the best and the brightest. That is why it is a national treasure, the virtual research university.

If we are going to invite those people to come to our country, pay for their education at taxpayer's expense, and then require them to go home and compete with us, it doesn't make a lot of sense, so I personally think, you know, and ten years ago, I might have been

one of the first to suggest we staple a green card to every advanced degree given to a foreign national from a U.S. university. I still think that that is such a simple law that even Republicans and Democrats could get together to pass it.

But aside from that, the effort we are making to improve K–12 education is to get more kids interested and qualified to study engineering, science, mathematics, at the university level, to perhaps decrease the need for H–1B visas. But I think the whole debate on H–1B visas and green cards is a good debate for us to be having, because it means we are attracting the best and brightest minds in the world to the United States, which is exactly what we need to be competitive.

Chairman GORDON. Excuse me. We have one minute. Does someone else want to address that?

Mr. BAIRD. Just one brief followup. I agree with that entirely, except that there are companies in my district that are working very hard to be involved in the high school and college education program, and frankly, they are freeloaders. They pay their $1,500, but if you ask them to do anything with the local school district to help out, they are AWOL. And somehow, to put some skin in the game for those companies, versus just go out and recruit abroad, seems to be consistent with your goals, and I think we might want to try to do a hybrid there. But I appreciate the points.

Chairman GORDON. The committee will be in recess for hopefully no more than—oh, not 45 minutes, will it be? Okay, 25, it will be at least 30 minutes, so we hope that you can stay.

[Whereupon, at 2:19 p.m., the Subcommittee recessed, to reconvene at 2:50 p.m.]

Chairman GORDON. In consultation with the minority staff, I have been given permission to start to move on. We are just finishing up votes, so folks will be coming in periodically. It was the last vote of the day, and folks are going to markups in other committees.

I also know that some of you have trains, planes, and buses to catch, so permission is not necessary. Please leave as you need to. We are just grateful that you are here today.

Let me—I will start off, and I would like to explore a little bit more—and maybe Dr. Lane, the NSF education programs, we were talking earlier, and I am disappointed that they have been cut almost 50 percent in the last few years. You might explain a little bit about what they do, and then, I would like the committee to give some thought to—I am not anti-Department of Education. I think there is probably a role for both, so maybe you could—we could talk a little bit about how that role in both agencies could help us get our goal—but Dr. Lane, if you would, please, start and tell us a little bit about those programs, and what you have seen as success or failures within those programs.

Mr. LANE. Thank you, Mr. Chairman. I also would want to say I am not anti-Department of Education, either. They have a big job to do. It is a different job from that of the National Science Foundation. I think that is what you want me to address.

The National Science Foundation has this broad mission to ensure the progress of science, engineering, mathematics, across the country, and they do that in various ways, and it is not limited to

research. It is all about knowledge creation and knowledge transfer, to and among people, and to the marketplace, where things can be applied to benefit the American people in broader ways.

So, where the NSF, I think, really shines is through its programs to bring innovation to the classroom, and to help teachers try new things, help schools try new ways of teaching. Summer camps that enable teachers to take the time to get together, learn from one another, new approaches to mathematics, new approaches to curriculum. They have been doing that for decades and decades. And then, they got involved, in the last 15 years or so, in systemic reform of our schools, where they would work in partnership with cities, school districts, cities, states, regions, to not tell the state or the region how to teach, but simply to try to connect what has been learned about pedagogy, what has been learned about teaching and learning, with on-site, large-scale experimentation.

They have the authority to do that from the Congress. Department of Education cannot really do that. NSF uses peer review to review and respond to proposals, and select the best ideas and the best people, the best get funded, and the others don't. The Department of Education can't really do that. The National Science Foundation has this direct relationship with the best—many of the best scientists and engineering researchers in the country, and can tap into that knowledge-base and that experience, and those skills, to try to help to get that in front of the teachers, help the teachers pick up the passion for science and for learning, that they can then pass along with their students.

So, NSF is about innovation. It is about research. It is about high risk, if you like, taking those kinds of opportunities, and investing this money in a way that can then be evaluated, and be responsive to the American people.

So, it is a special agency, I think, in that regard. It is not that it is better than the Department of Education, it is different, and has a different role, which I believe it does very well.

Chairman GORDON. Thank you, Dr. Lane. Dr. Dynes is going to have to leave. If you want to make a swansong, and then, you could be excused.

Mr. DYNES. Well, let me address this issue first. A swansong, no. No, I am not ready for my swansong, Mr. Chairman.

But let me say something that I have said before, and I really believe this, and that is the strength of the American universities is that we integrate education and research. Those two are coupled together, and the more I have traveled in China and India, the more I have seen that until they learn to copy that, they are going to be behind us. And we should be leading with our strengths, and that is our strength.

And insofar as the NSF nurtures that part of our mission, it is an important place to put resources. It is not that it is—that I am opposed to the Department of Energy—I am sorry, Department of Education—I have energy on the mind—the Department of Education, they have a very, very important mission. But we can't lose sight of the integration, of what we have learned in our research transferring to education.

And with that, I will bid adieu and pledge my support for these bills.

Chairman GORDON. Again, thank you for making a coastal hit and run. Would anyone else like to address that topic?

If not, I am going to yield five minutes to the gentleman from Texas, Mr. Lampson, Chairman of our Energy Subcommittee.

Mr. LAMPSON. Thank you, Mr. Chairman.

I remember sitting in this room a few years back in another life and listening to testimony from one of our federal agencies about what we could do to keep employees at that agency. And most of the things that were being talked about were financial incentives. And I got up and walked down from here, and sat out in the midst of a bunch of students, who I asked, huddled them up, and said if you all were testifying right now, what would you say? And almost to a person, it was—it wouldn't be about money, it would be about giving us something to dream that we can achieve. Give us something to work on that gives us satisfaction, to know that we are accomplishing something with our lives.

So—and another part of that is that my youngest daughter just quit her sixth grade math teaching, she was teaching math, honors math classes, and she has left that. But how do we tackle the problem that teaching isn't an attractive career option in the United States? The work is hard, the pay is low, compared to what a strong math and science student can make outside of teaching. What national policy actions can turn the tide on this?

Mr. AUGUSTINE. I will take a crack at that one.

Mr. LAMPSON. Please.

Mr. AUGUSTINE. Certainly one of the significant problems we face in encouraging young people to teach and stay in teaching is compensation. It seems to be a failing of our free-enterprise system that we undervalue teachers, nurses, and soldiers, and overvalue CEOs, rock stars, athletes, and so on. That is something you probably won't solve with legislation, nor will I solve it by talking about it.

I would, however, add two things. One, with regard to compensation, however, I don't think we will change the basic compensation structure of the Nation, but I do think that it is possible to offer some incentives to teachers at the federal level. We proposed some of these in *Rising Above the Gathering Storm.* For example. . .the program that is going to be sponsored by ExxonMobil has some incentives for teachers that make a difference to the math and science teacher, to the good teacher, to the one that remains for a long time.

True, we who are scientists and engineers—I am an engineer—have failed to convey to young people the excitement of what we do. Part of the result is that the teachers in the lower grades, who are not scientists and engineers, don't have that fire, that passion. I look at my own career. I played a very small part, and I mean a small part, in sending 12 of my friends to the Moon and bringing them back. But how good does it get? How many people can say that they did something like that? That is heavy. And we need to convey to young people that this kind of thing is exciting. Certainly, we need to pay a decent wage, but we don't want teachers that are there only for the money.

Mr. LAMPSON. The *Gathering Storm* report emphasizes the need for increased funding for research in physical sciences, computer

science, engineering, and math. Why are these subjects seen as the priority areas, and should funding be diverted from other fields?

Mr. AUGUSTINE. I will address that from the *Gathering Storm* report, and my colleagues would care to add to it. Basically, we looked at a large number of studies that showed that 50–85 percent of the growth in the gross domestic product of America in the last half-century was attributable to math and science.

We found that the creation of new jobs was attributable to math and science. The return from investments in math and science was huge. What we have is a shortage of mathematicians and scientists and engineers. Candidly, not lawyers and accountants and CEOs and athletes. That is why we don't want to underestimate for a minute the importance of such subjects as reading. I attended a liberal arts school to study engineering, and I did it for a reason; but in any case, America's future is going to depend to a very large degree on our prowess in math and science.

Mr. LAMPSON. Anyone else want to make a comment? My time is just about up, and—Ms. Wince-Smith first, and then——

Ms. WINCE-SMITH. I would just add—and I would offer as a model what is going on in our military academies, which I think have a very, very advanced process for how they are fusing math, science, and engineering with the liberal arts and humanities and languages. And so, you have young people that, no matter what field they are going to go into, whether it is history or languages, they also are coming out with engineering degrees, so what Norm was saying about infusing more math and science and engineering into the traditional undergraduate liberal arts curriculum in our four year colleges, I think, is very, very important.

And the other thing that I would want to add on the teacher issue is I really do think we have to have some flexibility now to tap into the tremendous resources of people who are now in their fifties, sixties, that want to give back, and are willing to come in and teach in schools. I mean, I know in my case, I had a math teacher that was 70 years old and retired from Goodyear Rubber Company, and you know, he was teaching junior girls, a little girls school, we were doing advanced calculus, and you know, we loved it. We loved having him there. That is not really allowed in most of our schools today, so we don't have that flexibility, and we are losing a whole cadre of people who have the skills and the love, and they would like to be with young people.

Mr. LAMPSON. Mr. Chairman, can Dr. Barrett and Dr. Lane both respond?

Mr. BARRETT. Two quick comments. I think the concept of meritocracy in the K–12 public school system is absolutely needed, and that is a pay for performance issue. Higher performance of teachers, they ought to get paid more for it, as opposed to just—for time and service. I think every example where that has been used shows that, and every study of the education system has suggested that as a way to motivate more people to participate in the K–12 teaching area.

As far as the areas that the *Rising Above the Gathering Storm* singled out for increased R&D spending, I think that those are the fundamental areas that have been driving the U.S. economy for the last half-century, and they also are the areas where the funding

has been flat, in an absolute dollar standpoint, for the last two or three decades. So, in essence, they have been defunded over the last 20 years, on the basis that the funding has been flat, and inflation has eaten into the investment in those areas.

Mr. LANE. Mr. Lampson, on the issue of teacher respect, let me just mention something I think you know that we are doing in Texas. The Texas Academy of Medicine, Engineering, and Science, an institution that really was stimulated by the interest of Senator Kay Bailey Hutchinson, has taken on an education project, really being prompted by the *Gathering Storm* report, and the way they are addressing—we don't know how they are going to address K–12 education in general. They are just starting to have a look at it.

But one thing they are doing is bringing teachers from the schools into contact with Nobel laureates, members of the National Academies, at their annual meetings, and having them sit and dine with them, hearing from them and their comments, making it clear that the scientists and engineers, the technical professionals, believe these people are important, that they have got an important job to do, and they care about what their problems are, so it doesn't involve any money in that particular case. I completely agree with Dr. Barrett in terms of merit salary considerations. This is yet a different kind of thing that one can also do, just to show you care, just to show it makes a difference.

Mr. LAMPSON. There is a program, Mr. Chairman, at NASA, that had to do with a camera on the International Space Station, that could be operated by elementary school students, and that program, which was a minimal or almost no cost, is going to go away. And finding simple little things like that, I believe, adds to the opportunities that teachers have to inspire young children at the ages that we need them to be inspired.

Thank you very much for your extra time.

Chairman GORDON. Thank you.

Mr. LAMPSON. And thanks to the panel.

