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DoD STEM Education Strategy

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Outline

- **Why DOD is involved in STEM education**
- **DoD assets**
- **Coalition model**
- **Maryland pilot project**
- **Potential partnerships**



Problem Overview

What we care about, and why...

Assure High Quality Science, Technology, Engineering and Mathematics Workforce.

***Science and Technology provides
a vital force multiplying effect &
US "battlefield" advantage***

Sustaining U.S. Leadership in S&T requires

- ***World Class Technical Talent***
- ***State-of-the-Art Infrastructure***
- ***A Dynamic Innovation System***

***If the US loses its Technology Advantage --
National and Economic Security are At Risk***



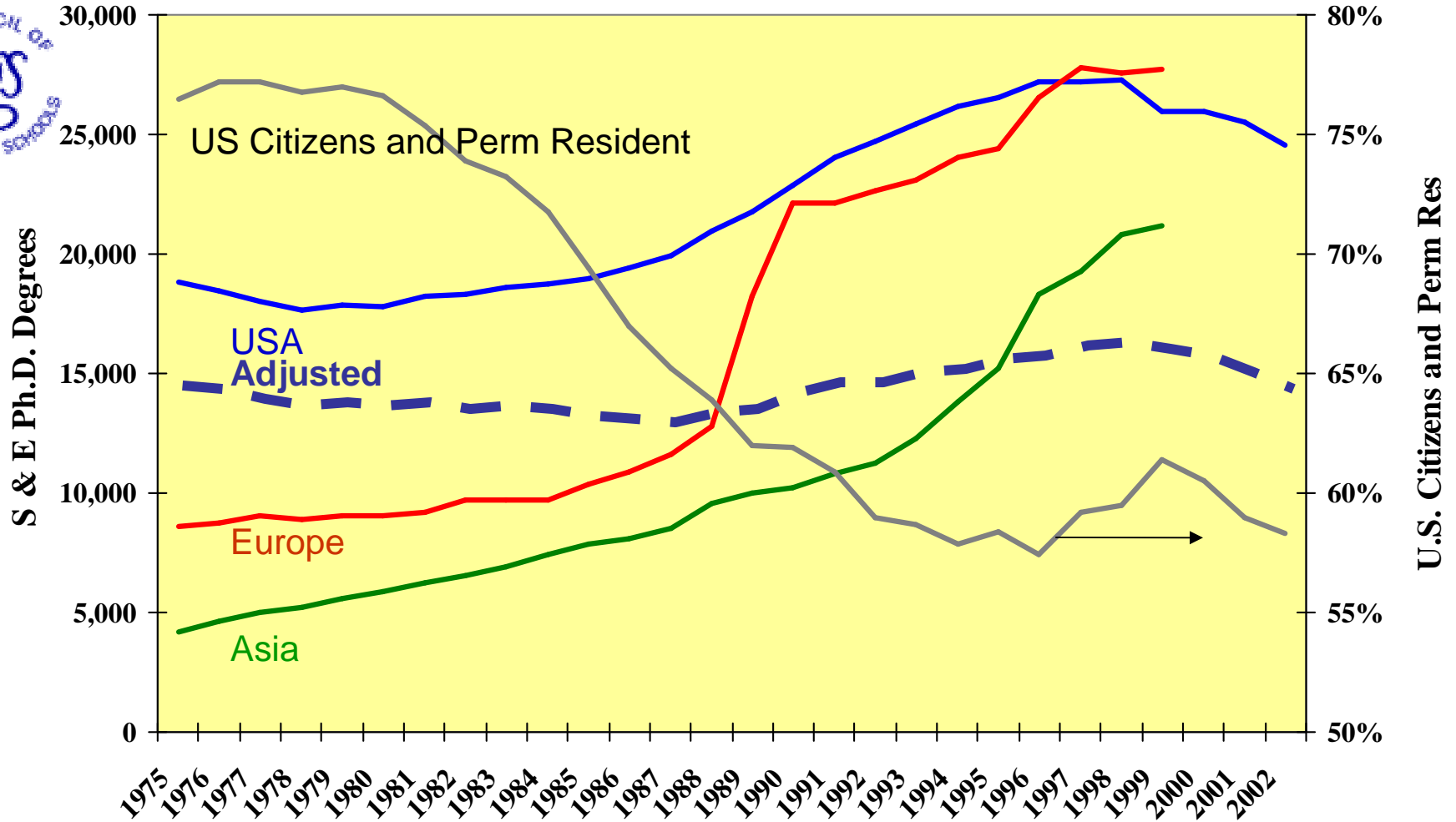
A National Issue

12 major studies (1999-2006) have pointed up key U.S. vulnerabilities in science, technology, engineering, and mathematics (STEM)

- **Under-performance of K-12 education**
- **Stimulating interest in STEM disciplines/careers**
- **Attrition in post-secondary STEM education**
- **Graying of the workforce**



