Tying the Ribbon: Science, Technology, Engineering, Mathematics (STEM) and the Future of the Defense Industrial Base

Dr. Patricia Falcone
Assistant Director, National Security Office of Science and Technology Policy

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Office of Science and Technology Policy

- Science and technology for policy
- Policy for science and technology
Innovation for National Security is a Presidential Priority

“Reaffirming America’s role as the global engine of scientific discovery and technological innovation has never been more critical ... Our renewed commitment to science and technology ... will help us protect our citizens and advance U.S. national security priorities.”

National Security Strategy, May 2010
“How then is America to maintain, or preferably enhance, the future standard of living of its citizenry? The answer (and seemingly the only answer) is through innovation.

Innovation commonly consists of being first to acquire new knowledge through leading edge research; being first to apply that knowledge to create sought-after products and services, often through world-class engineering; and being first to introduce those products and services into the marketplace through extraordinary entrepreneurship. “

Rising Above the Gathering Storm, Revisited – Rapidly Approaching Category 5 (2010)
Innovation and National Security

A track record of success….

… new challenges and threats in the future
“We know what it takes to compete for the jobs and industries of our time. We need to out-innovate, out-educate, and out-build the rest of the world.”

President Obama
January 25, 2011
President’s Strategy for American Innovation

Innovation for Sustainable Growth and Quality Jobs

Catalyze Breakthroughs for National Priorities

Spur Productive Entrepreneurship and Promote Efficiency

Invest in the Building Blocks of American Innovation

http://www.whitehouse.gov/innovation/strategy

- Unleash a clean energy revolution
- Accelerate biotechnology, nanotechnology, and advanced manufacturing

- Encourage high-growth and innovation-based entrepreneurship
- Promote innovative, open, and competitive markets

- Educate Americans with 21st century skills and create a world-class workforce
- Strengthen and broaden American leadership in fundamental research
Focusing on Strategy Elements

1. Invest in the Building Blocks of American Innovation
   - Catalyze Breakthroughs for National Security
   - Spur Productive Entrepreneurship and Promote Efficiency
   - Educate Americans with 21st century skills and create a world-class workforce
   - Strengthen and broaden American leadership in fundamental research
A world class workforce

- Scientifically literate public
- Adept in the modern global economy
- Plenty of scientists and engineers
First university degrees in natural sciences and engineering, selected countries

Thousands


China
US
Japan
S Korea
UK
STEM Doctoral Degrees Awarded to Foreign Students (2007)

- Physical Sciences: 46%
- Mathematics: 52%
- Computer Science: 57%
- Engineering: 63%
Science and Engineering Degrees Awarded to US Citizens & Permanent Residents

By Type, Ethnicity, and Gender-- 2006

High School Graduates
Total: 3,115,220
- Minority Men: 14%
- Minority Women: 15%
- Non-Minority Men: 34%
- Non-Minority Women: 37%

First-time Freshmen
Total: 1,903,400
- Minority Men: 11%
- Minority Women: 14%
- Non-Minority Men: 35%
- Non-Minority Women: 40%

First-time Freshman Interested in S&E
Total: 928,000
- Minority Men: 11%
- Minority Women: 13%
- Non-Minority Men: 41%
- Non-Minority Women: 35%

S&E Bachelor's Awarded
Total: 455,441
- Minority Men: 6.9%
- Minority Women: 6.8%
- Non-Minority Men: 53.6%
- Non-Minority Women: 32%

MS Natural Science & Engineering
Total: 43,104
- Minority Men: 7.7%
- Minority Women: 4.9%
- Non-Minority Men: 53.6%
- Non-Minority Women: 32%

PhD Natural Science & Engineering
Total: 11,189
- Minority Men: 3.6%
- Minority Women: 3.1%
- Non-Minority Men: 70.5%
- Non-Minority Women: 20.3%

PhD Engineering
Total: 2,380
- Minority Men: 6%
- Minority Women: 4.5%
- Non-Minority Men: 70.5%
- Non-Minority Women: 20.3%

Non-Minority = White & Asian
Minority = Black/African American, Hispanic, and Native American

Figure courtesy of the Office of Naval Research
Demographics at the top of the pyramid

**S&E Bachelor’s Awarded**
- Total: 455,441
- 6.9% Computer Science, Math, Engineering, Biological and Physical Sciences
- 10.4% All Disciplines

**BS Engineering**
- Total: 60,466
- 7.7% Computer Science, Math, Engineering, Biological and Physical Sciences
- 6.8% All Disciplines
- 53.6% 42.2%
- 32% 40%