Chairman GORDON. The gentleman's time has expired. Looking to my right, I see no one, so Mr. Lipinski, you are recognized for five minutes.

Mr. LIPINSKI. Thank you, Mr. Chairman, and thank you, Mr. Chairman, for holding this hearing, and bringing together this panel. Thank you all for your testimony.

It is really an issue that hits close to my heart, but unfortunately, I just felt a little guilty there. Mr. Augustine was talking about the, for example, how the engineers have to let young people know, you know, the excitement of their profession, and every time I hear something like that, I think about the fact that I left engineering behind to go into political science, and then, to come here, and I sort of feel guilty that maybe I am not giving that, talking about that excitement of being an engineer, although it just didn't turn out to be what, the road that I was going to go down, but I always think that that education was the best education I could have gotten.

One thing, in Mr. McGraw's testimony, you had said that the key to America's competitiveness challenge is innovation, and there is a bill that we passed on the House floor yesterday that I authored,

to help the metals industry, steel, aluminum, other metals industries, by providing federal funding that would go to colleges, universities, other research institutions, and would be matched with a 70 percent federal, 30 percent industry match, to do research and spur innovation, for the metals industry to be able to be more efficient, more environmentally friendly, and I think this is a rather unique way of going about funding R&D.

And is this something that you think is a good way of going about it, is this a good example of what we can be doing?

Mr. MCGRAW. I think it is a start. I think if you take a look at most successful companies, and especially on the technology side, they are doing a tremendous amount of cooperative alliances with various research universities, university labs and the like, and so anything that will tie the academic and the business world together, will let you see those most innovative and most creative ideas. So, anything that would spur that, I would think would be a good thing.

Mr. LIPINSKI. And do you think this is lacking right now, or do you think there are any other ways we can incentivize this, or there—is this not the best direction to go, in terms of innovation?

Mr. MCGRAW. Well, you know, I think you are either going to go there or you are going to be gone, and it is going to be very difficult to survive in this kind of global environment with the kind of competition you are facing, if you are not innovating. And I think you want to take a look at any company, in terms of how they are using their free cash flow, how do they generate free cash flow, and then, what are they doing with it?

And now, I think we have gotten to the point where we have over-financially engineered some of our organizations, and I think some of the climate that all goes well for the short-term, and less for the longer-term puts certain public companies in a very bad light.

And, this is key, you want to take a look at what a company is generating in terms of organic growth. And I would say to you that for basic industry today, organic growth is way too low, and that is a result of the business climate and the environment and the financial markets, and less of a willingness to take risk, and so forth. So, yes.

Mr. LIPINSKI. Sort of leads into my next question. Recently, BP gave a $500 million grant to build and operate an energy biosciences institute, and unfortunately, Dr. Dynes is not here any more for me to compliment. Berkeley, both University of California–Berkeley and the Lawrence-Berkeley Lab, along with the University of Illinois, have a partnership that was awarded this $500 million grant. They are going to research biomass.

What else can we do to incentivize this type of grant giving, this kind of work by private companies, to help further with innovation?

Mr. MCGRAW. On the energy sector, you are using the BP example? Well——

Mr. LIPINSKI. Or anywhere else.

Mr. MCGRAW. For a public company, you have to have enough balance within your overall business portfolio, such that you can take those kind of risks. And eventually, you have got to get returns out of that, so when you start talking about a $500 million

fund that BP is talking about, actually, that is not a very good example. They have not done a very good job at investing in alternatives, and yet, their core infrastructure, in terms of some of their oil and gas abilities, has not gone very well. They haven't reinvested in some of the existing equipment.

But to encourage, incentivize people that way, you have got to have a path towards a return. Otherwise a public company, you know, is going to be less inclined to do that.

Chairman GORDON. Dr. Barrett, the gentleman's time has expired. Mr. Rohrabacher is recognized for five minutes.

Mr. ROHRABACHER. Thank you very much. Mr. Chairman, I would like to congratulate you on just getting a running start in your new job as Chairman with this legislation, and I like the idea that you are moving forward, trying to provide a benefit, educational benefit, but at the same time, requiring some kind of service in exchange for the benefit, which I think is something that will actually be a twofer.

Whenever you move forward, you should at least try for a twofer. When we are here in this job, we are not only helping some young person get an education, but we are also providing, perhaps, a service to schools that need a science or engineering or mathematics teacher. We are providing them someone who could help them for a few years.

So, I will be looking very closely at this legislation, to see if it is exactly what I can support, but it is certainly going in the right direction, and we will see.

With that, I, you know, a couple times during the testimony, I couldn't help but hear, and maybe Mr. Bilbray may have already brought this up, I couldn't help but over-hear and just sort of shoved into the discussion concepts like H–1B visas, and getting students from overseas here. Let me just note that when you take a look at the supply and demand and wages, and things like that, the very last thing we need to do to encourage our young people to get involved in science, mathematics, or engineering, is to provide the hundreds of thousands of H–1B visas, which are being asked for for business, in order to keep down wages.

You know, every time we turn around, you are saying we need to get more immigrants into this society to do those jobs that Americans won't do. Well, we are talking about jobs that are high paying jobs that Americans should want to do, and the very last thing you need to do is bring the pay level down on those jobs, or put a lid on it by having more people come in from overseas.

So, I would submit that as just for the record, as something that whatever, if we can talk about giving, you know, providing more classroom and more classes, and more science teachers, but unless the kids know that, in high school in particular, that there are good jobs that are available, that they can afford to live in a nice home and raise their family, as compared to just people who want to be lawyers, you end up, all the lawyers end up in the nice houses, and the engineers end up not being able to be renters some place in a place that is not so nice, you are not going to get more quality young people into that profession.

So, again, I think the secret, Mr. Chairman, that we people always overlook, because it requires coming up against power struc-

tures, is pay more money to engineers and scientists and mathematicians, pay more money to science, mathematics, and engineering teachers, and you are going to get more of them. And if you insist on having basket-weaving and gymnasium teachers getting the same amount of money as someone who is teaching engineering and math, then you are not going to get—you are not going to have the quality people that you want, and it just comes down to that.

One last note, and again, it was just sort of thrown in here about, and I think it was Mr. McGraw who mentioned it, but maybe might have mentioned as well, something about, you know, we don't want kids to drop out of college. We don't want—we want kids to get that bachelor's degree, or the AA degree from a junior college. In my area, we have got a junior college of 20,000 kids. They only have 180 kids in that program who are involved in the nursing or healthcare training program. Yet, all the kids who end up getting out are going on to get a BA, they can get great jobs at $30,000 or $35,000 when they get out, but if they get trained as a healthcare person, they can end up getting a $50,000 to $60,000 a year job.

So, I would submit that we need to be training our young people for things that are, for jobs that are going to give them a good livelihood, and jobs that are necessary and pay well, as compared to just try to—oh, everybody is going to need a BA. Well, everybody—well, I don't think everybody does need a BA. I think we need to get some training in there, and anyway, those are some thoughts. I would be happy to have the panel shoot me down or whatever.

Mr. MCGRAW. Well, let me take a quick crack.

Mr. ROHRABACHER. Yes. Yes, sir.

Mr. MCGRAW. You know, it is—and I would hope, Mr. Chairman, that you could find a bridge to the education agenda, because I think there would be a lot of shared thoughts that could be very helpful.

But you are talking about, you know, a landscape that is very, very different. When we are talking about dropout rates, we are talking about in our inner city schools, our largest inner city schools, 45 to 50 percent dropouts.

Mr. ROHRABACHER. I thought you were talking about college and dropping out.

Mr. MCGRAW. And college as well, but coming back to your saying let us get more teachers and all that, you know, there are so many things that go into, so many socio-economic things that go into why that is.

But I come back to a comment that we were talking offline with the Chairman about, and that is that if you really want to get after a more serious rigor—and we are not just talking, you know, the highest level of scholar and science achievement, we are talking about math and science skills at the high school level, so that you are proficient—then you have got to focus on reading. Because the problems are all coming back to reading, and that is why you see all of the emphasis in the early parts of No Child Left Behind focused on the reading achievement. Because if you lose, after a year, if I lose a student after a year, I have probably lost him. And if it is two years, it is done, on my part.

And what we are finding now is that it is not just at the early childhood learning aspect, it is at the middle school, in particular, because most of those people are coming now with reading deficiencies that can't get them into the other disciplines. They can't get into the higher math and the higher science, and they don't have those comprehension levels. So, the focus has got to be on reading to get the higher math and science capabilities. One of the things that was very disappointing in the NAEP test that we mentioned, 35 percent of seniors in this country that are graduating, are not proficient, or 35 percent are proficient in reading, the rest not. At math, it was 23 percent are proficient. I mean, these are horrible outcomes, for you know where we are as an advanced nation. And we have to do a better job.

But I would come back to you that the first thing that we have to focus on is the reading capability.

Chairman GORDON. The gentleman's time has expired. I think Dr. Barrett wanted to address Mr. Lipinski, but we are going to wait just a moment, be patient. Ms. Giffords has been here for quite a while, and I warn you, she is ready. She has a copy of the *Gathering Storm,* and it is even tabbed and underlined, so she has taken her assignment very well.

Ms. GIFFORDS. Thank you, Mr. Chairman. Of all the committee hearings that I believe we are going to have this year, I honestly think this is probably the most important one, and so, I just want to appreciate you all being here. This is really important, and it is really serious stuff that we are talking about, and I just commend you, Mr. Chairman, for bringing the panel together, and continuing to highlight that this document is one of the most important documents that this Congress is going to face. This really is serious, this brewing crisis we have.

Quick story. I was in Scotland a couple of years ago, actually with a group called the Global Enterprise Challenge, which are young high school kids who are tasked to put together an entrepreneurial program all across the world. Groups from, you know, from South Africa to Antarctica, I mean, really all over the planet, these high school groups competing. It was fantastic.

And I met with a woman named Lady Strathmore, related to the Royal Family, who told me about this wonderful woman in Arizona, Barbara Barrett, so you even have to sometimes go to the other side of the world to learn about some of the resources that you have in your own home state. So, it is good to see you, Dr. Barrett.

I am going to just throw out a couple of questions. It is hard with five minutes, but these are issues that are important to Arizona that are not addressed in the document, and I just want to know whether or not you have taken any of these issues into consideration.

Our world is different. When I look back to the 1960s and 1970s, President Kennedy's vision, sending a man to the Moon, why we pushed forward in innovation, those days are gone. Families are no longer like those families. Our schools are different. Our society is really different. So in a lot of ways, you know, we are looking at a totally different world. In Arizona, the proficiency in terms of just English, the proficiency in just literacy levels, I mean, the whole world is different. The family structure is different.

So, my first question I have is what is going to be the new Apollo mission? I believe it could be energy. I mean, I keep trying to get people excited about the way that we heat and cool our homes, and we move around this planet. I really think that we could get that next generation of kids excited about that. And I am curious whether or not, you know, if you all, as a group, have thought about that spark, something that is really going to stimulate, you know, young people's minds.

The second question, and I don't think this is addressed in the document, is early childhood development. All the data and research that I have seen shows that if you don't get kids at the really early levels—it is not—I am not saying it doesn't matter what you do at K–12, because it does, but if you don't get the, you know, the 0 through 3, the 0 through 5, it is tough to go back and take those minds, and do the developmental work that needs to be done.

Third question, and there was an article just a couple days ago in the paper about this, women working in the United States, where other industrialized societies have realized that population growth is decreasing because more women are deciding to have a career. I am a good example of that. So with that, with professional women now choosing not to have children, we see populations declining, but not a big move by this government to realize that if we want professional people to have children, that we are going to have to make some accommodations in the workforce, because you just can't have it all. So, that is my third point.

