Systemic Change in STEM

Department of Energy

Workforce Development for Teachers & Scientists

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Director

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National Mission

National Goal

The Office of Workforce Development for Teachers and Scientists will prepare a diverse workforce of scientists, engineers, and educators to keep America at the forefront of innovation. The Department of Energy will utilize its unique intellectual and physical resources to enhance the ability of educators and our Nation's educational systems to teach science and mathematics.

- **Prepare a diverse workforce of scientists, engineers, and educators to keep America at the forefront of innovation.**
- **Utilize DOE's unique intellectual and physical resources to enhance the ability of educators and our Nation's educational systems to teach science and mathematics.**
- **Implement a proactive, data-driven, and results-focused model that promotes and strengthens the greater STEM education and research community.**

Finding and Training the "Best and Brightest"

- DOE National Laboratories
  - World-class research facilities
  - Conducting state-of-the-art cutting edge research
- Cutting Edge Research Requires Top Scientists
  - Law requires U.S. citizens at the laboratories

U.S. Trains the Workforce of the World

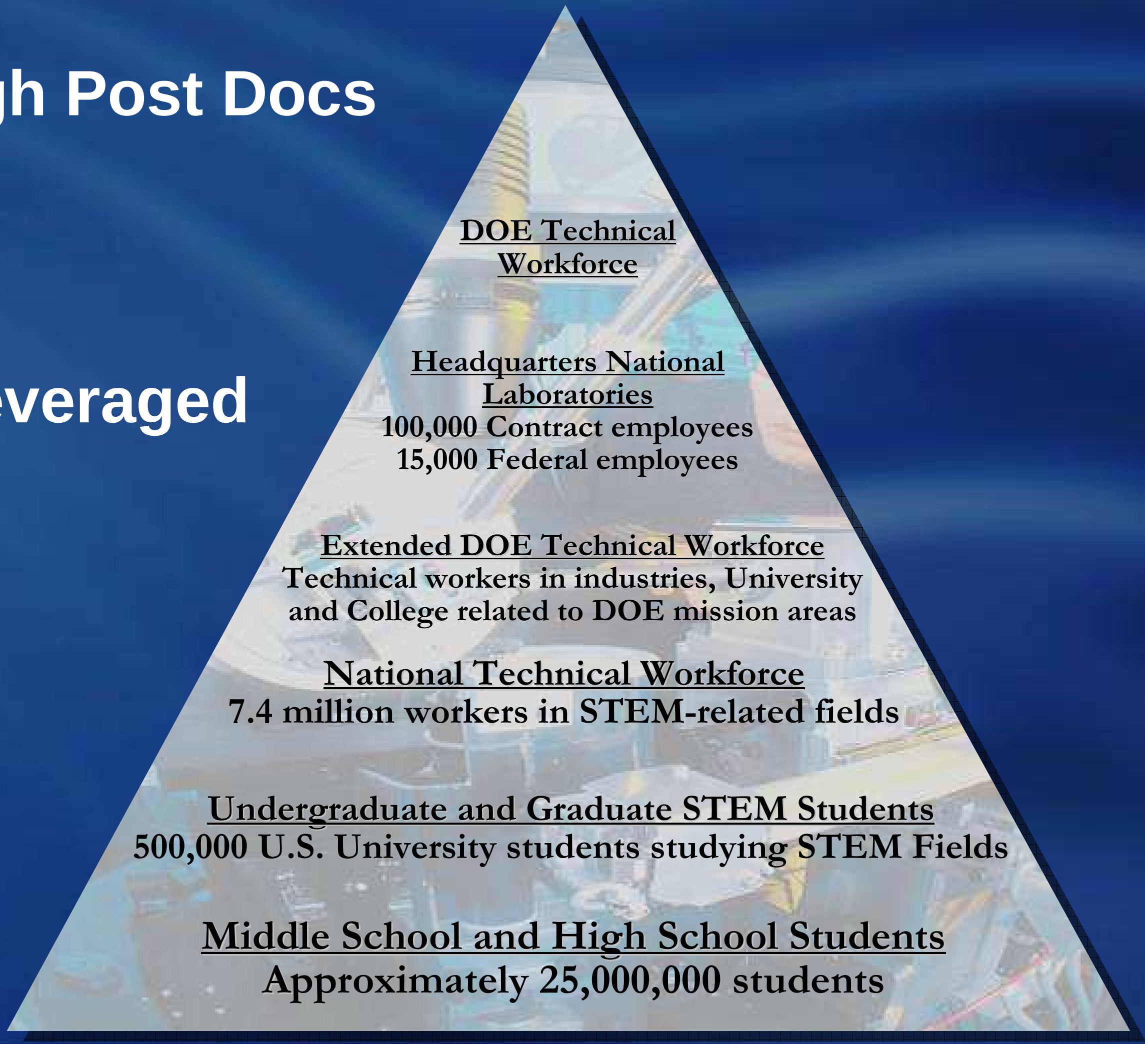
- The U.S. possesses an immense capacity for training the world's scientists
  - Large percentage of research conducted at the university level is by foreign nationals
  - Approximately one third of graduate students in the sciences are foreign nationals
  - The U.S. needs to utilize this capacity with its own citizens
- Large Pool of U.S. Talent to Draw From
  - 3 – 4 % of the U.S. population are involved in STEM-related fields
  - 15 – 20% of the U.S. population is science literate or a science attentive audience
- Other Countries Have Similar Needs for Native-born Scientists
  - Trained in the U.S.
  - Bring Skills Back Home