Doctoral S&E Degrees by World Region



Council of Graduate Schools

— USA — Europe — Asia — % US Citizens

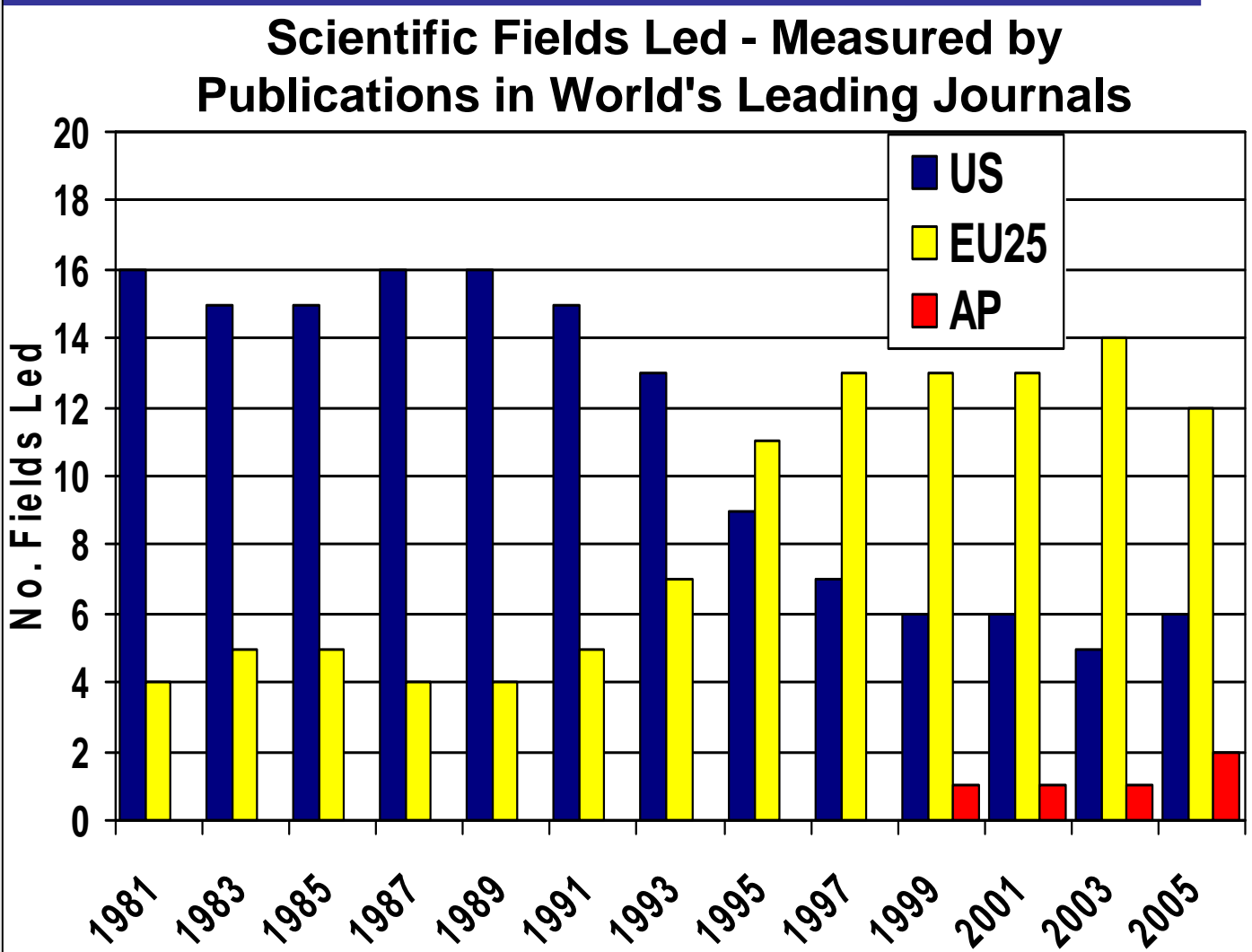
www.cgsnet.org⁵

Source: NSF Science and Engineering Indicators



World Technology Leadership

- 20 Technology Areas**
- Agricultural Science ~~-X~~
 - Biology & BioChem
 - Chemistry ~~-X~~
 - Clinical Medicine
 - Computer Science***
 - Ecology & Environment
 - Engineering ~~-X~~
 - Geoscience
 - Immunology***
 - Materials Science ~~-X~~
 - Math
 - Microbiology
 - Molecular Bio & Genetics***
 - Multidisciplinary***
 - Neuroscience***
 - Pharmacology ~~-X~~
 - Physics ~~-X~~
 - Plant & Animal Science
 - Psych & Psychiatry***
 - Space Science
- (*Led by US in 2005)
- X US is third in 3 way race**



From: R. Duane Shelton, Data Source: Thomson Scientific, National Science Indicators, ISI 2006, Copyright retained
 US= United States, EU25= European Union, AP= Asia Pacific