And fourth point, as we know, girls tend to drop off in math and science at about the sixth, seventh grade, and this, I don't believe this document really addresses what we can do for that next generation of really targeting girls in math and science, and re-looking, reexamining what we can do in that arena.

Mr. BARRETT. Could I try real quickly? Arizona, is it? Right on on energy. Energy is a math, science, engineering intensive problem, with the U.S. wanting to be independent from its energy requirements—program—it is a softball waiting to be hit by either party. I am surprised it hasn't been hit to date.

Second, there is—there have been many interesting studies about early childhood development, and the latest one that I have seen is all-day kindergarten versus not. By the third grade, it is a wash. It turns out the longer kids stay in the K–12 education system, the worse they do. You either have to fix the K–12 education system, ultimately, or it is a perfect filter. It filters out the kids that we want to succeed in math and science going forward.

So, there is not a simple answer anywhere, but there are things that I think the United States could rally around. The *Gathering Storm* suggested the DARPA energy focus, primarily because we thought energy could be a national focus to get kids, and the political air cover to get kids interested in math and science going forward.

Mr. AUGUSTINE. I might just add to that. You asked a group of really good questions.

What could be the spark? I agree with Craig, and that was the view of the National Academies as well, that energy is the issue. Not only is it heavily dependent on the kind of math and science

we were promoting, but as you know, it affects everything from the environment to the economy to national security.

With regard to your point about affecting children at an early age: that is critical. We found that often children were lost to math and science by the time they were in fourth grade. We can't, I am afraid, always count on parents. Today, 70 percent of parents of high school children believe that the math and science their children are getting is adequate. Parents are comfortable. I think the teachers and the schools are going to have to provide that spark. Again, if we could bring people in that would teach those younger children, and *I think there are a lot of people who would.* In my own case, when I took early retirement, so I could teach, I couldn't teach in our public schools. I can't teach fourth graders, so I taught engineering in Princeton instead. There seems to be something wrong with that.

My last comment is to strongly endorse your remark about women. Women are 18 percent of engineering graduates in this country. Minorities are far more under-represented: less than five percent. If we are going to compete in the world market, having over half our population not participate, it is a handicap we can't endure.

Ms. GIFFORDS. Thank you.

Mr. BAIRD. [Presiding] Dr. Lane, it looked like you might have a comment, and then I will call on Mr. Rothman.

Mr. LANE. And let me mention this, because we haven't mentioned the word technology in the context of education, I think, in this hearing. And Ms. Giffords, among the many things that have changed in the environment that our young people are growing up in is technology, and so, you know, my little grandkids and medium grandkids, they talk on cell phones, and they have computers, and they do all that stuff.

I am connected with a not-for-profit in Texas called Reasoning Mind, that has an extraordinarily exciting online math technology availability that we are experimenting with in Houston, and it has had wonderful success. You know, it has an onscreen little genie, helpful, it addresses all kinds of different levels. My point about it is that we do, of course, need wonderful teachers, and we need more of them than we have right now, but we are probably never going to have enough of those teachers, but what they don't need, that some of the tools, that technology can deliver. And we haven't had great success getting technology in the classroom. I think, though, we should not ignore the fact that our young people are growing up in that kind of environment. And there are some tools, I think, that can be provided to even the best teachers to enable them to reach more students than they are currently able to do. So, I would put in a plug for the more innovative technologies that we can find to support.

Mr. BAIRD. Thank you very much. Mr. Rothman, I am going to let Mr. Rothman proceed. Did you feel like—Ms. Wince——

Ms. WINCE-SMITH. Oh, well, I just wanted to comment on the issue of women, and there is an initiative underway that has tremendous outcome metrics now for encouraging women to actually be involved in this entrepreneurial economy that I talked about, and that is professional science masters. These are programs that

a number of schools are starting. Georgia Tech has one that is fantastic. Women and minorities are getting, in terms of the numbers, very high numbers of these degrees. For instance, in the Georgia Tech case, they have a degree in nanodevice fabrication, and then, they have accounting, business, all the skills you need to actually go out and take this knowledge and create something and deploy it for commercial value.

And it is very interesting, when you look at the trends, that the majority of graduates of professional science masters are women and minorities. So, something is going on there that is enabling a very systemic type of thinking, and also, the skills that you need to go out and create something in the business world. I would urge you to look at professional science master's, and particularly the linkages with women.

Mr. BAIRD. Mr. Rothman.

Mr. ROTHMAN. Thank you. First, let me apologize for being late. I have three hearings scheduled at the same time. I am sure I am not unusual in that regard, with the rest of my colleagues. So I apologize for being late, and if I have asked—I am about to ask a question that you have already answered.

And I hope this is not too far afield from this subject, but you are all great scholars and successful people, so I thought I would ask you.

Is there something about our culture, our American culture, that is preventing greater success in our public education system? And if you have any thoughts on that subject, I would like to know, or any—in particular, any suggestions as to what we can do to counter either the negative trends in our culture, or to enhance the positive aspects of our culture that would improve the educational performance of our student body? That is number one.

Number two, you know, depending on what you read, you know, you have people saying oh, we are doing just fine. Our expectations are too high, to expect Ph.D.s from every single one of our children, and everything is just unreasonable. I would like to have your thoughts on that.

And the third thing is the role of parents. I have five kids now, and the role of parents, I think, is critical, but not everyone has the luxury of spending the time with their kids, or coming in and becoming a part of the school family, school community, that raises the expectation level for the teachers and administrators, as well as their own children. So, what do you do about those kids whose families are not, that don't have that extra time to devote?

Mr. MCGRAW. Well, first of all, the educational system in the United States worked. It gave us the largest economy in the world. It gave us technological excellence. It gave us the highest productivity levels, and so, it worked. The issue, and what changed, was a world grew up, and what we are seeing is a global economy in the works, with increasing worldwide competition.

And we have come to the realization that, we have to bring more people along, better skills, and better capabilities, and we have taken our foot off the accelerator, and we have got to put it back on. And you just aren't going to do that overnight. And that is why programs like H–1B visas or anything in the short-term, to be able to jumpstart some of these things, is very important.

I think—a conversation we had a little earlier, you know, it was governors in the '80s, that were running deficits in some of their large cities, and in their state, and it was them, that was—to survive politically, it was about achieving economic growth, and if it was about achieving economic growth, it was reaching out to the private sector. It was about jobs. It was about the right kind of skill sets, and therefore, it was about your education system.

That is the first time, the first time that the achievement of economic growth and the education system has been linked. The system has been in reform, really, only a very short period of time, and now, with the realities of what we are facing, in terms of a world competition, we have to get moving again.

And so, a lot of these things are wakeup calls, and I think H.R. 362 is, H.R. 363 is, but again, the tide the Chairman was talking about, back to the education agenda, the problems are enormous. You know, in 1997, only a third of the states had academic standards. No Child Left Behind, which was fabulous in terms of landmark legislation. Is it perfect? Has it put all the weights in the right spots? No, but it started aligning federal, State, and local education. Today, all 50 states have academic standards. It would be nice if some of them were more common, but all 50 have them, and what you are starting to see, in terms of instruction, is that standardized instruction is starting to go up, which means you are coalescing around academic standards. In other words, I am going to buy reading materials for every class in every school, and we are going to get behind research-based, proven-to-work kinds of product.

There is no way to have everybody doing things in different fashions. You can do remedial and intervention, but you are going to get to more standardized instruction. So, I think it is pretty clear that if you fast forward, we are on a path right now that you are starting to see all the concerns and new thinking starting to take place, but it is going to take us a while. That is why I think some of the comments about alternative certification are interesting. I mean, the fact that Norm can't teach a fourth grade class. We have got to get into those kinds of issues. We have to encourage people that have done well to find other ways to give back, as we all live longer.

So, the other one is, is that you have got to tie it to the job market, and you know, we can talk about math and science at the high school level, and having those kind of competencies. You can talk about scholarly work at the National Science Foundation and the like, but in terms of getting those capabilities, you have really got to tie it to a job market, and I think the comment about churn was so right. Every three months, we lose seven to eight million jobs. Every three months, we gain seven to eight million jobs. Change is taking place so quickly that skills have got to be able to match some of those new capabilities.

Chairman GORDON. The gentleman's time has expired. Does anyone else on the committee want to take on that monumental—yes, ma'am.

Ms. WINCE-SMITH. Well, I think it is interesting to link this question, also, to regional economic development, because throughout the country now, for the first time, we are beginning to see an

alignment between investments and workforce skills. You know, we are spending about $15 billion going out to workforce boards. Public education reforms must be aligned with economic development strategy, because people are choosing to live and stay and work and build their lives in communities where there are high performing schools.

And so, education is becoming a very important asset for not just keeping people, but also, attracting within our country people that want to live and work in areas that are considered high value entrepreneurial regions. So, the area that I think is the Achilles heel to all of this is how much localization do you have in determining these standards in performance. If you look at the current school system, and you compare it to any private enterprise, you know, the productivity levels are worrying. We are spending more per child than any other country but Switzerland, approaching $600 billion, and yet, in terms of these outcomes, we are not really seeing progress.

So, I think the school boards have to really take some ownership here. I mean, they are approving contracts, they are approving the contracts for teachers who have no math, science skills, but are teaching math and science. And the parents are on these school boards, so it is a whole continuum, and I think until communities come together in an integrated way, we are going to continue to see these things being looked at in stovepipes, and that is very bad for the country and for our children.

Chairman GORDON. Mr. Augustine.

Mr. AUGUSTINE. You mentioned three issues: culture, parents, and expectations. My view is that the culture has changed. And that change is closely related to the role of parent. My parents never had the opportunity to go to college. Obviously, neither was a scientist nor an engineer, but they darn well understood the importance of an education, and they made it clear to me. Another cultural change that somehow has been missed in all this is that the great teachers I had were almost all women. Today, those teachers are probably lawyers and doctors and bankers. In those days, they didn't have much choice, other than to be teachers, and there has been a profound change that you don't hear much about.

With respect to culture, it becomes a matter of priority to a very great degree. Many of our children place more emphasis on being great athletes than great students. Our society promotes that. About two years ago, I was visiting an Asian country that had just been hit by the tsunami. There was wreckage everywhere, but there was also a school outdoors in the jungle, where it was extremely hot and ten-year-old children were sitting there eight hours a day going to school. We probably wouldn't have seen that here.

With regard to expectations, clearly, the intent of the Academies was not primarily to promote huge numbers of Ph.D.s in math, science, and engineering. The thought was that Ph.D.s are important because they do the basic research that is going to create jobs for the rest of us; but the rest of us have to be at least articulate enough to understand fundamental math and science.

Chairman GORDON. Well, I think—Mr. Bilbray was here most recently, but Mr. Bartlett was here earlier, and so, Mr. Bartlett, we yield to you for five minutes.

Mr. BARTLETT. I'm on? Okay. Apologize for not being here during the questioning. I don't know whether this issue has come up or not.

I think the really big challenge we face is a cultural one. What you are proposing is fine. These two bills are okay, but they really won't solve our problem. A society gets what it appreciates, and we just do not appreciate people who are in these technical areas. A bright young guy is now called—when I was in school studying science, we were what, squares? Now, they are geeks and nerds, and the pretty girls have to play—I mean, bright girls have to play dumb to get a date.