National Needs Delivered Locally

- Define Large Scale Goals in terms of the Local Delivery Mechanisms
  - Implement at the local level
  - Local outcomes percolate up to National & Transnational Levels
    - Local goals must align with higher level goals
    - Local programs coordinate to create national platform
- Understand the local conditions
  - Industrial Needs: chemical, pharmaceutical, electronic and technology
  - Rural/urban
  - Diverse workforce
- National Imperatives
  - GDP & national economy
  - National security
- Training a Workforce Locally to Meet National Imperatives

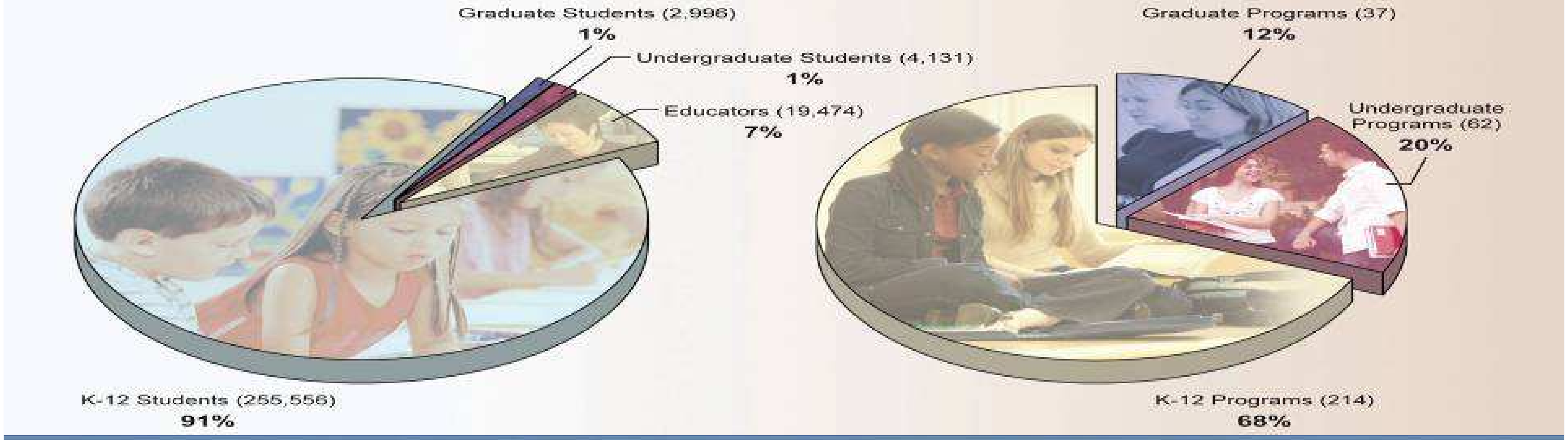
Pipeline Approach

- Kindergarten through Post Docs
  - "Life long learners"
  - "K through grey"
- Integrated Highly Leveraged Partnerships
  - Sustainability
  - Long-term thinking