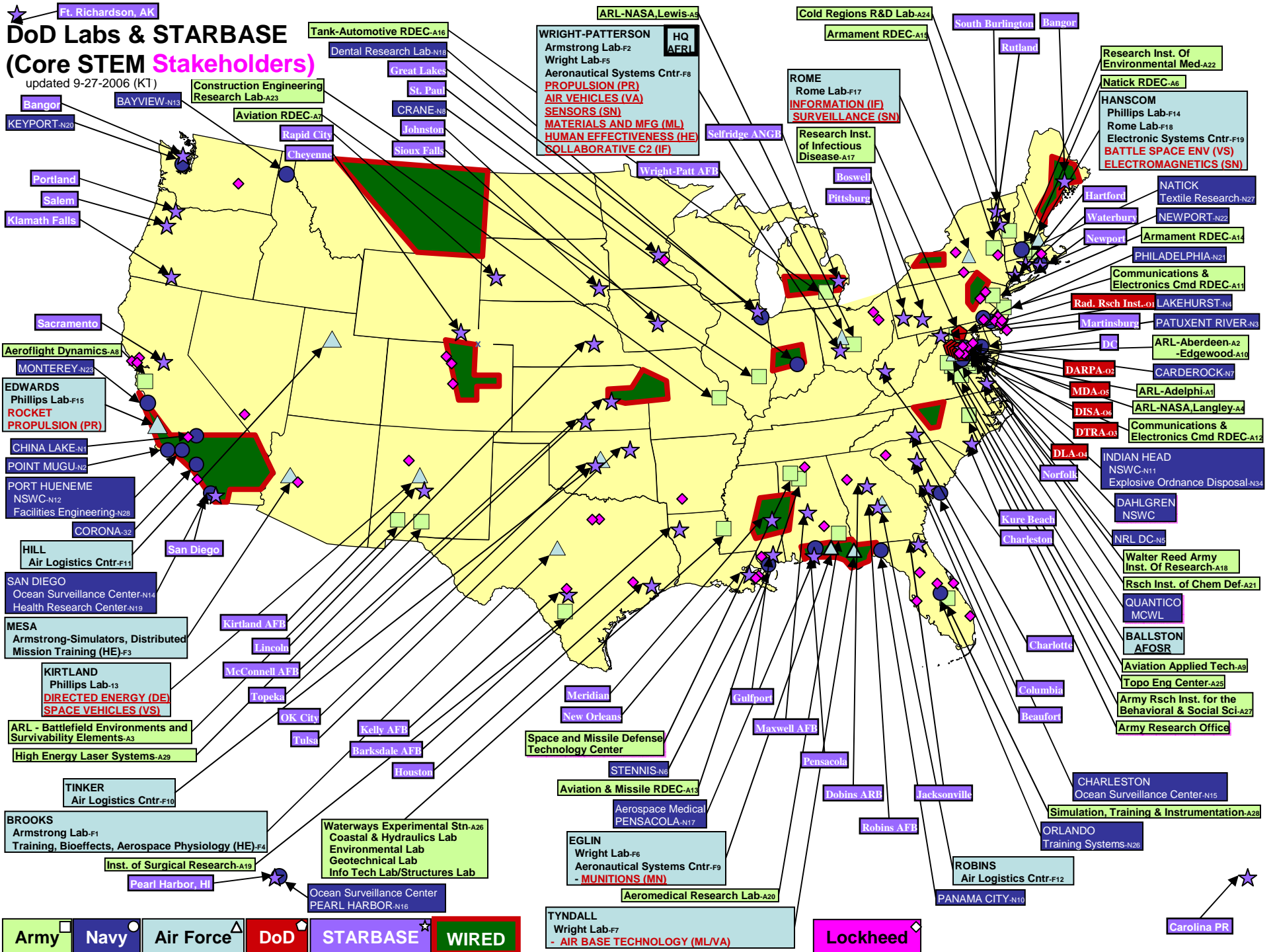


What DoD Brings to the Table

- Cutting edge tools, facilities and experts
- Distributed state-of-the-art research assets
- A large pool of committed STEM volunteers
- Significant industry and university relationships
- Far-reaching Congressional authorization in education and workforce development
- Many ongoing local and national programs
- High level of commitment including resources

DoD Labs & STARBASE (Core STEM Stakeholders)

updated 9-27-2006 (K1)



Army
Navy
Air Force
DoD
STARBASE
WIRED

TYNDALL
 Wright Lab-F7
 - AIR BASE TECHNOLOGY (MLVA)

Lockheed

BANGOR
 KEYPORT-N20

Portland
 Salem
 Klamath Falls

Sacramento
Aeroflight Dynamics-A8
 MONTEREY-N25

EDWARDS
 Phillips Lab-F15
ROCKET
PROPULSION (PR)
 CHINA LAKE-N1
 POINT MUGU-N2
 PORT HUENEME
 NSWC-N12
 Facilities Engineering-N28

CORONA-32
HILL
 Air Logistics Cntr-F11
 SAN DIEGO
 Ocean Surveillance Center-N14
 Health Research Center-N19

MESA
 Armstrong-Simulators, Distributed
 Mission Training (HE)-F3

KIRTLAND
 Phillips Lab-13
DIRECTED ENERGY (DE)
SPACE VEHICLES (VS)
 ARL - Battlefield Environments and
 Survivability Elements-A3
 High Energy Laser Systems-A29