I think that I will have some confidence that the culture is changing when the White House invites academic achievers in and fawns all over them the way they do sports figures. Clearly, what we need is an appreciation of the contribution that these professions make in our society. It just isn't there. And what concerns me is that it is there in countries like China and India that are going to eat our lunch if we aren't careful. China this year will graduate at least, they will graduate more English-speaking engineers than we graduate, and about half of our English-speaking engineers are Chinese students.

What can we do to change the culture in our country, because that is the real problem? I remember when we put a man on the Moon, and there was a little cartoon that came out, which said the whole thing. A little buck-toothed, freckle-faced young fellow, and he said: "Six months ago, I couldn't even spell engineer, and now, I are one." Everybody wanted to be in this, because it was culturally, it was the thing to do, and it was really appreciated.

What can we do to change the culture? Because I know all these other things are just nibbling at the margins, Mr. Chairman. Until we change the culture, we are not going to get there. What can we do to change the culture? Dr. Lane.

Mr. LANE. Well, I don't want to make a political comment in a place like this. But you mentioned President Kennedy. I believe the American people are looking for vision and leadership of that kind. I mean, we will have a chance, we have elections coming up. We will have a chance to see whether such a leader emerges or not, but I really believe the people, with all the changes that have occurred, I think at a fundamental level, there is an anxiousness on the part of the American people to find an exciting idea, an individual that can really follow where the case kind of makes itself. And maybe the answer will be around something like energy and environment.

I don't know what the issues will be, but it is going to require, I think, leadership at the highest levels in our government, in branches of government, and you know, again, I applaud you, Mr. Chairman, for your leadership, and the room is full of leaders now and in the past, attempting to do that. I think we need that. I am looking for that. I think that is what is going to help my grandkids that I talked about earlier in my testimony, and I am not sure

what, short of that, actually would cause the entire country to begin to move in a different direction.

Mr. HALL. Would the gentleman yield?

Mr. BARTLETT. Yes, sir.

Mr. HALL. Dr. Lane, would it be the time, then, for somebody to come riding in on a great big beautiful white horse? Knowledgeable, with a track record, solid citizen, leader, handsome——

Chairman GORDON. I think Ralph is announcing.

Mr. HALL.—success, totally successful, has been appointed by every President to lead studies, has been a leader in everything that is good and successful and wholesome for the United States of America. Is it time for Norm Augustine to make his announcement? We are looking for an Eisenhower somewhere now.

Mr. LANE. I second that nomination.

Mr. HALL. I yield back my time.

Mr. BARTLETT. Thank you. I just wanted to note that if having a lot of descendants makes you more cognizant of the problems we have, I have—we have ten children and fifteen grandchildren and two great-grandchildren, and I am here because I was concerned that the world I grew up in, the United States I grew up in, was not going to be the United States they were going to live in. We have too darn much government. It regulates too much. It taxes too much, and we don't have enough respect for careers in these technical areas, and you know, help us decide what we can do here in the Congress to make this change.

Leadership is really, really what we need, Mr. Chairman. We can do some things from the Congress, but you know, we really need that leadership from the highest levels of government. They are enormously more effective than we are.

Chairman GORDON. The gentleman's time expired. Mr. Bilbray is recognized for five minutes.

Mr. BILBRAY. Thank you. Maybe we will start having television shows about engineers rather than lawyers, then, Mr. Chairman.

I think that the perception of the cultural challenges we face, but I just say that, because let us face it, how many engineers shows have you seen over the last 30 years, and how many about lawyers? And frankly, if you look at where our kids are going, they are following the cultural line.

I just have to point out that when we talk about the culture, the '57 Sputnik created an urgency and a perception of threat, and we responded to that urgency, that perception of threat, and that the people working, becoming engineers then were perceived as being the guy who may save America from the Great Red Horde that was coming. There was—and it was a misperception, that somehow the race for space was about national defense.

But that aside, let me sort of move back to the—some of the discussion. I have got a question here. I come from San Diego County. I have the high techies in my district, and I have seen where the cooperation between educational institutions and the private sector has made a huge breakthrough. In fact, let me just throw up an item there. There is a classic example, one of the few locations where I see that academia doesn't think it is illegitimate to aim straight for economic opportunity from an education. There is too much, I think, in academia that somehow, they need to be above

the economic realities, and jobs should be a secondary issue, not the primary. But I think that if you look at our universities, and their cooperation with the private sector, it has been a big plus.

Mr. Chairman, there is another big plus that isn't used, and that is building on the success that we have in San Diego of the spin-offs of those who were in the military, who have learned engineering, learned a lot of this kind of high tech stuff with federal funds, and actually have gone in and filled the gaps in our economic need for these opportunities with the private sector.

I actually just want to ask you, along with that high tech, we have biotech, and if we look at the challenge of fuel, of alternative fuels, though in the past, providing, fueling America took civic engineers and geologists. The future may be biologists, but genetically altered enzymes may be the secret to developing fuel independence that we don't know about.

Is there a reason why the life sciences aren't being highlighted here?

Mr. AUGUSTINE. With regard to the National Academies' work, we view the life sciences as of enormous importance, not only for the reason you cite, but because of their impact on health sciences and many other things.

The reason we did not emphasize those fields was due to the good work of this committee and others in recent years. We saw a doubling of the budget in the life sciences, and the biosciences, whereas the physical sciences, math, engineering, have been flat, in real terms. So, we felt it was time to give the physical sciences, math and engineering, the same emphasis that the biosciences have already received. And we have been careful to always say that we don't want this emphasis to be at the expense of the biosciences, to let them atrophy by not accounting for inflation; not increasing their budgets would be a mistake. We are just now reaping the benefits of that growth in the budgets for the biosciences. In no way do we diminish the importance of those sciences. It is just that the physical sciences were left out for the last 20 years.

Mr. BILBRAY. Okay. Let us talk the H–1Bs. There is the issue—my colleague from the other half of the Surfing Caucus, Mr. Dana Rohrabacher, was pointing out the threat of H–1Bs on employment opportunities for certain groups.

It is kind of interesting, Mr. Chairman, that when it is an engineer and a college graduate who may have their jobs threatened with an immigration policy, they come unglued. If it is blue collar working people, it is not a big issue. I think there is a real opportunity here, though, to expand the H–1Bs within the realm of logical immigration policy.

And a good example was the fact that we have a thing called, and I would ask the Chairman to really look at this, the lottery, the immigration lottery, which is really a just let us see who comes up with the lottery, 55,000 a year, people without any qualifications that we need in this country, people coming from countries that are the highest risk for terrorism, and I think this is one place that this committee and Judiciary ought to sit down and say does it, is it logical for this country to set aside 55,000 slots for somebody with—don't identify we need, when we have H–1Bs over here that aren't being serviced? And maybe, we want to shift our prior-

ities and say, first priority should be to what America needs first, and then, and only then, after that, do we talk about what somebody in a foreign country may want to immigrate or may not want to immigrate.

And I think, I just ask comment on that, is setting these priorities within the existing immigration policy, do you guys agree that there may—we ought to be more aggressive about looking for those opportunities?

Ms. WINCE-SMITH. I would comment on that, because I think beyond the H–1B and particular technical skills, we should be looking for highly skilled people across a whole range to come to the United States. That was really the discussion this morning around capital markets, that our immigration policy, overall, is one that is not relevant to what we need for the 21st Century, and of course, there is a humanitarian issue that is part of being American, but I would agree with you that there ought to be some look at that.

The other thing I wanted to make a comment on, and maybe my colleagues from industry could answer this, I have spoken before about the shortage of engineers, and what is going on in China. There was recently a group of investors in New York, and they said well, what you are saying is completely poppycock, because if we needed engineers so much, why aren't they being paid? Why aren't they getting the salaries? Why aren't companies paying them? Why aren't they paying scientists and engineers the same kinds of signing bonuses that lawyers get? And I didn't really have the answer to that, so I don't know what is the answer.

Chairman GORDON. The answer is they are being outsourced, because, as Mr. Augustine pointed out, the world is flat. Get it on the Internet. That is the problem that we are having.

Ms. WINCE-SMITH. If they are lower value engineers, but the higher ones, the ones that have Ph.D.s, I didn't have the answer.

Mr. AUGUSTINE. I think it is true; engineering, like many other things, is being commoditized on a world basis, and the salaries of engineers are being determined more and more by what engineers in India and China can be bought for, and that is not going to be true only of engineers; it is going to be true of a lot of other people before we are done here.

Chairman GORDON. The gentleman's time has expired. Mr. Baird was shortchanged a little earlier, and so, I would like to recognize him again.

Mr. BAIRD. Thanks very much, and I appreciate the panelists for coming back after the delay. Sorry about the interruption, but you know, the question is, Mr. Chairman, many of us have talked about culture, Mr. Bartlett did. I think we might want to look at our own house. It would be troubling, I would warrant, that if we were to look at the number of memorial resolutions we pass under suspensions honoring sports teams, movie stars, et cetera, versus scientists, engineers, and teachers, it would be a symptomatic disproportion. So, we may be guilty of it as well.

But Dr. Augustine, I was very interested in a couple things, and these are both potentially controversial, but I am going to put them out for actually any of the panelists. One is, there is a brief allusion in the *Gathering Storm,* to the possibility of a voluntary national curriculum in the sciences. I am actually pretty intrigued by

that. We have school districts in my district that have 40 percent turnover every year, so you have got a kid who comes in one year, gone the next. And ironically, under No Child Left Behind, they somehow may be failing, even though 40 percent of the kids haven't been in the district.

But setting that aside, every time they move districts, move states, they may have to somehow get into a different sequence of education, a different textbook, et cetera, and I would be interested in your thoughts about the inefficiencies there. That is point one.

The second question, and this is really possibly a third rail, is—it is clear to me, almost by definition, that at some level, the colleges of education are not doing the job of turning out qualified teachers. And we tend not to talk about it. It may be an easy target, and overly convenient, but I wonder, I know that there seems to be an increasing awareness that we need to involve the disciplinary colleges in the sciences, in coordination with the colleges of education, but I don't think the colleges of education alone can do this, for a variety of reasons, and I would open up both of those to the panelists for their commentary.

Mr. AUGUSTINE. Those are two very good questions. With regard to the voluntary curriculum, the reason we proposed that is that it was our observation that within math and science, the curricula in many school systems are, frankly, not very good, not very demanding, and we thought that math and science lend themselves to a standardized curriculum. Until you just mentioned it, I had never thought of the impact on the mobile society; it is a very important secondary impact that we overlooked.

With regard to the colleges of education, our proposal was that through competitive scholarships, we find young people who want to study math and science, and in return, agree to teach for five years, in the hope that they will stay beyond that. That is our way to get around the fact that many of the students in the colleges of education just aren't interested in math and science. We would like to give incentives to children into those fields.

Mr. MCGRAW. They are very good questions, and they are very thorny, because of the way things are funded. And one, we have already started to see experimentation in standardized instruction, but the issues that you raise, in our inner city schools, because of some of the housing requirements, even, what you are seeing is just a tremendous amount of churn, and if you don't have any kind of standardized instruction, somebody could be learning reading in a whole language approach, and then go over here, and be doing it on a phonics basis, and you have got big issues there. You really have to get after states to be more willing on that.

But on the teacher quality, you have got 3.2 million K–12 teachers in America. Over the next five to seven years, you are going to see two million new teachers replacing current teachers. Unfortunately, they are going to be equal to or less than those that are leaving. We are not talking just about our teacher colleges, but they are coming from all over, and they are not as skilled, and they are not as prepared. And it is a very, very difficult situation.

Mr. BAIRD. Dr. Lane.

Mr. LANE. I think, certainly I agree with the idea of some level of national and voluntary standards in science and mathematics.