Resource Requirements

- Extremely Resource Intensive Process
  - $14 trillion dollar U.S. economy
  - $600 billion expenditure on K-12 education each year
  - $135 billion Federal R&D budget
  - $3 billion Federal investment in STEM Education
- Scale and Scope
  - How to maximize impact



Scale and Scope

United States Education Infrastructure

K-12	
Number of Public School Students	48,132,518[1]
Number of K-12 Students	51,610,806[2]
Number of School Districts	15,397[1]
Number of Elementary Schools	95,201[2]
Number of Secondary Schools	38,161[2]
Number of Public Schools	94,112[2]
Number of Teachers	3,044,012[1]
Number of STEM Teachers	1,700,000[1]
Number of 504/IEP Students	6,727,000[3]
Number of Charter Schools	1,010[4]
% of Public Schools with Internet Access	99%[4]
Number of Title I Schools	8,770[4]

Higher Education	
Number of 4-year Colleges and Universities	2,533[4]
Number of 4-year Undergraduate Students	10,726,181[4]
Number of STEM Undergraduate Students	~400,000[1]
Number of Graduate Students	2,157,000[3]
Number of STEM Graduate Students	~100,000[1]
Number of Schools of Education	1,206[5]
Number of Pre-Service Teachers *degrees awarded (2001)*	106,300 degrees awarded (2003)[3]
Number of Community Colleges	1,683[4]
Number of Community College Students	6,545,863[4]

