Why Should DoD Invest in Basic Research?

A Presentation for

The 9th Annual NDIA Science & Engineering Technology Conference/DoD Tech Exposition

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Deputy Under Secretary of Defense
(Laboratories and Basic Sciences)
Office of the Director
Defense Research and Engineering,
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Context

- The growth rate of the world population is declining
- 90% of population growth is in developing and poorer countries
- 40% of the world’s population – 2.5 billion people – live on less than $2 per day
- Proportion of working age adults (15-59) is expected to decrease in every area except Africa
- 880 million people were illiterate, 250 million children worked and 110 million school age children did not attend school, as of 2000

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007,
Context

• By 2030, China is expected to have 348 million people over 60, nearly as many as the entire projected population of the US.

• 13% of the global population lived in cities in 1900. Today the global proportion of the urban population is 49%. 60% of the globe’s population - 4.9 billion people - will live in urban areas by 2030.

• Massive urbanization – 17 of 22 “mega cities” will be in the developing world by 2015.

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007,
Context

- Since the 1970’s, weather/climate-related losses have increased about 10% per year and accounted for 88% of all property losses covered by insurers from 1980 to 2005
- India and China will develop “first world” energy appetites
- Many oil exporting countries may use production for their own economies

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007
Context

- Current major supplies of petrochemical products will not keep pace with projected demand
- Only 12 years from now, machine intelligence could equal or surpass that of humans – eventually, it will become impossible to differentiate between man and machine
- Weapons of mass effect will shrink and proliferate: nuclear, bio, directed energy, nanotechnology, and CYBER

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007
Context

• Science, technology, and engineering are available globally
• US scientific leadership is at risk
• Multi-disciplinary technologies will have revolutionary impact - 70% of world R&D is conducted outside the US
• China is now the third largest investor in R&D (adjusted for purchasing power), behind only the US and Japan

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007
Context

- The United States is today a net importer of high technology products (+$54B in 1990 to -$50B in 2001)

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007
OUTLINE

• DoD Basic Research

• DoD STEM Education

• Prize Competition
Leaders support Basic Research

• President Bush:

“…double federal support for critical basic research in the physical sciences…”

• The Secretary of Defense supports Basic Research

“… greater emphasis on basic research, which in recent years has not kept pace with other parts of the budget.”
Basic Research

- Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts *without specific applications towards processes or products in mind.*

*It is farsighted high payoff research that provides the basis for technological progress.*

Why Does DoD fund Basic Research?

• DoD is perpetually, permanently in the capability business
• By design, DoD’s capabilities depend on technology
• Technology is the fruit of science
• Basic Research produces the new, transcendent ideas
• Threats are multiplying, ramifying
• Science is burgeoning outside the US, spawning new technologies
• Technologies move rapidly across borders
• If technology exists, it will be used, first in weapons

*We cannot know when a discovery will become a capability but we know with absolute certainty that without discovery, our capabilities remain static.*
Why Does DoD fund Basic Research?

• Generates discoveries, new knowledge, and improved understanding
• Achieves technological superiority
• Prevents technological surprise
• Educates scientists and engineers in physical science disciplines
• Ensures that scientific expertise and engineering rigor supports DoD technical decisions
• Sustains the human talent and research infrastructure
Don't expect Basic Research to solve all problems
DoD S&T Requests

Note: Advanced Technology Development funding began in FY78
DoD Basic Research Funding FY1998-2009

( President’s Budget Request & Appropriated )

Appropriated

+28%

Requested

FY08 Constant Dollars (in Millions)

Source: DOD, DDR&E
RDT&E Budget Request Growth

FY09 Compared to FY08

(TY Dollars in Millions)

<table>
<thead>
<tr>
<th>BA-1</th>
<th>BA-2</th>
<th>BA-3</th>
<th>BA-4</th>
<th>BA-5</th>
<th>BA-6</th>
<th>BA-7</th>
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<tbody>
<tr>
<td>+271</td>
<td>-102</td>
<td>+543</td>
<td>+112</td>
<td>+1,439</td>
<td>+231</td>
<td>+2,185</td>
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</table>
RDT&E Budget Request Growth