There isn't any kind of, you know, Texas math and Oklahoma math and New York math, well, there actually is, but—that is just a joke, I mean.

And the same thing is true in science. I mean, there is not this kind of East Coast biology and West Coast biology. Mobility is just extremely important to our nation, as it is to other parts of the world that are wrestling with a similar kind of issue. And by having these kinds of problems that you are addressing present in our system, we are just sort of shooting ourselves in the foot. How far you go with that now really begs a lot of detailed questions that I am not qualified to answer, but I think that is an extremely important issue, and we do need some sort of national standards.

On the issue of quality of teacher education at universities. I have wrestled with that for a long time. Often on a campus, many of us grew up on campuses where the teacher ed department was over there somewhere, and if you are a physics major, chemistry major, math major, you probably never got over there, nor did you ever see any of them in your classroom. It was just a different kind of an institution. It is them and us. Now, things have improved enormously in many of our campuses, but maybe not far enough. And beyond that, I think the universities have a—I don't know if you want to call it a responsibility to deal more directly with the K–12 challenge than has been the case in the past.

The point was made earlier that the quality of those universities and their products depends on who comes in the front end. They have a stake in this. It is important to all of them what goes on in the K–12 classroom, not only in their own region, but around the country. Also, there is a knowledge base there that can be tapped into in ways we really haven't done before.

So, I recognize there would be a lot of resistance to it, but these partnership kind of efforts, that I think this committee favors, I think it would be carried much, much further, and our universities can take a larger degree of ownership, I guess I should say, for this enormous national challenge, than we have done in past years.

Chairman GORDON. The gentleman's time has——

Mr. BAIRD. Two quick comments. One, I note that many of the countries that are now scoring higher than us on some of these international standardized tests, in fact, have national curricula. Now, some are below, so that may not be the only variable for sure, but many have national curricula.

The second point is, I have talked to some folks in colleges and universities who have said if you really want to get the sciences involved in teacher education and producing more scientists, link NSF grant applications to productivity of science and math educators, and suddenly, the science departments will get very interested in working with the education departments.

Chairman GORDON. If I could, Dr. Lane, within our legislation, it provides for the universities to set up integrated programs where they bring together the math and science and education, and that is a part of the scholarship. I mean, you have to agree to teach for five years.

The Chair yields to my friend from Texas.

Mr. HALL. Just one question, and I won't even ask the effect of it or what you think about it. I have heard that at least half the

Ph.D.s issued in the universities of this country are issued to foreigners. Is that true or untrue?

Mr. AUGUSTINE. No, it is—in engineering, it is 56 percent. It is more than half.

Mr. HALL. More. Would that just be in engineering? Would—Ph.D.s in general?

Mr. AUGUSTINE. In science, it is slightly less than 56 percent. I don't know for non-engineering and science, the answer, Mr. Hall.

Mr. BILBRAY. Would the gentleman yield?

Mr. HALL. Yes.

Mr. BILBRAY. What is—is it the economic motivation for these institutions to encourage foreign nationals to come here to go to school? Are they making such a huge profit?

Mr. HALL. That is what I agreed not to ask them.

Mr. LANE. I could comment on that. There are many, I think, different kinds of answers to that, but if you are a university that aspires to be a major research university in this country, for all the reasons we have heard, it is a contribution that these institutions are making to America, then your research programs have to be strong. Your laboratories have to function. You have got to be able to attract faculty who can do their research programs. And frankly, when they look around for students to get their education in the university, get their degree, graduate, even post-docs, they don't find nearly enough American-born men and women, for the other reasons that we talked about today.

So, it may sound self-serving, and maybe it is, in a way, but it is all about maintaining the strength of American higher education. It has been a result of efforts to do that, and the net result is what we have just heard. There are other reasons, but that is one reason.

Mr. BILBRAY. May I—yield—Mr. Chairman, I just bring it up, and as the ranking member of—the American people are doing a lot of subsidizing for this higher education, and I think we have a right to ask why are we subsidizing the education of foreign nationals, and I keep hearing well, it is money, but I think the voters will be saying money, too, and you are saying it is essential, because we just don't—aren't producing this resource in America, so we must import it to fill our universities, to create the engineers.

Chairman GORDON. I think in fairness that we need to point out that many of these Ph.D.s that are created stay here, develop products, develop companies, and create jobs. So, this is a higher level of entrant.

Let me——

Mr. HALL. Mr. Chairman.

Chairman GORDON. Yes, sir.

Mr. HALL. I think it might be a good study, and a good hearing, to look into that, and see, really, if we are getting our dollar's worth, what are the facts on how many stay here, and what are the facts as to where they come from, and to where they go back to, and what are the benefits.

This might be the time to look at it, because we are at war for knowledge. We are in a knowledge war today, and our war is fighting for our little troops to start carrying a gun in the first grade, in the second and third grade, and learn to march and all that.

And we need to teach them science and math, and I think that would be a good thing to think about.

Mr. BILBRAY. If the gentleman would yield, I would just say that I am sure there are kids in the Northeast over here, that if they had the foundation, and if they, you know, there are many American kids in working class neighborhoods, that would die for the opportunity, but just don't have the tools. And this issue of importing our students because our domestic sources just cannot compete, should be the big warning sign, and not accept this as being the best we can do, and so, I would ask that we take a look at that hearing.

Chairman GORDON. Well, I would suggest that we have two answers, and two answers are H.R. 362 and H.R. 363, and would hope everyone would support that. Let me also say to Mr. Hall, he has put up with a lot of our hearings, and so, I would welcome his, any recommendation that he wants to have, to put one together. We will participate with him in a hearing.

And let me say to the panel, are there any closing remarks that anyone would like to—Mr. Augustine.

Mr. AUGUSTINE. Mr. Hall raised an important question, and I would just throw out one statistic. Of all the basic researchers with Ph.D.s in math, science, and engineering in this country, 38 percent are foreign-born. One-third of the Nobel laureates in America in math and science in the last 15 years were foreign-born. Our science enterprise in this country would hardly function today without foreign-born people. You raise a very important question.

Chairman GORDON. Mr. McGraw.

Mr. MCGRAW. Well, again, thank you, Mr. Chairman, for your leadership in H.R. 362 and H.R. 363, and the business community supports it, and we look forward to see its passage.

I would say that some of the comments that you have made earlier on are some of the areas that I think we need to focus on even further, and that is the whole role of public/private sector cooperation.

Now, I think when you start to see what ExxonMobil has done, in terms of the funding issues, I think there is an awful lot of coordination that could take place around some of these ideas, that would allow it to be more efficiently done.

Chairman GORDON. Any other comments?

Well, let me say that this panel now holds the Science and Technology Committee indoor endurance record. And I think it is indicative of the importance of this panel, and also, of the issue.

We thank you for being here, and the witnesses are excused, and this hearing is adjourned.

[Whereupon, at 4:05 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Norman R. Augustine, Chair, Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, Division on Policy and Global Affairs, the National Academies; Former Chairman and CEO, Lockheed Martin Corporation

Questions submitted by Chairman Bart Gordon

Q1. The Gathering Storm *report places a strong emphasis on the importance of increasing funding for basic research, particularly in the physical sciences, engineering and mathematics.*

Q1a. Did your National Academy of Sciences committee, in its call for increased research funding, intend to include the portion of NASA's budget that supports basic research?

A1a. The committee included all the basic research in the physical sciences, engineering, and mathematics research funded across the Federal Government. You will see that in the committee's cost estimate on p. 508 of the report which is based on an NSF analysis, this includes NASA. According to NSF's analysis, NASA funds 21 percent of the Federal Government's support of these fields.

Q1b. As you know the President has proposed substantial budget increases for NSF, the DOE Office of Science, and NIST, but not for the science components of the NASA budget. Do you believe this is a mistake?

A1b. The committee did not attempt to construct an actual "bottoms-up" budget, but rather sought to identify overall disciplines deserving increased funding. The allocation within agencies would require further study, but there was certainly no intent NASA (or DOD) be excluded.

Q1c. Also, the NASA aeronautics budget has declined by 70 percent from the FY 1994 funding level to the FY 2008 request. Could you comment on how aeronautics is related to the future economic competitiveness of the United States? Would you consider aeronautic research as one of the fields that should be part of efforts to increase research funding for enhanced U.S. competitiveness?

A1c. The committee I chaired did not address this issue, although it clearly is an area having a significant impact on the balance of trade.

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering, and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to teach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. The committee recommends a $10,000 bonus every year to participating teachers in under-served schools in inner cities and rural areas. There is no limitation on the number of years this bonus is received. We did, of course, recommend a five-year teaching commitment in exchange for the scholarship support.

Q2. H.R. 363, "Sowing the Seeds through Science and Engineering Research Act," *is well-designed to assist early-career researchers by supporting their work during a critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop our domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or be given preference?

A2. The committee did not address this specific issue in its report other than to note the under-representation of those groups in the science and technology workforce. The National Academies Committee on Science, Engineering, and Public Pol-

icy (COSEPUP) that oversaw the development of the "Rising Above the Gathering Storm" report may well address this issue in its potential study, requested by several members of the Senate, that will focus on the issue of under-represented groups. This potential study is now in the fund-raising stage.

In addition, a workshop conducted on May 3–4 by the Academies Board on Life Sciences and sponsored by the NIH will focus on the issue of "Understanding Interventions that Encourage Minorities to Pursue Research Careers: Major Questions and Approaches."

Q3. With regard to Action Item A–3 of the Gathering Storm *report, would Advanced Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. This recommendation is based on a very successful program in Dallas. You can see more information on this program at the following website: *http://www.nationalmathandscience.org/programs/dallas.htm*

Quoting the most recent data from their website (prior data is in the *Gathering Storm* report):

> *"When the Dallas Independent School District (DISD) started a training and incentive program for AP courses in 10 schools in 1996, the number of students scoring a three or higher on AP mathematics, science, and English exams was just two-thirds of the national average. At these schools, where half of students receive free or reduced price lunch and 60 percent are African-American or Hispanic, the number of AP exams with scores of three or higher increased over 700 percent from 1995 to 2006 and increased by over 1,700 percent for African-American and Hispanic students over this time period. In 2006, the students at these schools earned scores of three or higher at a rate that was 68 percent greater than the national average. More impressively, African-American and Hispanic students at these DISD schools surpassed the national average of these ethnicities by almost 200 percent.*
>
> *The success in the original 10 schools has led to all 23 high schools in DISD adopting a similar training and incentive program. At five particularly disadvantaged DISD schools, where more than 70 percent of students receive free or reduced price lunch and more than 90 percent are African-American or Hispanic, the number of students graduating from college in four years is on track to at least double since the inception of its training and incentive program."*

Questions submitted by Representative Daniel Lipinski

Q1. Thank you for chairing the committee charged with drafting this very timely and eye-opening report. It has truly served as a blueprint for the Science and Technology Committee as we have worked to advance our competitiveness agenda. You mention in your testimony that studies have shown that between 50 and 85 percent of the Nation's growth in per capita GDP during the last half-century can be attributed to science and engineering progress. This is an astonishing figure that illustrates just how critical our discussions and actions today are to the long-term health and vitality of our country. Can you give some specific examples of progress in the 20th Century that led to this growth, and elaborate on current advancements that are contributing to the Nation's GDP today?