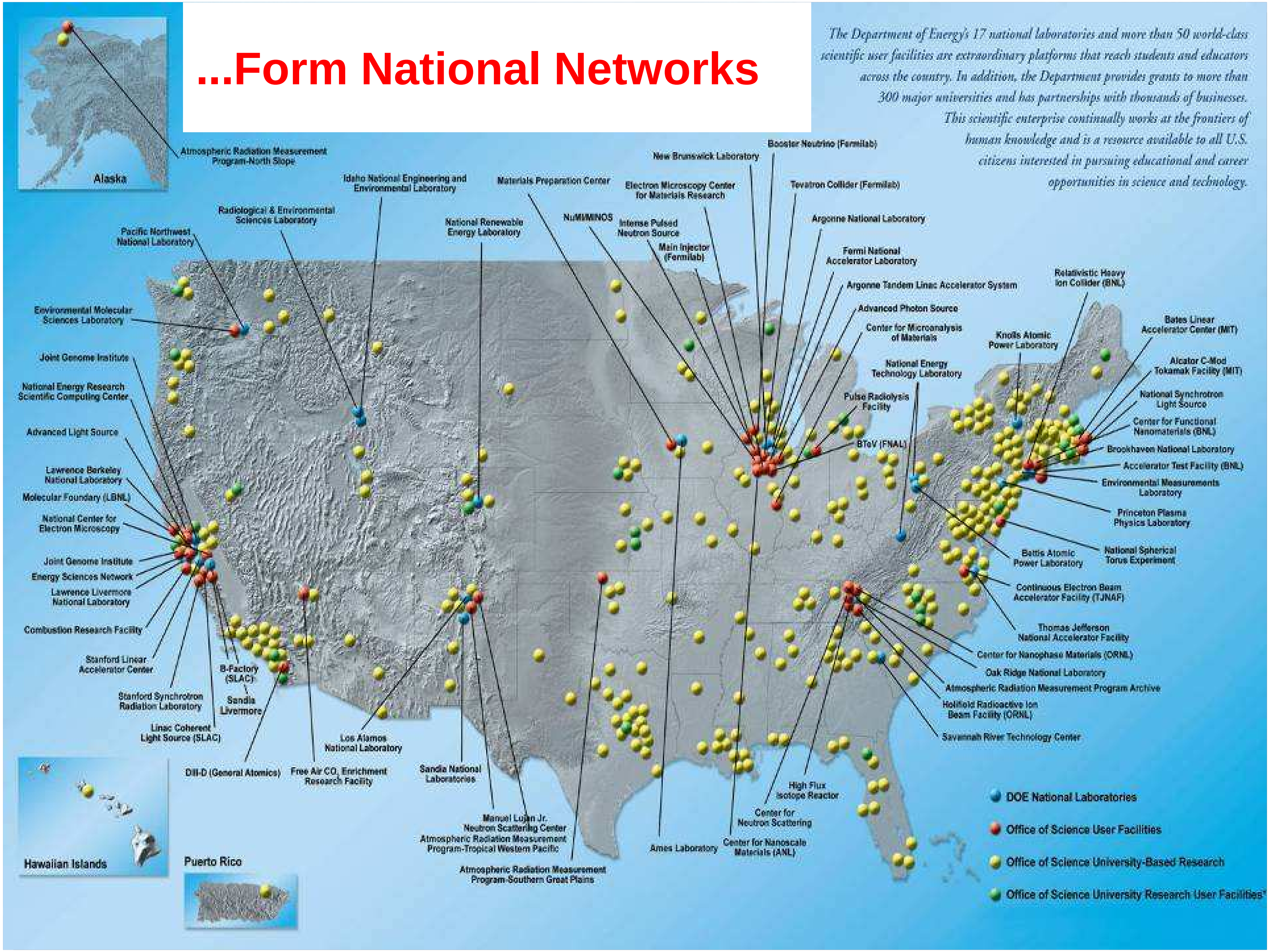
Local Reform Programs

- Local Education Reform Programs Are Costly
  - Battelle – $20 Million program
    - Partnership with Ohio State University
    - The Metro School established in 2006 with 100 ninth-graders
    - University faculty will train teachers at the school (learning laboratory)
  - GE – $100 Million program
    - Reaching four school districts
    - Curriculum, teacher training, administrative reforms
  - DOE ACTS - $60,000 per teacher
    - Three year investment
    - Teachers become district liaisons

National Laboratories with WDTS Funding

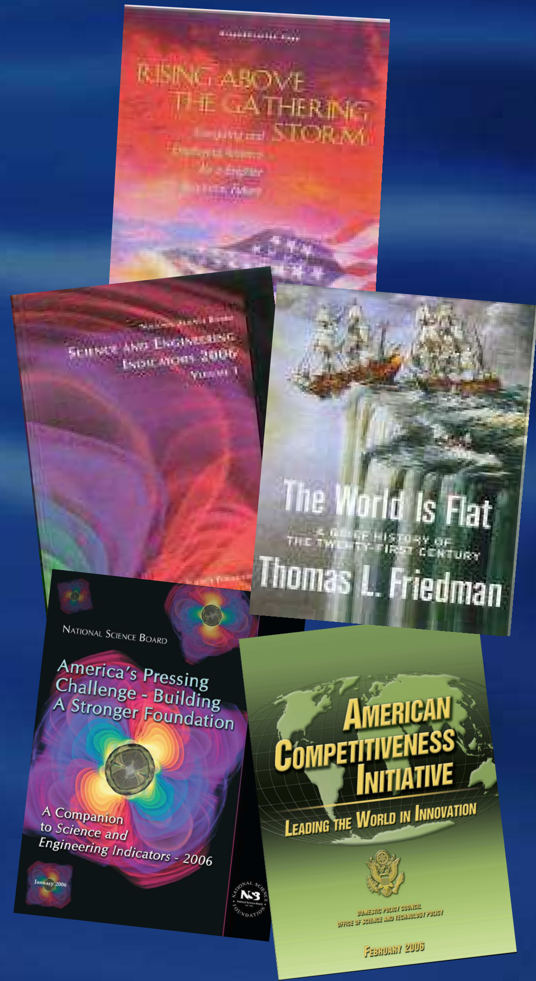
Local Reform Programs...