TINKER
 Air Logistics Cntr-F10
BROOKS
 Armstrong Lab-F1
 Training, Bioeffects, Aerospace Physiology (HE)-F4

Pearl Harbor, HI
 Ocean Surveillance Center
 PEARL HARBOR-N16

Tank-Automotive RDEC-A16
 Dental Research Lab-N18

Construction Engineering
 Research Lab-A23
 Aviation RDEC-A7

Rapid City
 Cheyenne

Great Lakes
 St. Paul
 CRANE-N8
 Johnston
 Sioux Falls

Kirtland AFB
 Lincoln
 McConnell AFB
 Topeka
 OK City
 Tulsa

Kelly AFB
 Barksdale AFB
 Houston

Waterways Experimental Stn-A26
 Coastal & Hydraulics Lab
 Environmental Lab
 Info Tech Lab/Structures Lab

Ocean Surveillance Center
 PEARL HARBOR-N16

WRIGHT-PATTERSON
 HQ AFRL
 Armstrong Lab-F2
 Wright Lab-F5
 Aeronautical Systems Cntr-F8
PROPULSION (PR)
AIR VEHICLES (VA)
SENSORS (SN)
MATERIALS AND MFG (ML)
HUMAN EFFECTIVENESS (HE)
COLLABORATIVE C2 (IF)

Selfridge ANGB
 Research Inst. of Infectious
 Disease-A17
 Boswell
 Pittsburg

ROME
 Rome Lab-F17
INFORMATION (IF)
SURVEILLANCE (SN)

Cold Regions R&D Lab-A24
 Armament RDEC-A15

South Burlington
 Rutland
 Bangor

Research Inst. Of
 Environmental Med-A22
 Natick RDEC-A6
HANSCOM
 Phillips Lab-F14
 Rome Lab-F18
 Electronic Systems Cntr-F19
BATTLE SPACE ENV (VS)
ELECTROMAGNETICS (SN)

Natick
 Textile Research-N27
 NEWPORT-N22
Armament RDEC-A14
 PHILADELPHIA-N21
 Communications &
 Electronics Cmd RDEC-A11

Rad. Rsch Inst.-01
 LAKEHURST-N4
 Martinsburg
 PATUXENT RIVER-N3
 DC
ARL-Aberdeen-A12
 Edgewood-A10
CARDEROCK-N7
ARL-Adelphi-A1
ARL-NASA, Langley-A4
 Communications &
 Electronics Cmd RDEC-A15

DARPA-02
MDA-05
DISA-06
DTRA-03
DLA-04
 Norfolk
 INDIAN HEAD
 NSWC-N11
 Explosive Ordnance Disposal-N34

DAHLGREN
 NSWC
 NRL DC-N5
 Walter Reed Army
 Inst. Of Research-A18
Rsch Inst. of Chem Def-A21
QUANTICO
MCWL
BALLSTON
AFOSR
 Aviation Applied Tech-A9
 Topo Eng Center-A25
 Army Rsch Inst. for the
 Behavioral & Social Sci-A27
 Army Research Office

Kure Beach
 Charleston
 CHARLESTON
 Ocean Surveillance Center-N15
 Simulation, Training & Instrumentation-A28

ORLANDO
 Training Systems-N26
 PANAMA CITY-N10
ROBINS
 Air Logistics Cntr-F12

Carolina PR



Strategy

Recognize: Going it alone will continue to achieve marginal gain

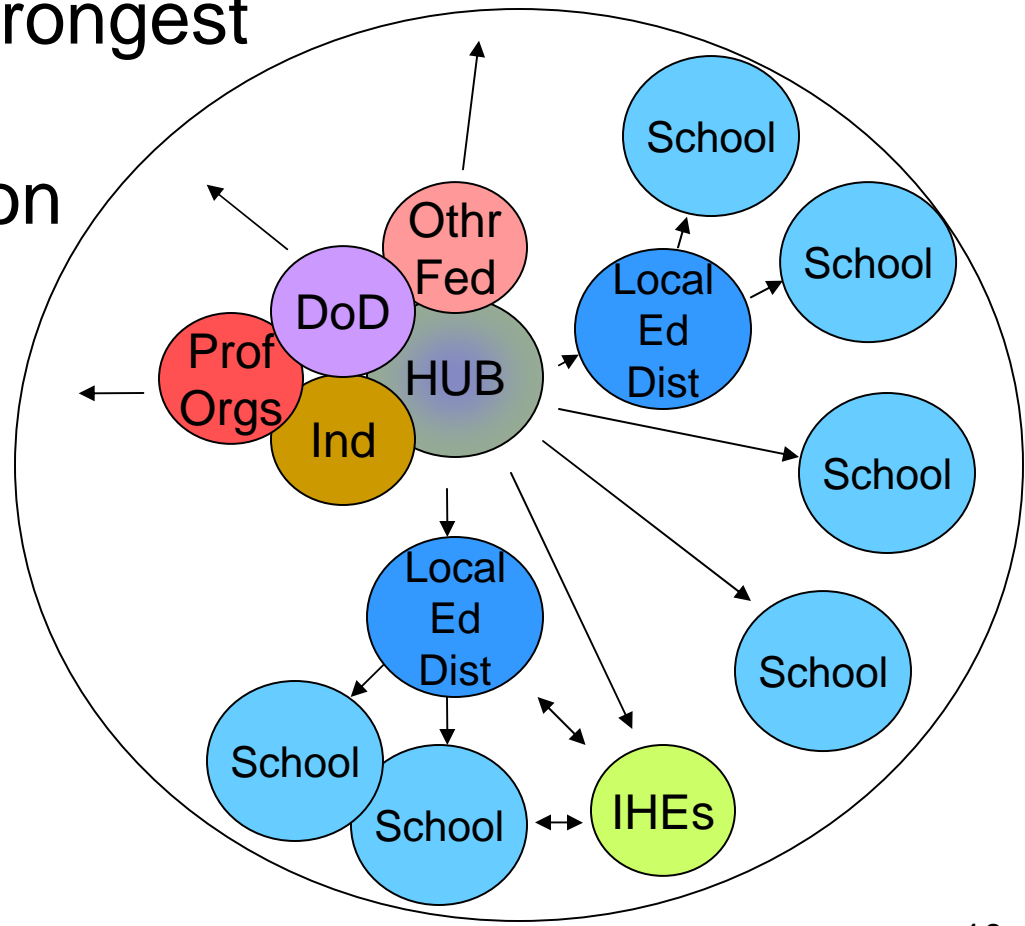
Engage – Collaboratively and Comprehensively