A1. Thank you for your comments. On page 44 of the full *Gathering Storm* report, you'll see a summary of the Twenty Great Achievements of the 20th century as identified by the National Academy of Engineering. It is reproduced below:

BOX 2-2
Twenty Great Engineering Achievements of the 20th Century

Electricity: steam turbine generators; long-distance, high-voltage transmission lines; pulverized coal; large-scale electric grids
Automotive: machine tools, assembly line, self-starting ignition, balloon tire, safety-glass windshield, electronic fuel injection and ignition, airbags, antilock brakes, fuel cells
Aeronautics: aerodynamic wing and fuselage design, metal alloys and composite materials, stressed-skin construction, jet propulsion, fly-by-wire control systems, collision warning systems, Doppler weather radar
Water supply and distribution: chlorination, wastewater treatment, dams, reservoirs, storage tanks, tunnel-boring equipment, computerized contaminant detection, desalination, large-scale distillation, portable ultraviolet devices
Electronics: triodes, semiconductors, transistors, molecular-beam epitaxy, integrated circuits, digital-to-optical recording (CD-ROM), microprocessors, ceramic chip carriers
Radio and television: alternators, triodes, cathode-ray tubes, super heterodyne circuits, AM/FM, videocassette recorders, flat-screen technology, cable and high-definition television, telecommunication satellites
Agriculture: tractors, power takeoff, rubber tires, diesel engines, combine, corn-head attachments, hay balers, spindle pickers, self-propelled irrigation systems, conservation tillage, global-positioning technology
Computers: electromechanical relays; Boolean operations; stored programs; programming languages; magnetic tape; software, supercomputers, minicomputers, and personal computers; operating systems; the mouse; the Internet
Telephony: automated switchboards, dial calling, touch-tone, loading coils, signal amplifiers, frequency multiplexing, coaxial cables, microwave signal transmission, switching technology, digital systems, optical-fiber signal transmission, cordless telephones, cellular telephones, voice-over-Internet protocols
Air conditioning and refrigeration: humidity-control technology, refrigerant technology, centrifugal compressors, automatic temperature control, frost-free cooling, roof-mounted cooling devices, flash-freezing
Highways: concrete, tar, road location, grading, drainage, soil science, signage, traffic control, traffic lights, bridges, crash barriers
Aerospace: rockets, guidance systems, space docking, lightweight materials for vehicles and spacesuits, solar power cells, rechargeable batteries, satellites, freeze-dried food, Velcro
Internet: packet-switching, ARPANET, e-mail, networking services, transparent peering of networks, standard communication protocols, TCP/IP, World Wide Web, hypertext, web browsers

Imaging: diagnostic x-rays, color photography, holography, digital photography, cameras, camcorders, compact disks, microprocessor etching, electron microscopy, positron-emission tomography, computed axial tomography, magnetic-resonance imaging, sonar, radar, sonography, reflecting telescopes, radiotelescopes, photodiodes, charge-coupled devices
Household appliances: gas ranges, electric ranges, oven thermostats, nickel-chrome resistors, toasters, hot plates, electric irons, electric motors, rotary fans, vacuum cleaners, washing machines, sewing machines, refrigerators, dishwashers, can openers, cavity magnetrons, microwave ovens
Health technology: electrocardiography; heart–lung machines; pacemakers; kidney dialysis; artificial hearts; prosthetic limbs; synthetic heart valves, eye lenses, replacement joints; manufacturing techniques and systems design for large-scale drug delivery; operating microscopy; fiber-optic endoscopy; laparoscopy; radiologic catheters; robotic surgery
Petroleum and petrochemical technology: thermal-cracking oil refining; leaded gasoline; catalytic cracking; oil byproduct compounds; synthetic rubber; coal tar distillation byproduct compounds, plastics, polyvinyl chloride, polyethylene, synthetic fibers; drilling technologies; drill bits; pipelines; seismic siting; catalytic converters; pollution-control devices
Lasers and fiber optics: maser, laser, pulsed-beam laser, compact-disk players, barcode scanners, surgical lasers, fiber optic communication
Nuclear technology: nuclear fission, nuclear reactors, electric-power generation, radioisotopes, radiation therapy, food irradiation
High-performance materials: steel alloys, aluminum alloys, titanium superalloys; synthetic polymers, Bakelite, Plexiglas; synthetic rubbers, neoprene, nylon; polyethylene, polyester, Saran Wrap, Dacron, Lycra spandex fiber, Kevlar; cement, concrete; synthetic diamonds; superconductors; fiberglass, graphite composites, Kevlar composites, aluminum composites

SOURCE: G. Constable and B. Somerville. *A Century of Innovation: Twenty Engineering Achievements That Transformed Our Lives*. Washington, DC: Joseph Henry Press, 2003.

With regard to current, promising advancements, any list would certainly include nanotechnology, biology and information technology.

Q2. I am pleased that Dr. Dynes mentioned the University of Illinois–Urbana-Champaign/UC–Berkeley/Lawrence–Berkeley National Lab partnership in his testimony. Having recently won the global competition for BP's $500 million grant to build and operate an Energy Biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country—reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in our society. How can Congress entice others in the business community to follow suit?

A2. The committee recommended the creation of the Advanced Research Project Agency-Energy (ARPA–E) that would support out-of-the-box transformational energy research to meet the Nation's long-term energy challenges. It would encourage industry and universities to become partners in such research activities. As you know, the committee identified energy research as a centerpiece of the proposed effort, for the reasons cited in the report.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Harold McGraw III, Chairman and CEO, The McGraw-Hill Companies; Chairman, Business Roundtable

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering, and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to teach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. Business Roundtable is a strong supporter of the Robert Noyce Scholarship Program authorized in the *National Science Foundation Authorization Act of 2002.* By encouraging science, technology, engineering and mathematics (STEM) undergraduate majors to pursue teaching careers, and by requiring that scholarship recipients teach in a high-need local educational agency after graduation, the program directly addresses two Business Roundtable priorities: recruiting math and science teachers with disciplinary content knowledge and closing the achievement gap in student performance.

Business Roundtable has endorsed H.R. 362, the *"10,000 Teachers, 10 Million Minds" Science and Math Scholarship Act,* including section 104 amending the Robert Noyce Scholarship Program. The amendments included in H.R. 362 will, if enacted, strengthen the Noyce Scholarship Program.

Business Roundtable shares Representative Johnson's concern about the need to close the achievement gap in high-need school districts. We believe that reducing the term of service for those who choose to teach in high-need school districts, as provided for in H.R. 362, will provide added incentive for new teachers to make that choice. Imposing a five-year commitment upon scholarship recipients could create the unintended consequence of discouraging students from participating in the Noyce Program.

Q2. H.R. 363, the Sowing the Seeds through Science and Engineering Research Act, *is well-designed to assist early-career researchers by supporting their work during a critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or given preference?

A2. Business Roundtable has endorsed H.R. 363, the *Sowing the Seeds Through Science and Engineering Research Act,* including sections 3 and 4, which authorize early career research grants programs at the National Science Foundation and the Department of Energy, respectively. H.R. 363 contains a provision that requires broad dissemination about when and how to apply for early career research grants, including outreach to minority-serving institutions. Business Roundtable believes that outreach and inclusion are important aspects of these grants programs as authorized in H.R. 363. We would be hesitant, however, to recommend adding preferences to this program because the NSF has other excellent programs that are specifically designed to address the need to increase participation of under-represented groups in science and engineering.

Q3. With regards to Action Item A–3 of the Gathering Storm *report, would Advanced Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. Business Roundtable supports efforts to train additional Advanced Placement (AP), International Baccalaureate (IB), and pre-AP–IB math and science teachers, as recommended in Part 3 of Action Item A–2 in the National Academies' *Rising Above the Gathering Storm* report. Published data indicate that students who participate in AP and IB programs have significantly higher college graduation rates

than students who do not. The model program for training AP, IB, and pre-AP–IB math and science teachers is the AP Incentive Program in Dallas, Texas. The University of California's College Prep Program, which offers AP courses to high school students, has also been viewed as a successful model.

Questions submitted by Representative Daniel Lipinski

Q1. You state in your testimony that the U.S. ranks 17th in the world in the proportion of the college-age population earning a degree in science or engineering. As an engineer by training, and one of the only nine current Members of Congress educated in the vocation, I must say that this statistic is very worrisome to me. In order to draw attention to the profession and good work done by our nation's engineers, earlier this Congress I, along with Members of this committee, sponsored and passed a bill to recognize and honor our nation's engineers. Now more than ever our country requires the service, and we should do everything in our power to see that our institutions of higher learning are producing increasingly greater number of engineers. Back to the ranking, is America 17th place holding steady, or is this ranking increasing or decreasing in the context of other countries? Do you believe this is a direct affect for the off-shoring of American industries to other countries? Could you elaborate on other factors contributing to this low ranking?

A1. The U.S. ranking, in terms of the proportion of the college-age population earning a degree in science and engineering, has declined compared to the rest of the world. The other nations have developed their higher education sectors and produced increasingly higher numbers of graduates with Bachelor's degrees in science and engineering. Whether the U.S. ranking will continue to decline depends on the actions of all interested parties to encourage more Americans to pursue science and engineering studies. Highly capable American students have more choices than some of their international counterparts. Careers in business and law beckon high-performing U.S. students with greater potential earning power and social status than technical careers. It is not clear that structural changes in the economy, including the impact of globalization on workers and industries, have an impact on students' choice of undergraduate major. However, fundamental market forces may eventually influence students' decisions. Acute shortages of science and engineering talent will drive up salaries and thereby attract more people to the field.

Q2. As you mention in your testimony, the key to America's competitiveness challenge is innovation. It is clear that technological innovation drives productivity growth, creating new products and processes and generating high-wage employment and a higher standard of living for all Americans. I worked to pass a bill in the House earlier this session to make our metals industries more competitive and innovative. The Legislation provides grants to universities, with additional funding from industry, to develop new technologies to spur innovation and give our steel and aluminum industries a competitive advantage in the global marketplace. I believe this Congress must continue to lead by giving our industries the tools necessary to compete in the increasingly competitive world economy. Can you give us a picture of the current innovation indicators of the United States? Is our innovative growth rapidly declining, or are we suffering from a gradual change like the frog being slowly boiled in a pot of water where may be too late to act by the time we notice a problem?

A2. By every measure, the United States is the world's innovation leader. The problem is that America's lead is slipping. Other economic competitors around the world, including India and China, are following the U.S. model of advanced economic development by investing in their capacity to innovate. They are investing in science and engineering research, investing in math and science education, opening their doors to top science and engineering talent from around the world, and creating tax incentives for research and research infrastructure investments in their countries. It is important to note that China has more than doubled its research and development spending as a percentage of gross domestic product (GDP) from 0.6 percent in 1995 to 1.4 percent today, and the EU set a target by 2010 to invest three percent of its GDP into research and development, up from the current rate of just over 1.8 percent of GDP. More importantly, in the U.S., federal funding for research and development has declined from 1.25 percent of GDP in 1985 to 0.75 percent today. This trend has to change.

Q3. I am pleased that Dr. Dynes mentioned the University of Illinois–Urbana-Champaign/UC–Berkley/Lawrence–Berkeley National Lab partnership in his testimony. Have recently won the global competition for BP's $500 million grant to

build and operate and Energy Biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country—reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in our society. How can Congress entice others in the business community follow suit?

A3. Business Roundtable is proud of our member companies' contributions to America's innovation capacity, including the BP America, Inc. collaboration with Lawrence–Berkeley National Laboratory, the University of California, and the University of Illinois to establish an energy biosciences institute. We are also proud of the ExxonMobil Corporation's $125 million commitment to the National Math and Science Initiative, a nonprofit organization created to facilitate the national scale-up of programs that have a demonstrated impact on math and science education in the United States.