...Form National Networks



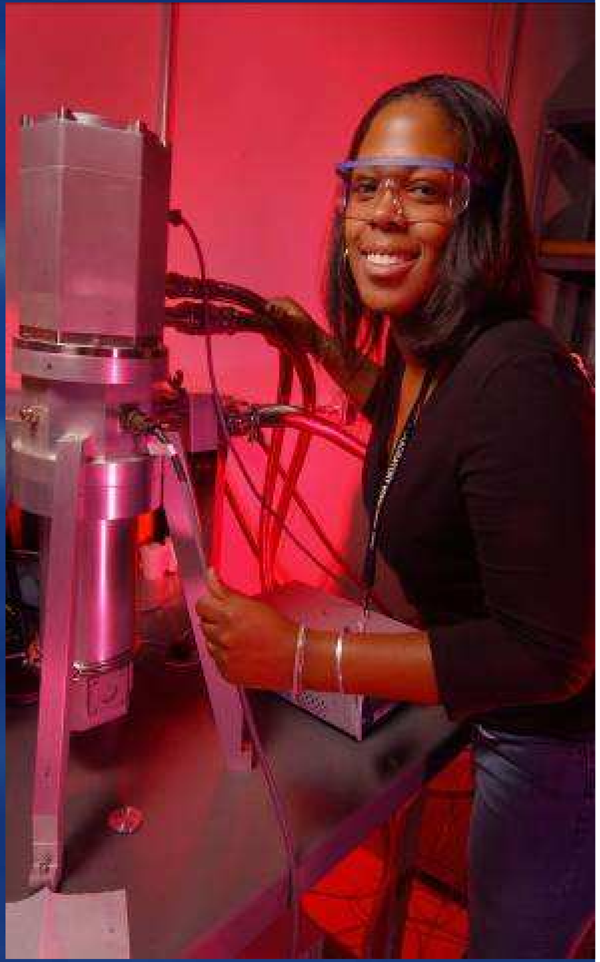
Mission Agencies

- The Role of Department of Education
- The Role of National Science Foundation
- The Mission Agencies
  - American Competes Act
  - Provide experiential learning opportunities
    - Hands on experiences
    - Mentored
    - Apprenticeships
- DOE's Crosscutting Role is Unique
  - Take lead role in brings various stakeholders together



Future Workforce Strategy

- **Educators:** Highly qualified K-16 educators who engage students in authentic science and improve the nation's STEM education capabilities.
- **Students:** Greatly expanded, more knowledgeable, and more diverse population of skilled scientists, engineers, and mathematicians.
- **Workforce Development:** Sustained pipeline of workforce-ready talent available to DOE's national laboratories, Federal workforce, private industry, and academia.
- **Program Capacity:** Leverage expertise and resources through specially-configured, high-impact public/private partnerships that will maximize, expand, and sustain the nation's STEM workforce.