- **Perspective** -- Address the whole Pipeline
 - Identify effective activities at all levels, K-graduate
- **Pathways** – Connect Learning to Life & STEM Careers
 - Link in-school and lab-based opportunities
 - Engage students as they progress through the continuum
- **Partnerships** -- Build Coalitions
 - Industry, State & Local Education Authorities, Educators, Academia, and other Government Agencies
 - Defy the Not-Invented-Here mentality



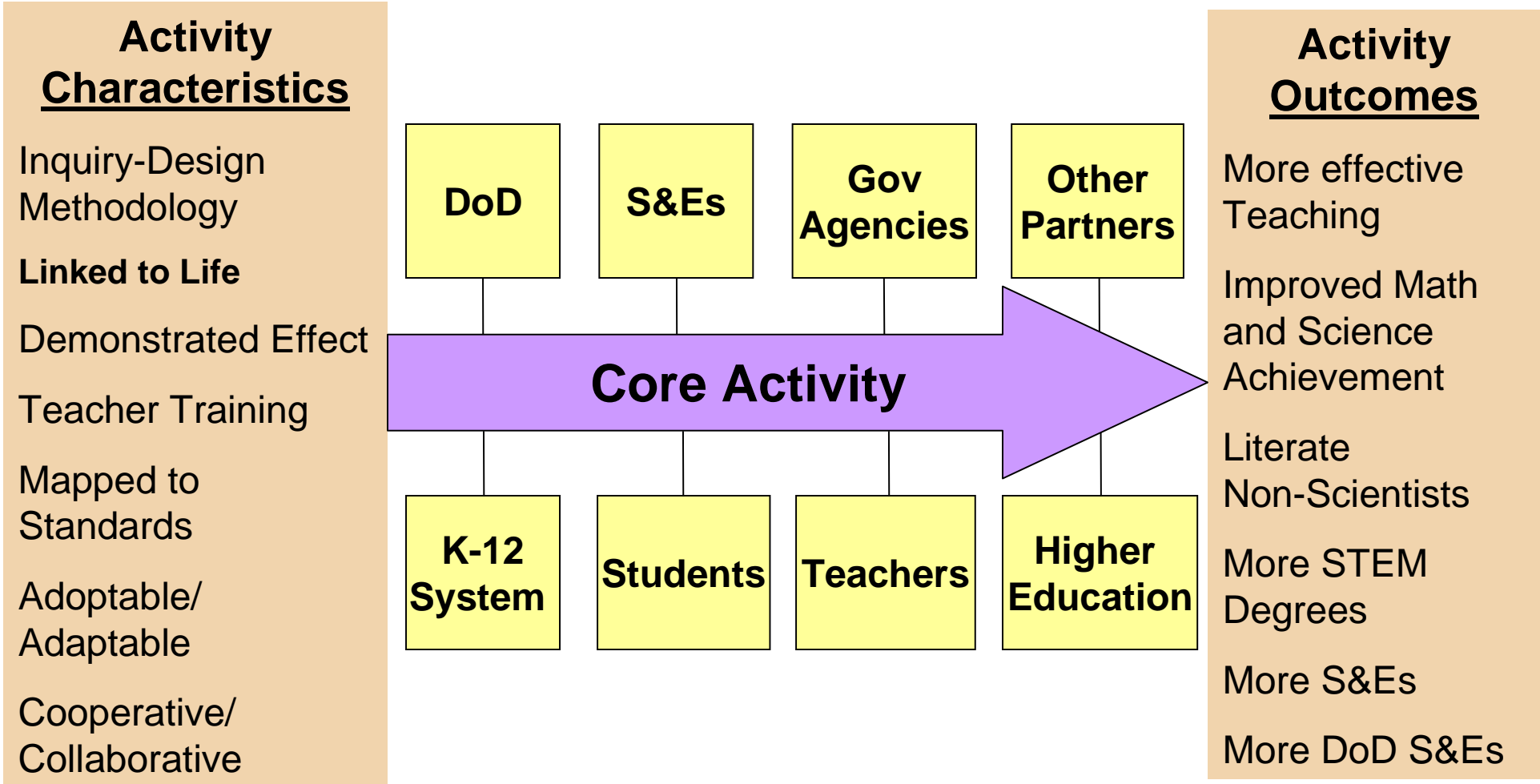
A Model for Outreach/Integration

- HUB & Spoke Interface
 - HUB should be Strongest STEM Presence
 - Easier Coordination
 - Local Meetings
- Comprehensive Delivery
- Critical Mass
- Greater Impact Training Teachers
- Improved ROI For Everybody





Coalition Model





Objectives

- Internal
 - Align assets around a coordinated strategy
 - Identify and Use effective approaches
- External
 - Create momentum around a single, specific effort