Business Roundtable believes that the most effective action Congress can take to encourage business's continued investment in American's capacity to innovate would be to enact the policy agenda outlined in the American Innovation Proclamation:

- Renew America's commitment to discovery by doubling the basic research budgets at the National Science Foundation, the National Institute of Standards and Technology, the Department of Energy's Office of Science, and the Department of Defense;
- Improve student achievement in math and science through funding of proven programs and incentives for science and math teacher recruitment and professional development;
- Welcome highly educated foreign professionals, particularly those holding advanced science, technology, engineering, or mathematics degrees, especially from U.S. universities, by reforming U.S. visa policies; and
- Make permanent a strengthened R&D tax credit to encourage continued private-sector innovation investment.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Robert C. Dynes, Professor of Physics and Material Science; President, University of California

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering, and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to teach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. The University's experience, and that of other institutions as well, is that providing incentives for work in high need schools yields better outcomes than does a requirement. Students are often reluctant to accept funds that unduly limit later vocational choices, since so many other life choices can be affected by such commitments. Current federal loan forgiveness programs that require teachers to perform services in high need schools for five consecutive years have not yielded desirable outcomes. So, I would encourage that we treat these forgiveness programs as incentives to students, rather than requirements.

Q2. H.R. 363, "Sowing the Seeds through Science and Engineering Research Act," *is well-designed to assist early-career researchers by supporting their work during the critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop our domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or be given preference?

A2. I believe early career award programs, like the ones that would be established by H.R. 363, can play an important role in providing support to young scientists and engineers and those at early stages in their careers. It can be difficult for such individuals to obtain grant support, and an award program like the one promoted by H.R. 363 can help encourage and sustain our next generation of scientists. Encouraging under-represented minorities to apply for such awards is a worthy goal, and the bill takes a step in that direction, at least, by directing that information about the awards be disseminated broadly and that officials responsible for the programs should conduct outreach to Historically Black Colleges and Universities and minority institutions. Drawing talented individuals from diverse backgrounds into careers in science and engineering is important. I believe the effort needs to begin early, by improving math and science education in K–12 and in ensuring that children from all backgrounds are well prepared and encouraged to pursue higher education in science and math, so that they will then be well positioned to be part of a highly-trained domestic STEM work force.

Q3. With regard to Action Item A–3 of the Gathering Storm *report, would Advanced Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. Mini-scholarships used to encourage students to enroll in AP courses and to take the exams related to these courses have proven to be effective inducements to low-income students. However, it is important that the funds be made available at the time payment is required of the student. Rebates are much less effective because the family must make the initial payment, but they often do not have the ready cash to do so. In addition, families feel uncertain that the rebate will actually be received to cover the cost of the exam.

Questions submitted by Representative Daniel Lipinski

Q1. I am pleased that you mention the University of Illinois–Urbana-Champaign/UC–Berkeley/Lawrence–Berkeley National Lab partnership in your testimony.

Having recently won the global competition for BP's $500 million grant to build and operate an Energy Biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country-reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in our society. Do you believe the United States should encourage more of these types of initiatives from private industry in order to achieve these objectives? How can Congress entice others in the business community to follow suit?

A1. Land Grant institutions like the University of California and the University of Illinois have a long history of collaborating with industry in support of instruction, research, and public service. I do believe that partnering with industry is increasingly important, in part to ensure that research innovations discovered by University scientists can be developed into useful services, technologies, products, and therapies that can benefit the public. Collaborating with industry helps ensure delivery of research from the bench to the patient's bedside, to the farmer's field, and into the community generally where the public can enjoy its benefits. In addition to the crucial role industry plays in technology transfer, industry also provides a critical source of funding for research, and collaboration across departments, disciplines, institutions, and sectors (i.e., public/private) is increasingly important in addressing the ever more complex scientific and societal issues we all face. Federal patent and tax laws can and do encourage University-Industry collaboration, and can provide incentives for industry to invest in research. There are also federal grant programs that encourage University-Industry cooperative research. And it would be my hope that these kinds of programs would continue to receive federal support.

Of course, federal funding is by far the most important source of support for University research, and we would not want to see industry funding, which is often more targeted and less likely to be directed to basic research, looked to as a replacement for robust federal investment in university research, which remains critical for our nation's competitiveness.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Craig R. Barrett, Chairman of the Board, Intel Corporation

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering, and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to teach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. I believe that the program would indeed be strengthened by a multi-year commitment requirement, to teach generally, in order to obtain full benefit of the investment made in the student. What is important is getting the properly trained teachers into the school systems, and that is true for all schools, not just high-need schools.

Q2. H.R. 363, "Sowing the Seeds through Science and Engineering Research Act," *is well-designed to assist early-career researchers by supporting their work during a critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop our domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or be given preference?

A2. I believe that the program should be available to all researchers, and awards should be based upon the merits of their work. I have no opinion on the questions of preferences, this is in the expertise of Congress.

Q3. With regards to Action Item A–3 of the Gathering Storm *report, would Advanced Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. Rebates and scholarships would serve as a further inducement to students to apply themselves to the AP discipline. It is one among many incentives we propose to motivate students to tackle math and science. I am not aware of specific program experiments in this regard.

Questions submitted by Representative Daniel Lipinski

Q1. You stated that we have come close to having critical research facilities close, such as the Brookhaven heavy ion collider. As you may know, Fermi Laboratory, with assistance from DOE, has put in a bid for the International Linear Collider. Could you elaborate on the positive impacts of the creation of new *facilities such as this? In the same vein, can you expand on the potential consequences were the United States fail to be awarded crucial facilities, such as the ILC, this decade?*

A1. New facilities that are on the cutting edge of research, such as the ILC, if located in the U.S., are a benefit to U.S. scientists and engineers and to the constellation of industry users that are interested in the research. The siting of such facilities in the U.S. also stimulates interest in the U.S. university programs that inevitably are partners in the research.

Q2. I am pleased that Dr. Dynes mentioned the University of Illinois–Urbana-Champaign/UC–Berkeley/Lawrence–Berkeley National Lab partnership in his testimony. Having recently won the global competition for BP's $500 million grant to build and operate an Energy Biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country—reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in

our society. How can Congress entice others in the business community to follow suit?

A2. Congress can entice the business community by providing policy direction to the labs to pursue such cooperative research, and providing to businesses the proper financial incentives to make the investment in uncertain basic research—such as by making permanent the Research and Development Tax Credit, which is reauthorized every one or two years on an ad-hoc basis. This does not provide for the stability of resource planning that business needs to make these investments over the long-term.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Neal Lane, Malcolm Gillis University Professor, and Senior Fellow of the James A. Baker III Institute for Public Policy, Rice University

Questions submitted by Chairman Bart Gordon

Q1. The Gathering Storm *report places a strong emphasis on the importance of increasing funding for basic research, particularly in the physical sciences, engineering and mathematics.*

Q1a. Should the portion of NASA's budget that supports basic research be part of initiatives to increase basic research funding?

Q1b. As you know the President has proposed substantial increases to double the budgets of NSF, the DOE Office of Science, and NIST, but not for the science components of the NASA budget. Do you believe this is a mistake?

A1a, b. NASA support for basic research in space and earth science has been a very important part of the U.S. effort. It is being cut in order to find funds for the President's Moon-Mars exploration program. I believe that these are flawed priorities. NASA should cleanly separate out its basic research programs, build a firewall between those and human exploration, and ask the President to include NASA basic science in the American Competitiveness Initiative. But, if the basic science funding cannot be protected from human exploration, then it should not be included—in any manner—along with NSF, DOE Office of Science, and NIST, lest some of those agencies' research funding be tapped (at the appropriations committee level) to shore up the exploration program. I would also point out that, in addition to cuts in basic research, NASA is also cutting back on its satellite Earth observation programs (including basic research in Earth sciences). In this case, we lose the scientific information that is critical to improving our ability to improve weather predictions (e.g., hurricanes) and as well as monitor climate change.

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering, and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to teach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. I believe that the length of service in high-need schools deserves further discussion. I do not feel qualified to say that one year is too short and five years is the right tenure. One must consider how best to develop the career of the young teacher as well as insure that the students in the high-need schools get the education they deserve. Such a decision needs to be based on pedagogical research findings; and if those data and analyses do not exist, then pilot programs, if done in conjunction with relevant research, could help answer the question.

Q2. H.R. 363, "Sowing the Seeds through Science and Engineering Research Act," *is well-designed to assist early-career researchers by supporting their work during a critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop our domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or be given preference?

A2. The need to develop our science and engineering domestic workforce certainly should emphasize the special challenge of attracting more women, African-Americans and Latino men and women as well as members of other under-represented communities to careers in science and engineering. Of course, this is not an unrecognized need. Many federal agencies, e.g., the National Science Foundation, have designed and implanted programs over the years to do just that; but progress has been slow, especially for under-represented minorities. I do believe that some significant

effort should be made to encourage members of unrepresented groups to apply for any of the early-career programs. However, that should be done, only if effective mentorship arrangements are in place at institutions applying for these funds to assure that all young scientists and engineers are given a fair chance to succeed. Retention is just as important as recruitment and learning to succeed in the highly competitive environment that characterizes excellence in academic research and education is especially challenging for young people from under-represented groups and for women in general.

Q3. With regards to Action Item A–3 of the Gathering Storm *report, would Advanced Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. AP exam rebates have been successfully used by the State of Texas, for instance, to reduce exam fees across the State. In addition, Texas has refunded the district professional development funds used by teachers to develop their content knowledge in select AP summer institutes mostly held by universities across the State. The summer institute model serves as a good model of collaboration between the College Board and universities in implementing high-quality and reliable professional development opportunities. Both of these actions have resulted in a significant rise in the number of exams taken statewide by AP students in public schools.

Question submitted by Representative Daniel Lipinski

Q1. I was pleased to hear the University of Illinois–Urbana-Champaign/UC–Berkeley/Lawrence–Berkeley National Lab partnership in Dr. Dynes's testimony. Having recently won the global competition for BP's $500 million grant to build and operate an Energy Biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country—reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in our society. How can Congress entice others in the business community to follow suit?

A1. It is increasingly clear that reducing this nation's dependence on fossil fuels is among the top few most critical needs in the new millennium and that biomass offers an important option to address this need. This new $500 million partnership to manage the Energy Biosciences Institute is an excellent example of how the priorities of a major energy company can come into alignment with the missions of major universities and federally funded research laboratories to solve large national, indeed world problems. Biomass is a most promising energy technology, but much research remains to be done. With this as a model, other universities and companies can partner to take on a large research agenda in many areas of energy R&D, e.g., solar, wind, nuclear in addition to biomass. Congress should hold hearings showcasing programs and partnerships underway and inviting companies and agencies to propose new ways to move forward. The energy crisis is real and the need for alternative approaches is urgent.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Deborah L. Wince-Smith, President, Council on Competitiveness

Questions submitted by Representative Eddie Bernice Johnson

Q1. The "10,000 Teachers, 10 Million Minds" *bill amends the Noyce Scholarship program, which reminds me of the UTeach Program at the University of Texas. Noyce provides competitive awards to encourage talented science, technology, engineering and mathematics majors and professionals to become K–12 math and science teachers.*

I am concerned the commitment to high-need schools isn't strong enough to really make a difference. Do you think the program would be better if recipients were required to reach in high need schools for five years following graduation? Rather than just the one-year commitment reduction for working in high need schools?

A1. I believe a significant commitment of time is justified, as that would allow for a more stable, continuing curriculum for the students and represents a tangible expression of priorities by the Congress.