Models For Success

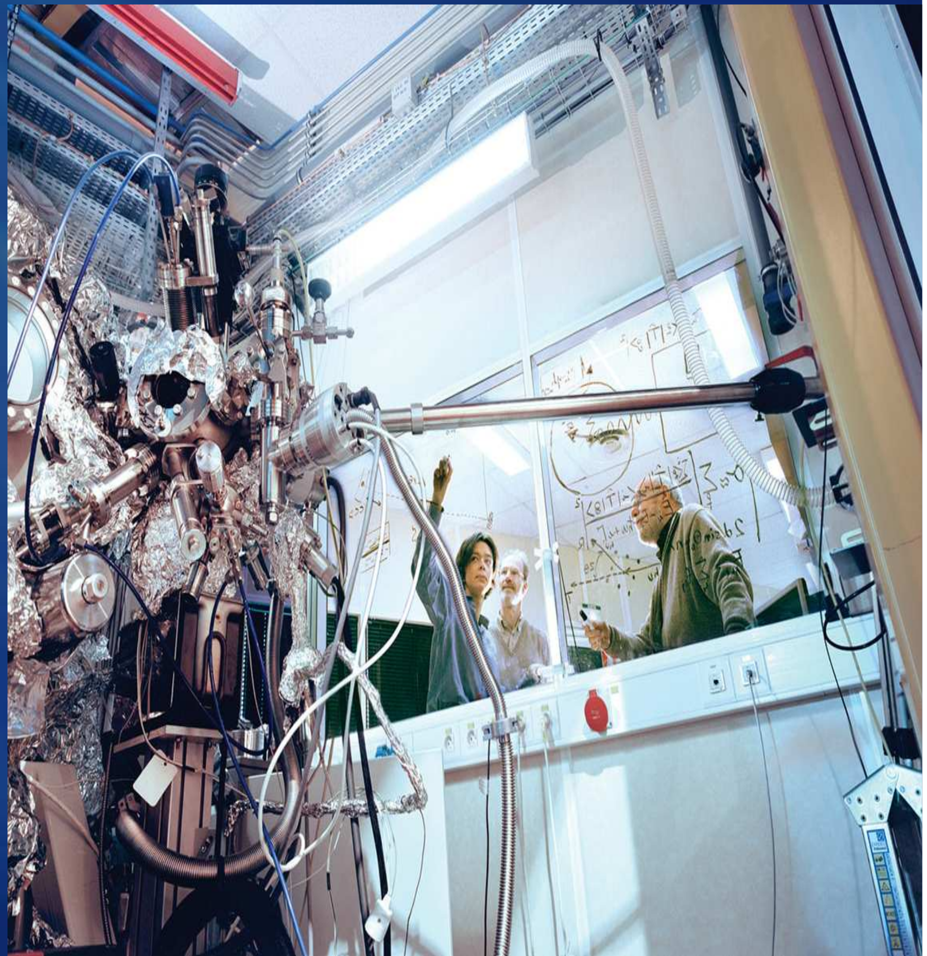
- There Are Many Successful Models:
  - Battelle in Ohio
  - General Electric at the district level
  - Dupont in Delaware
  - SACNAS
- The DOE Model:
  - Utilize structures already in place
    - National Laboratories & National Laboratory Consortium
  - Hands on mentor intensive research experience
- DOE Model Uses a National Platform that is Implemented at a Local Level
  - Model is based on 60-years of experience
  - Is a highly leveraged enterprise

Three Underlying Pre-Conditions

1. Catalyst For Change
2. Models Adapted to Fit Local Conditions
3. Support from Students and Families

Catalyst For Change

- **Someone Needs to Step Up and Be the Thought Leader**
  - **Champion For Change**
    - **Individual company, person or entity who serve as the catalyst**
- **Qualities Needed**
  - **Trusted by all parties**
  - **Ability to bridge gaps between various interest groups**
  - **Expert in educational reform**
  - **Able to negotiate many different partnerships**

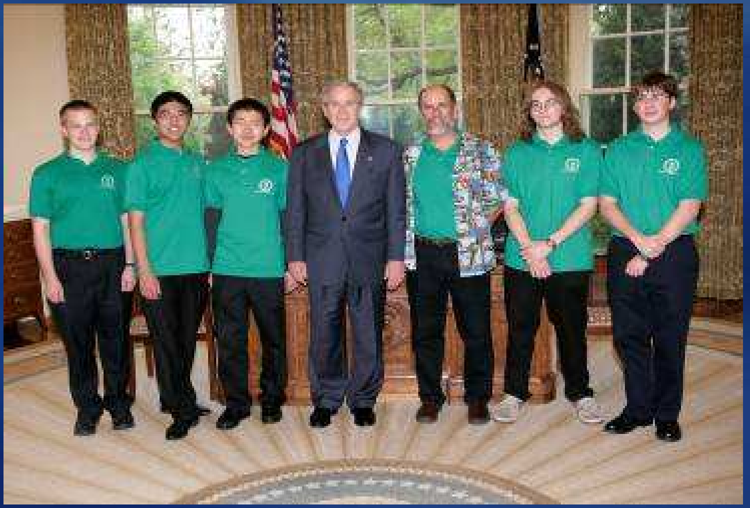


Models That Fit the Local Conditions

- **The Chosen Model should be Unique to the Local Condition**
  - U.S. has the premier University system in the world; a tremendous resource base for K-12 education; control is at the local level; NSF serves as the "thought leader" for reform efforts
  - Other countries have different strengths
- **Policies and Programs Must be Structured to Meet the Local Conditions**
  - Nations have difficulty replicating U.S. University system and send their students overseas to study, but design programs to get them back
  - In the U.S., the unit of structure tends to a single state, such as Idaho or Alabama