 - Foster a national culture of collaboratively engaging in STEM education improvement
 - Recognize, Adopt and Repeat:
No organization can build capacity on the scale that is required on its own – **We Must Work Together**

.....Work Together On What?



One Specific Effort

This effort meets all the criteria:

Materials World Modules

- Interdisciplinary approach to Inquiry-Design Based Instruction
 - Inquiry-Design based approach simulates the methodology used by DOD and Industry to develop technologically advanced products
- Curriculum enhancement developed and refined over 10 years by internationally recognized researcher
- Enables real-world application of textbook concepts
- Mapped to MD Standards (and others)
- Field-tested, evidence-based
- Opportunity for collaboration abounds
- MWM offers far more than just MWM – it's a rally point

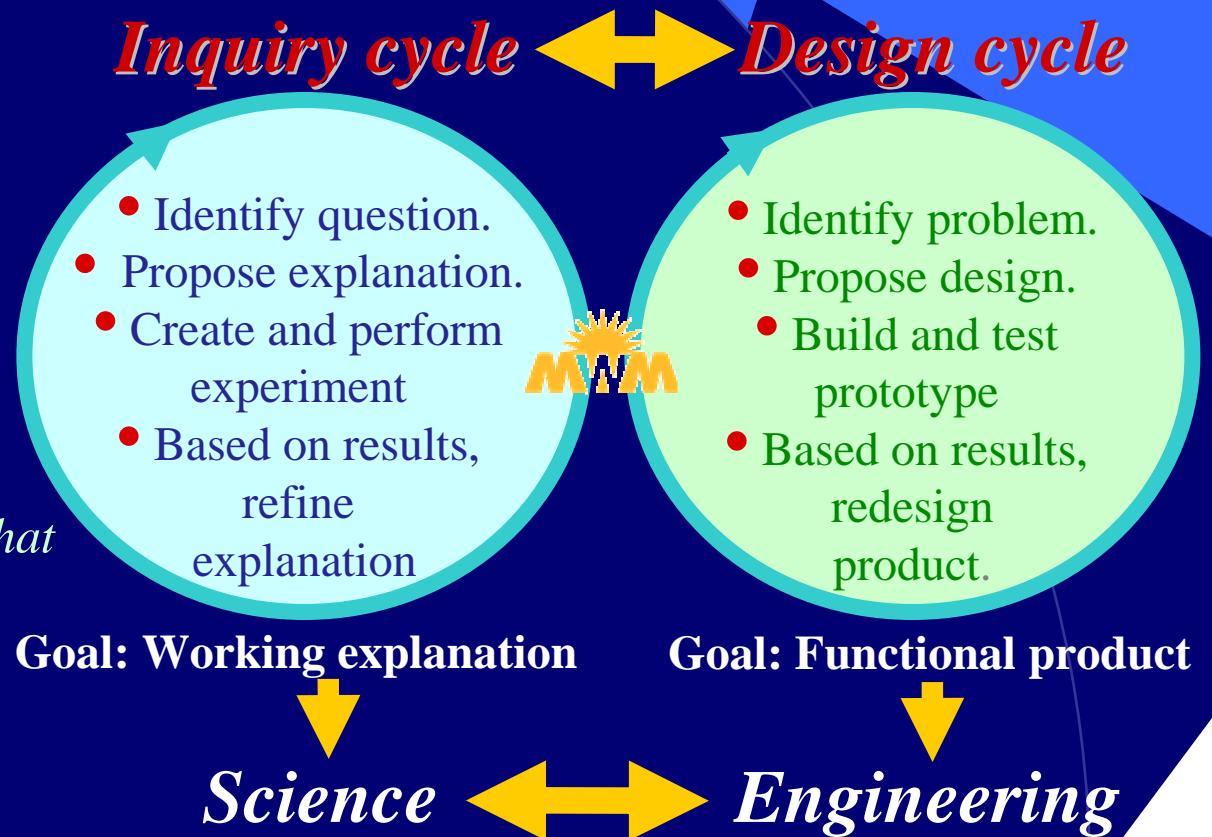


Materials World Modules

Northwestern University Materials World Modules (MWM)