FY09 Compared to FY01

(TRY Dollars in Millions)

BA-1 +482
BA-2 +1,111
BA-3 +2,350
BA-4 +8,964
BA-5 +10,876
BA-6 +1,746
BA-7 +16,046

FY09 Compared to FY01
FY08 & 09 DoD 6.1 Budget Request

Source: DOD, DDR&E
Sources & Destinations of Defense Basic Research Funding

**Sources**: 80% of Defense Basic Research is Investments by Military Departments

- **Army**: 22%
- **Navy**: 31%
- **DARPA**: 12%
- **DTRA**: 1%
- **CBD**: 80%
- **Industry**: 12%
- **Non-profits, Other**: 2%
- **FFRDCs**: 1%
- **Universities**: 53%
- **Intramural**: 7%
- **Industry**: 25%
- **OSD**: 4%
- **Air Force**: 27%
- **DTRA**: 1%
- **CBD**: 3%
- **DARPA**: 12%

**Destinations**

Performers of Defense Basic Research - 65% to Universities & Industry

- **Universities**: 53%
- **Industry**: 12%
- **Non-profits, Other**: 2%
- **FFRDCs**: 1%
- **Intramural**: 7%
- **Industry**: 25%
- **OSD**: 4%
- **Air Force**: 27%
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Sources: FY09 President’s Budget & DoD component inputs to NSF Federal Funds for R&D survey (FY06 - latest available)

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Recipients of DoD S&T Funds

*Includes non-profit institutions, State & local govt., & foreign institutions

Source: National Science Foundation Report (PBR08)
FY09 President’s Budget Request for DoD Basic Research

- Defense Research Sciences
- University Research Initiatives
- National Defense Education Program
- University & Industry Research Centers

$K

0 50,000 100,000 150,000 200,000 250,000 300,000 350,000 400,000 450,000

Chem/bio

DTRA

OSD

DARPA

Air Force

Navy

Army

ILIR

6.1

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Conceptual Strategic Planning Process

Joint Operational Capability Gaps

Not all joint operational capability gaps will have S&T capability gaps

Joint S&T Capability Gaps

QDR, SPG

Joint, Basic Research investment gaps

Map S&T Gaps Against Services’ Basic Research Programs

Extant Service specific Basic Research program

Some Service basic research initiatives address enterprise-wide issues

Department-level Basic Research Investment Guidance

Joint, Basic Research investment gaps

Not all joint S&T capability gaps will demand basic research investment

Some Service basic research initiatives address enterprise-wide issues

Unclassified

Classified

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Quadrennial Defense Review

Traditional

Irregular

Defeat
Terrorist
Extremism

"Shifting Our Weight"

Catastrophic

Counter
WMD

Defend
Homeland

Shape
Choices

Disruptive

Today’s Capability
Portfolio
Desired S&T Investment Areas

(Joint Training is Ubiquitous)
FY07 DoD Basic Research
(by Taxonomy Category)

Total
$1.548B
### Addition to DoD Basic Research

<table>
<thead>
<tr>
<th></th>
<th>FY08 PBR</th>
<th>FY08 Appropriation</th>
<th>FY09 PBR</th>
<th>Change from PBR 08</th>
<th>Real Change from PBR 08</th>
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</thead>
<tbody>
<tr>
<td><strong>Army</strong></td>
<td>305.8</td>
<td>381.5</td>
<td>379.4</td>
<td>24.06%</td>
<td>21.36%</td>
</tr>
<tr>
<td><strong>Navy</strong></td>
<td>467.2</td>
<td>506.1</td>
<td>528.3</td>
<td>13.06%</td>
<td>10.61%</td>
</tr>
<tr>
<td><strong>Air Force</strong></td>
<td>375.2</td>
<td>407.7</td>
<td>452.3</td>
<td>20.55%</td>
<td>17.93%</td>
</tr>
<tr>
<td><strong>Defense-Wide</strong></td>
<td>279.9</td>
<td>338.3</td>
<td>338.7</td>
<td>21.00%</td>
<td>18.37%</td>
</tr>
<tr>
<td><strong>Total Basic Research</strong></td>
<td>1,428.1</td>
<td>1,633.7</td>
<td>1,698.6</td>
<td>18.94%</td>
<td>16.36%</td>
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</table>
OUTLINE

• DoD Basic Research

• DoD STEM Education

• Prize Competition
A Unique National Security Problem

HIGH

Quality

LOW

Job Applicants

Desired Employees

Clearable at highest level

Clearability

Not Clearable
Opportunities

• “The development of a strategic S&T scouting effort linked to the US university and private

“When I compare our high schools to what I see when traveling abroad, I am terrified for our workforce of tomorrow.”