Involvement by Students And Families

- Students and Families Must Recognize the Value in a STEM Career
  - Attractive pathways for career success must be apparent
  - Conditions must be created where students and families see the value of a STEM education
- Marketing to Students & Parents
  - Opportunities for careers
  - Rewards
  - Recognition
    - National Science Bowl®
  - Prestige



Six Actions For a Successful STEM Program

1. Mentored Relationships Between Students & Educators
2. Apprenticeship Opportunities beginning at the earliest possible age
   - Real world experience in STEM
3. Competition With Reward
   - Both students and educators
   - Appropriate and meaningful resources and rewards

Six Actions For a Successful STEM Program

4. Educator Training
   - Broad reaching effect
     - Effective use of resources
   - Help become better communicators and practitioners
5. Dynamic Curriculum Development
   - Develop curriculum that meets local needs
     - U.S. is struggling with this concept
6. Sustained Partnerships
   - Takes time to build – DOE has been doing this for 60-years
   - Long term thinking – Reform takes decades, not years
   - Partnerships with key partners – particularly industry

Questions and Comments

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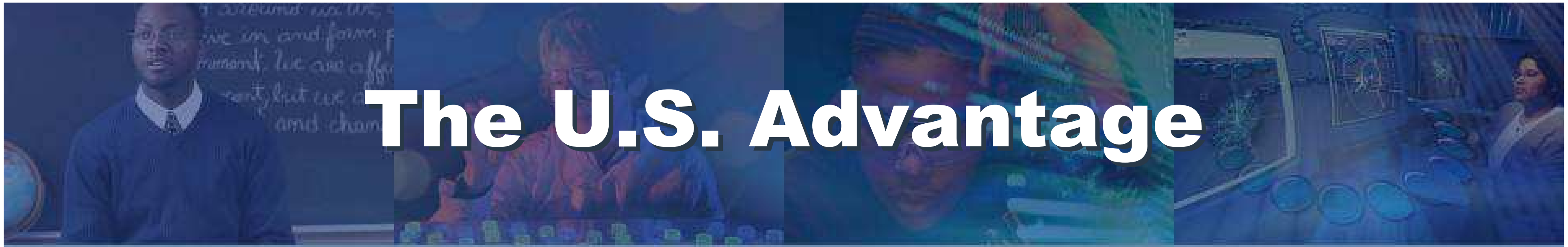

The U.S. Advantage

The United States has tremendous education assets:

- **The premier university system in the world**
  - **2,400 colleges and universities – including most of the Top 100 research universities in the world.**
  - **2,400 community colleges – two year associate degrees awarded in many technical areas; a unique national asset.**
  - **Trillions of dollars invested over the past 60 years in the most modern scientific infrastructure.**
- **An extensive K-12 educational system:**
  - **Serves 56 million students from widely different backgrounds.**
  - **Has school districts that rival those of any country’s.**
  - **Produces the seed corn for U.S. universities**

The U.S. Issues

The U.S. has serious educational concerns:

- Universities remain strong, but are dealing with changing dynamics:
  - Relationships with industry
  - Globalization
  - Tenure/Administrative Structures promote ossification
- K-12 is under the most stress:
  - No national educational standards
  - Uneven distribution of resources
  - Pressures resulting from immigration
  - Demands for accountability (testing)
  - A disconnect from local economic needs

Emerging U.S. Trends -- Universities

At the university level:

- A re-examination of industry partnerships
- International partnerships
- A movement toward multidisciplinary research as a way to break down barriers between departments
- Tentative movements toward collaborating with the K-12 world – particularly with K-12 teacher preparation
- Renewed focus on community colleges as a transition to the workplace and to 4-year degrees, particularly in engineering

Emerging U.S. Trends – K-12

Most attention has been focused on K-12 education:

- The role of testing is being re-examined.
- Science, technology, engineering and math (STEM) education is being re-emphasized.
- The link to economic development is being strengthened, particularly through apprenticeships with industry.
- Models of excellence (Ohio) are being developed and replicated.
- Industry and Foundations (Gates, Microsoft, Kauffman, etc.) are making huge investments