- Secondary School Curriculum
- Pedagogy integrates Inquiry and Design

- Students complete a series of hands-on, *inquiry-based activities* in each module
- Each module culminates in *design challenges*
- Students simulate the work of *scientists* (through activities that foster inquiry) and *engineers* (through activities that emphasize design)





DoD Approach to MWM Scale-Up

- Invest over (3-5) years to establish a sustainable program
- Leverage community college network to disseminate program and train teachers
- Demonstrate that collaboration at scale can occur through regional consortia
- Measure program effectiveness through rigorous evaluation



National Defense Education Program

| PE: 0601120D8Z | FY06 | FY07 | FY08 | FY09 | FY10 | FY11 | 07-11 |
|----------------|------|------|------|------|------|------|-------|
| PR-07 Request | 10.1 | 19.5 | 26.1 | 31.7 | 52.9 | 74.4 | 204.6 |

- National Defense Education Program (NDEP)
 - Addresses identified needs and stimulates holistic approach to improving STEM education (i.e., the entire pipeline)
 - Base program: SMART – comprehensive education and training program offers scholarship/fellowship and employment
- 2007 NDEP Highlights
 - Expansion of SMART scholarship/fellowship awards (~\$14.5M)
 - Expansion of Pre-College enhancement & coordination (~\$5M)
 - Inquiry-Design Based Instruction
 - Materials World Modules



SMART/NDEP Program

National Defense Education Program (NDEP)

Science Mathematics and Research for Transformation (SMART)

- Defense critical disciplines
- Security clearable
- Have & maintain a minimum GPA 3.0 on 4.0 scale
- Civil Service payback required (set at 1 to 1 by policy)
- Scholarship/Fellowship (Associate through Ph.D.)
- Employee status while enrolled
- Comprehensive education and training = shaped workforce
- Post degree follow-up
- ~40 awards in FY06 (30 in FY05)

<http://www.asee.org/smart/>



Partnership Opportunities

- **Leadership**
 - Take the lead near your facility
- **People**
 - Scientists and engineers
 - Partner with and Support classroom teachers
 - Support for after-school efforts
 - Coordination requires a Coordinator
- **Resources**
 - Funding
 - Facilities

**Beginning or Joining such an effort
will bring other collaborative opportunities into view**



Backup



DoD STEM Education Efforts

DoD is engaged in education enrichment activities at every level: K- 20 and Professional Development