- Bill Gates

technology, and engineering education in the United States.”

Rising Above the Gathering Storm, National Academy of Sciences, 2006.
Millennials are tomorrow’s workforce

• They watch wars and revolutions live on TV and the Internet
• Elvis died 20 years before they were born
• Satellite radio has been around since they were 5 years old
• They have only known two presidents
• WWI started nearly a century before they were born
• They have never seen a film camera
• There have always been hybrid cars

Source: “Millennial: About them” Navy Recruiting Command briefing, 7 Feb 2008
Millennials are tomorrow’s workforce

- They have always been online
- They have never known a world without digital phones or DVDs
- Soviet Union fell 7 years before they were born
- When Sputnik was launched, their parents were in kindergarten
- Their buddy lists span the globe.
- There has always been one Germany
- One electronic device does it all: TV, Internet, Phone, Music, Data, Computing

Source: “Millennial: About them” Navy Recruiting Command briefing, 7 Feb 2008
Globalism

• Millennials grew up seeing everything in the world as:
  – Global
  – Connected
  – Open for business 24/7

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008
Millennials are tomorrow’s workforce

• They are taking longer to graduate from college

• Only 37% of first-time freshmen at four-year schools earned their bachelor’s degrees in four years

• Another 6% took up to six years

Source: “Millennial: About them” Navy Recruiting Command briefing, 7 Feb 2008
Millennials are tomorrow’s workforce

- They are technology sophisticates
- Through media multitasking kids are spending 6.5 hours a day with media, but are packing more than 8.5 hours worth of exposure into that time

Younger kids have more and more media devices; of those 8-14 years old -
- 39% have cell phones
- 24% have a hand-held Internet device or PDA
- 12% have a laptop computer

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008
NDEP Portfolio Components

Pre-College (K-12)
- DoD Comm
- DoDEA
- Air Force
- Other Gvmt
- Digital Delivery
- Other Org’s
- STAR BASE
- Navy
- Math Content

Undergraduate Graduate
- DoD Employees
- DoDEA
- Other Org’s
- STAR BASE
- Navy
- Math Content

Post-Graduate
- NSSEFF
- DoD Affiliated Faculty

STEM Interest…
Potential DoD Employees

DoD Employees

Navy
Air Force
Other Gvmt
DoDEA
DoD Comm
Digital Delivery
Other Org’s
STAR BASE
Math Content

SMART

PEP
SLM
Note: Student awards (by state of residence)
NDSEG – Fellows’ Undergraduate Schools

As percentage of fellows selected for given year, with respect to FY07 top numbers
NDSEG – Fellows’ Graduate Schools

As percentage of fellows selected for given year, with respect to FY07 top numbers

KEY:

2004 Data
2005 Data
2006 Data
2007 Data

MIT
Stanford
Harvard
UC Berkeley
Princeton
Carnegie
U of MI
CalTech
Nwestern
U of IL Urbana
OUTLINE

• DoD Basic Research

• DoD STEM Education

• Prize Competition
Wearable Power Prize

- **1st Prize** $1M, **2nd prize** 500K, **3rd prize**: $250K
- Goal: Reduce weight of Warfighters’ power systems
- Competitors will produce prototypes that provide 20W average electric power continuously for 4 days, attach to a vest, and weigh 4 kg or less
- Capstone event will be held on October 4th, 2008, at the Marine Corps Air-Ground Combat Center, Twentynine Palms, California. See: [http://www.dod.mil/ddre/prize](http://www.dod.mil/ddre/prize)
Wearable Power Prize Team Registrations

169 Teams Registered
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