**MS Natural Science & Engineering**
- Total: 47,770
- 7.7% Computer Science, Math, Engineering, Biological and Physical Sciences
- 6.8% All Disciplines
- 58% 29.7%
- 3.3% 65.2%

**MS Engineering**
- Total: 17,461
- 11.9% Computer Science, Math, Engineering, Biological and Physical Sciences
- 3.3% All Disciplines
- 19.5% 65.2%
- 6.8% 3.3%

**PhD Natural Science & Engineering**
- Total: 11,189
- 4.5% Computer Science, Math, Engineering, Biological and Physical Sciences
- 1.9% All Disciplines
- 58.8% 33%
- 20.3% 6.8%

**PhD Engineering**
- Total: 2,380
- 3.1% Computer Science, Math, Engineering, Biological and Physical Sciences
- 6% All Disciplines
- 70.5% 20.3%
- 6% 3.1%

**Scale: 1/4,700**

**Figure courtesy of the Office of Naval Research**
Our STEM priorities

• Increasing STEM literacy so all students can think critically
• Improving the quality of math and science teaching from kindergarten through college based on new knowledge about learning and brain function
• Expanding educational success and representation in all parts of the science and engineering workforce of underrepresented groups, including women and minorities
Expanding best practices

Informal Science

Design and test of paper bag kites at the White House Easter Egg Roll
Instructions at HowToSmile.org

AP Training and Incentive Programs
U Teach Program
Young Leaders Initiative for Military Families

Great Teaching; Inspired Learners; A Committed Nation
A Public-Private Partnership
Improving teaching

“Major advances have yielded a consistent picture of how to best learn to think like a scientist or engineer”

Carl Wieman – Nobel Prize winner; college science teaching innovator; OSTP Associate Director for Science
Increasing numbers and representation

President with Google Science Fair Winners
October 7, 2011

First Lady at National Science Foundation
Family-Friendly-Policies Event
September 26, 2011
Focusing on Strategy Elements

1. Invest in the Building Blocks of American Innovation
2. Catalyze Breakthroughs for National Security
   - Spur Productive Entrepreneurship and Promote Efficiency
   - Quality Jobs and a Prosperous and Strong Nation
Our competitors are investing

Globalization of R&D and emerging centers-of-excellence around the world

698 billion yuan equals $108 billion U.S.
Source: China Science & Technology Statistics Data Book
Credit: Christina Baird/NPR

From NSF, Science and Engineering Indicators, 2010
Between Invention and Commercialization

Innovation Program to Bridge the Valley of Death

Adapted from Dr. Deborah Jackson, 2011
Bridging the *Missing Middle*

The *Missing Middle* – a gap in access to capital or other key resources at a crucial step in the development of new businesses or new technology.

The gap often occurs at the stage of development where opportunity and uncertainty are both high, or where there is little marketplace interest such as for capabilities exclusively for national security applications.
Currently, research and invention occurs in a rich science and technology (S&T) ecosystem of performers

- **Defense S&T**
  - Government S&T
    - Industry (large)
      - Funded R&D
      - IRAD
  - Defense S&T
    - Industry (small)
      - SBIR
      - VC

- **US & Global S&T**
  - Laboratories

- **Universities**

- **NGOs**

- **Application Centers**

- **Health ?
  - Quality ?
  - Climate ?
The Role of Young, High-Growth Firms

Young Firms Account for the largest Share of Job Creation

What to Do?
• focus on creating new firms
• remove barriers to emergence of high-growth companies
• target areas that are resources for high-growth firms: immigrants and universities

Source: Kauffman Foundation
Net Job Creation within Startups and without Startups

• **High-growth firms or “gazelles”** account for a disproportionate share of job creation in any given year, generating roughly 40 percent of new jobs in any given year.

• **The fastest-growing young firms** (between the ages of three and five) account for less than 1 percent of all companies in the economy, yet generate 10 percent of new jobs each year.

Revitalizing American Manufacturing

Advanced Manufacturing Partnership:
• National Robotics Initiative
• Materials Genome Initiative
• PCAST Report on Advanced Manufacturing
• Public-Private Partnerships in Manufacturing
• Defense Manufacturing and Industrial Base Investments

http://www.whitehouse.gov/administration/eop/ostp/pcast/amp
Government Procurement as a Catalyst


Strengthening the Defense Industrial Base
Shrinking the Missing Middle for Prosperity and Strength

Existing Research Resources

Existing Commercialization Resources

Prizes and Challenges

Lab-to-Market

Small Business Programs

Early Procurement

Startup America

Manufacturing Initiatives

Adapted from Dr. Deborah Jackson, 2011
Many Challenges Remain