Level of Support

Elementary

High School

Undergraduate

Graduate

Post-doctoral

Faculty

Continuing Education

Type of Support

Apprenticeship-Employment

Coop/ Work Study

Equipment Donation

Grants/Stipends

Mentoring/Tutoring

Release Time

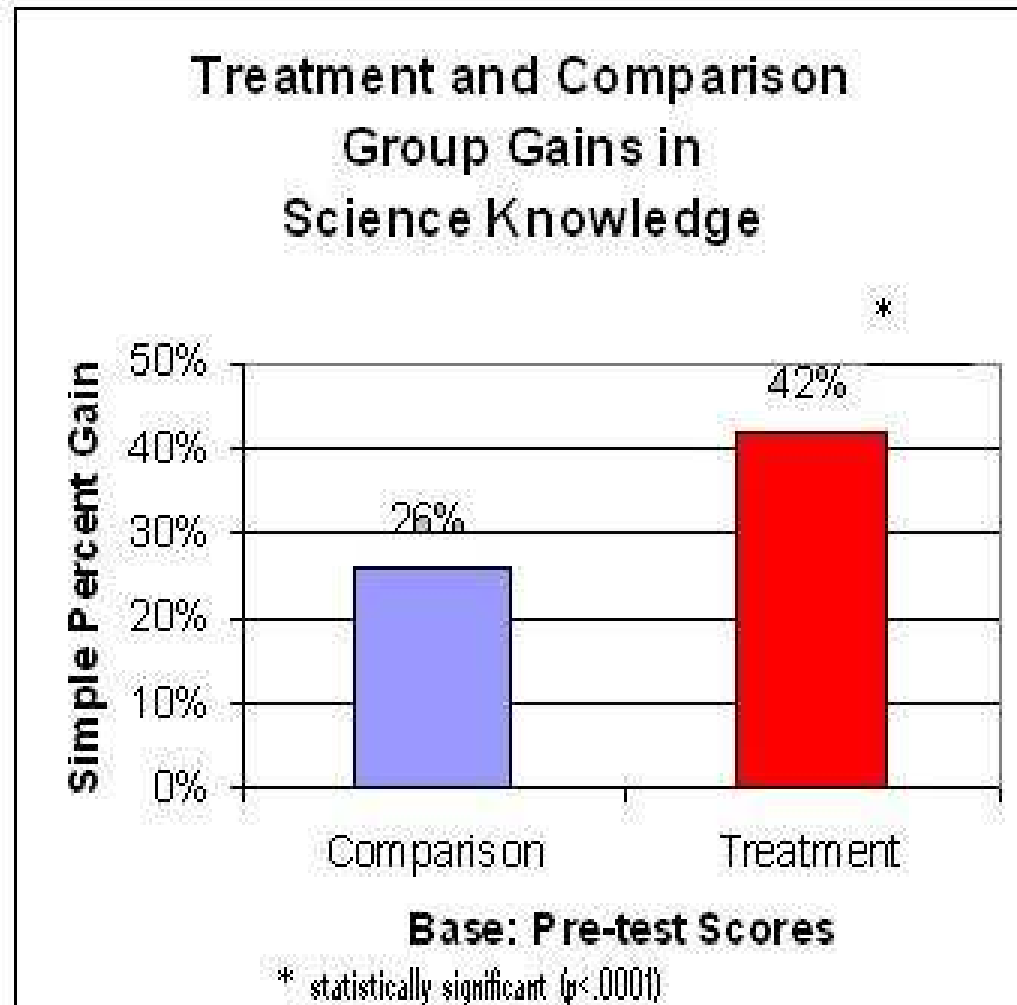
Scholarships/Fellowships

Tuition Assistance



Results of 2006 Summer Institute

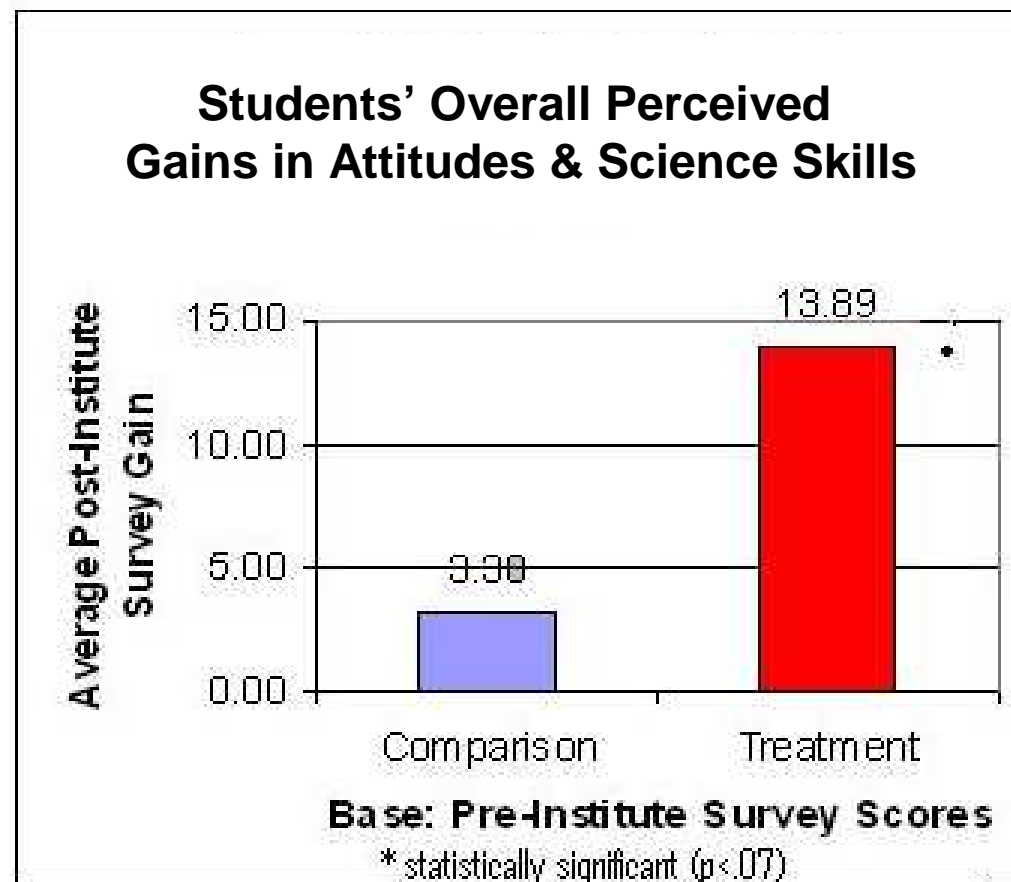
Impressive Gain (62%) over Control in Science Knowledge





More results

High Attitudinal shift





DoD S&E Challenges

- Attrition in DoD labs
- Unfilled needs in critical technologies
- Thinning supply of clearable students acquiring defense-related skills
- Increased competition for the best and brightest

Projected U.S. demand for:

Scientists will be up 17% and

Engineers will be up by 22% by 2014

(November 2005 BLS Monthly Labor Review.)



Rationale For Maryland Pilot

- High concentration of research labs including DoD, NASA, NIH, NIST
- Progressive force in STEM education
- Diverse economy and student population
- Many science and technology-based employment opportunities
- If we can't do it in Maryland...



Goals in Maryland

- Develop an implementation model that can be replicated
- Develop lessons learned that can be applied around the country
- Produce outcomes that capture national attention