Q2. H.R. 363, "Sowing the Seeds through Science and Engineering Research Act," *is well-designed to assist early-career researchers by supporting their work during the critical time. Young scientists and engineers struggle to earn grant funding and obtain tenure. However, the bill does not contain a provision to develop our domestic workforce of under-represented populations such as women, Blacks and Hispanics.*

Do you think such a grant program should contain provisions to encourage under-represented minorities to apply and/or be given preference?

A2. This grant program should encourage under-represented minorities to participate in the program. Minorities make up an integral and expanding part of our workforce and we need to ensure they have the skills to succeed, especially in science and engineering.

Q3. With regards to Action Item A–3 of the Gathering Storm *report, would Advance Placement exam rebates and AP "mini-scholarships" send the wrong message or really make a difference? What model systems have used this approach successfully?*

A3. I believe programs of this type have been successful in encouraging AP participation in certain areas of the country. Importantly, cost should not be a barrier to achievement, so if mini-scholarships or rebates can increase access to AP or similar programs, we should explore these opportunities.

Question submitted by Representative Daniel Lipinski

Q1. I am pleased that Dr. Dynes mentioned the University of Illinois–Urbana-Campaign/UC–Berkeley/Lawrence–Berkeley National Lab partnership in this testimony. Having recently won the global competition for BP's $500 million grant to build and operate an Energy biosciences Institute, the three partners will focus on one of the most pressing issues currently facing our country—reducing our dependence on fossil fuels—by researching biomass. This is a great example of how public and private entities can collaborate to solve critical problems in our society. How can Congress entice others in the business community to follow suit?

A1. Public-private partnerships will be critical to America's effort to find and commercialize alternate energy sources. BP's efforts demonstrate the power of the private sector to encourage this type of research, but the government also can and should create incentives for collaboration.

Appendix 2:

Additional Material for the Record

SECTION-BY-SECTION SUMMARY OF H.R. 362,
"10,000 TEACHERS, 10 MILLION MINDS"
SCIENCE AND MATH SCHOLARSHIP ACT

Summary

The bill implements most of the K–12 science education recommendations of the National Academy of Sciences (NAS) report, *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future."* It establishes a teacher education program at the National Science Foundation (NSF) to encourage math, science and engineering faculty to work with education faculty to improve the education of science and math teachers and to provide scholarships to science, math and engineering students who commit to become science or math teachers at elementary and secondary schools; authorizes summer teacher training institutes at NSF and DOE to improve the content knowledge and pedagogical skills of in-service science and math teachers, including preparing them to teach Advanced Placement and International Baccalaureate courses in science and math; requires that NSF include support for Master's degree programs for in-service science and mathematics teachers within the NSF Math and Science Partnerships; and authorizes funding for the NSF STEM Talent Expansion program and expands the program to include centers for improving undergraduate STEM education.

Sectional Summary of Bill

Section 1

Table of Contents.

Section 2

Findings on the role of NSF in K–12 and undergraduate STEM education.

Section 3

Definitions used in the bill.

Title I—Science Scholarships

Section 101

Short Title of the bill.

Section 102

Findings relating the bill to the NAS report recommendations.

Section 103

Policy objective of the bill—to increase by 10,000 annually the number of capable K–12 science and math teachers.

Section 104

Amends the NSF Noyce Scholarship program, established by the *NSF Authorization Act of 2002,* to create incentives for colleges and universities to improve the training of STEM teachers and increases the size and duration of the scholarships provided for science, math and engineering majors who pursue teaching credentials:

- Provides competitive awards to institutions of higher education (or consortia of such institutions) that (1) establish cross-department faculty teams (science, math and engineering faculty along with education faculty) to develop courses of instruction leading to baccalaureate degrees in fields of science, math and/or engineering and also preparing graduates to become certified or licensed to teach in a K–12 classroom, and (2) administer scholarships for students during their sophomore through senior years and summer internships during their freshman years.
- Requires early field teaching experiences for student teachers in the program under the supervision of highly experienced and effective teachers.
- Requires awardees to provide professional development and mentoring support to scholarship recipients, after matriculation.
- Sets scholarship amounts at the cost of attendance at particular institutions, not to exceed $10,000 per year, and provides up to three years of scholarship support for any individual.
- Requires scholarship recipients to commit to teaching for up to six years following graduation (the period of teaching commitment is based on the number of years of scholarship support), reduces the commitment by one year for individuals who teach at high-need schools, and converts the scholarships to loans if the teaching commitment is not met.

- Authorizes the NSF to accept donations from the private sector to help support scholarships and internships.
- Authorizes $70 million for NSF for FY 2008, $101 million for FY 2009, $133 million for FY 2010, $164 million for FY 2011, and $196 million for FY 2012.

Title II—Mathematics and Science Education Improvement

Section 201 amends the NSF Math and Science Education Partnerships program established by the NSF Authorization Act of 2002:

- Specifies that priority for awards under the program be given to applications that include teacher training activities as a main focus.
- Authorizes teacher training activities to prepare teachers to teach Advanced Placement and International Baccalaureate science or math courses and provides for mentoring by professional scientists, mathematicians and engineers.
- Authorizes the development of Master's degree programs for in-service science and math teachers.

Section 202 addresses teacher institute programs at NSF and DOE:

- NSF is directed to establish a grant program to support summer or academic year teacher institutes and authorizes summer teacher institutes as a component of the NSF 21st Century program. Such summer institutes are required to include teacher training activities to prepare teachers to teach Advanced Placement and International Baccalaureate science or math courses.
- Authorizes $32 million for NSF for FY 2008, $35.2 million for FY 2009, and $38.7 million for FY 2010, $42.6 million for FY 2011, and $46.8 million for FY 2012.
- The following amounts are authorized for the existing Laboratory Science Teacher Professional Development program at DOE: $3 million for FY 2008, $8 million for FY 2009, and $10 million for each year FY 2010 through FY 2012.

Section 203 requires NSF to ensure that, under the Math and Science Partnership program, Master's degree programs are developed and implemented for in-service math and science teachers, who attend on a part-time basis and who will be able to complete the degree requirements within two years. The programs have the following features:

- Provide stipends to defray the cost of attendance for teachers in the program.
- Allow for support for the development of the courses of instruction and related educational materials and equipment (offering of online learning is an option).
- Require the distribution of awards among institutions of different sizes and geographic locations.

Authorizes $46 million for NSF for FY 2008, $50.6 million for FY 2009, $55.7 million for FY 2010, $61.2 million for FY 2011, and $67.3 million for FY 2012.

Section 204: (1) establishes a national panel of experts to identify and collect K–12 science and mathematics teaching materials that have been demonstrated to be effective and to recommend the development of new materials in areas where effective materials do not exist; and (2) directs NSF and the Department of Education to develop ways to disseminate effective materials and support efforts to develop new materials, in accordance with the recommendations of the national panel.

Section 205 amends the NSF STEM Talent Expansion program established under the NSF Authorization Act of 2002 to create centers for improvement of undergraduate education in STEM fields, including:

- Development of undergraduate curriculum and teaching methods and training for faculty and teaching assistants in effective pedagogical practices.
- Assessment of the effectiveness of the centers and dissemination of information about materials and methods developed.

Authorizes $44 million for NSF for the STEM Talent Expansion program for FY 2008, of which $4 million is available for centers; $55 million for FY 2009, of which $10 million is available for centers; and $60 million for each year of FY 2010 through FY 2012, of which $10 million is available in each year for centers.

SECTION-BY-SECTION SUMMARY OF H.R. 363,
SOWING THE SEEDS THROUGH SCIENCE
AND ENGINEERING RESEARCH ACT

Summary

H.R. 363 implements recommendations related to strengthening long-term basic research contained in the National Academy of Sciences (NAS) report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* It authorizes 10 percent increases per year in funding for basic research in the physical sciences, mathematical sciences, and engineering at the principal federal agencies supporting such research; provides grant support through programs at NSF and DOE for outstanding researchers in the early stages of their careers of $80,000 per year for five years; establishes a floor of 1.5 percent of research funding appropriated for NSF for an existing program supporting graduate students in multidisciplinary fields of national importance; establishes a presidential innovation award to stimulate scientific and engineering advances in the national interest; and establishes a national coordination office to identify and prioritize research infrastructure needs at universities and national laboratories and to help guide the investments of new infrastructure funds authorized for NSF and DOE.

Section-by-Section

Section 1 is the short title of the bill.

Section 2 authorizes appropriations for basic research activities in the physical sciences, mathematics and computer sciences, and engineering at four agencies and authorizes appropriations for all basic (6.1) research at the Department of Defense. The funding levels increase by 10 percent for each year:

$ millions

Agency	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
National Science Foundation	2114.1	2325.5	2558.1	2813.9	3095.3
Department of Energy	2205.4	2425.9	2668.5	2935.4	3228.9
NASA	1669.7	1836.7	2020.3	2222.4	2444.6
National Institute of Standards and Technology	86.2	94.9	104.4	114.8	126.3
Department of Defense	1784.8	1963.2	2159.5	2375.5	2613.0

Of the amounts authorized, eight percent are designated for support of high-risk, high-payoff research to be selected by technical program managers at each agency.

Section 3 authorizes NSF to carry out a grant program for awards to scientists and engineers at the early stage of their careers in academia or in nonprofit research organizations. The NSF's existing Faculty Early Career Development (CAREER) program may be designated as the mechanism for awarding these grants. The awards will go to outstanding researchers at the beginning of their careers and are intended for individuals from a variety of types of institutions, including minority serving institutions. The grants provide five years of research funding support at a minimum of $80,000 per year per award.

NSF is required to designate at least 3.5 percent of funds appropriated for Research and Related Activities to the grant program for each of FY 2008 through FY 2012.

Section 4 authorizes DOE to carry out a grant program for awards to scientists and engineers at the early stage of their careers in academia or in nonprofit research organizations to conduct research in fields relevant to the mission of DOE. The awards will go to outstanding researchers at the beginning of their careers and are intended for individuals from a variety of types of institutions, including minority serving institutions. The grants provide five years of research funding support at a minimum of $80,000 per year per award, and priority shall go to proposals involving collaborations with researchers at DOE national laboratories.

Authorizes to DOE $25 million for each year for FY 2008 through FY 2012.

Section 5 directs NSF to allocate at least 1.5 percent of the amounts appropriated for Research and Related Activities to the Integrative Graduate Education and Research Traineeship (IGERT) program, which provides support for graduate students in fields relevant to national needs. It requires NSF to coordinate with other agencies to expand the interdisciplinary nature of the IGERT program and authorizes NSF to accept funds from other agencies to carry out the program.

Section 6 establishes the Presidential Innovation Award presented periodically, on the basis of recommendations from the Director of the Office of Science and Technology Policy, to citizens or permanent residents of the U.S. who develop unique scientific or engineering ideas judged to stimulate scientific and engineering advances in the national interest, to illustrate the linkage between science and engineering and national needs, and to provide an example to excite the interest of students in science or engineering professions.

Section 7 establishes a National Coordination Office for Research Infrastructure under the Office of Science and Technology Policy to identify and prioritize deficiencies in research facilities and instrumentation in academic institutions and national laboratories and to make recommendations for use of funding authorized. The funds authorized are to be used for competitive, merit-reviewed projects for construction and maintenance of research facilities, including instrumentation, computing and networking equipment and other physical resources. Authorizes $333 million per year for NSF for FY 2008 through FY 2012, and $167 million per year for the Department of Energy for FY 2008 through FY 2012.

Section 8 authorizes NSF, in carrying out its research programs on science policy and the science of learning, to support research on the process of innovation and the teaching of inventiveness.

○