

# National Nanotechnology Initiative from a Policy Perspective

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**Celia Merzbacher, Ph.D.**

Office of Science and Technology Policy

***X-rays and Neutrons:  
Essential Tools for Nanoscience Research***

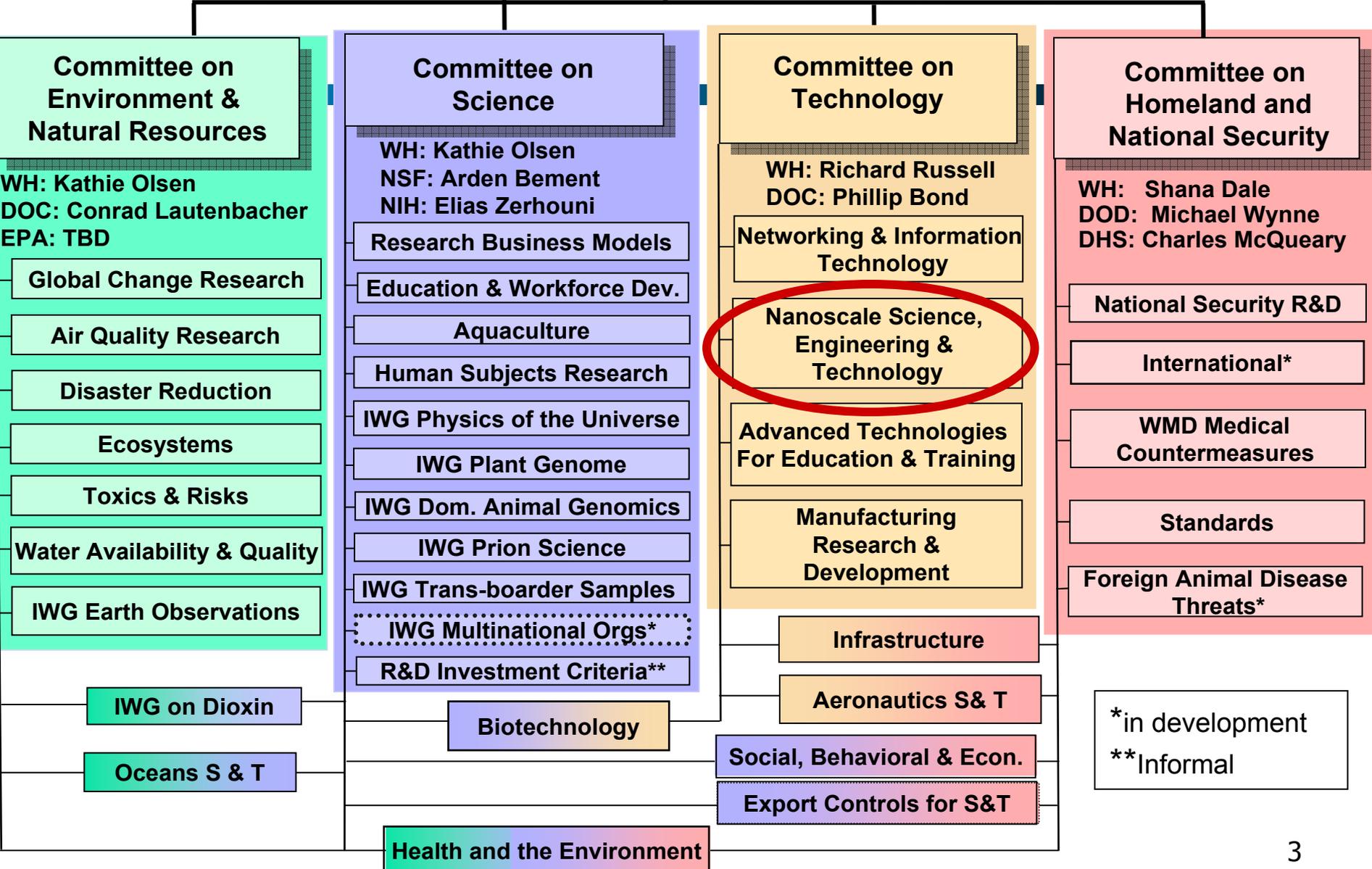
*Washington, D.C. \* 16 June 2005*



# Interagency R&D Priorities for FY 2006

*“...In order to ensure that nanotechnology research leads to the responsible development of beneficial applications, agencies also should support research on the various societal implications of the nascent technology. In particular, agencies should place a high priority on research on human health and environmental issues related to nanotechnology.”*

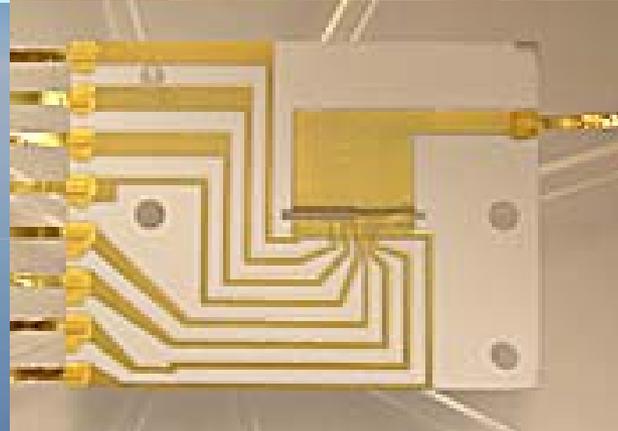
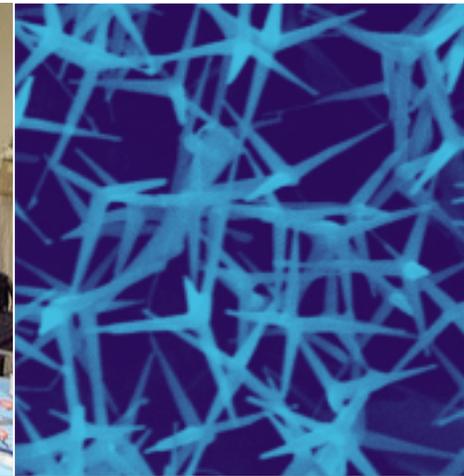
# NSTC Director, OSTP



\*in development  
\*\*Informal

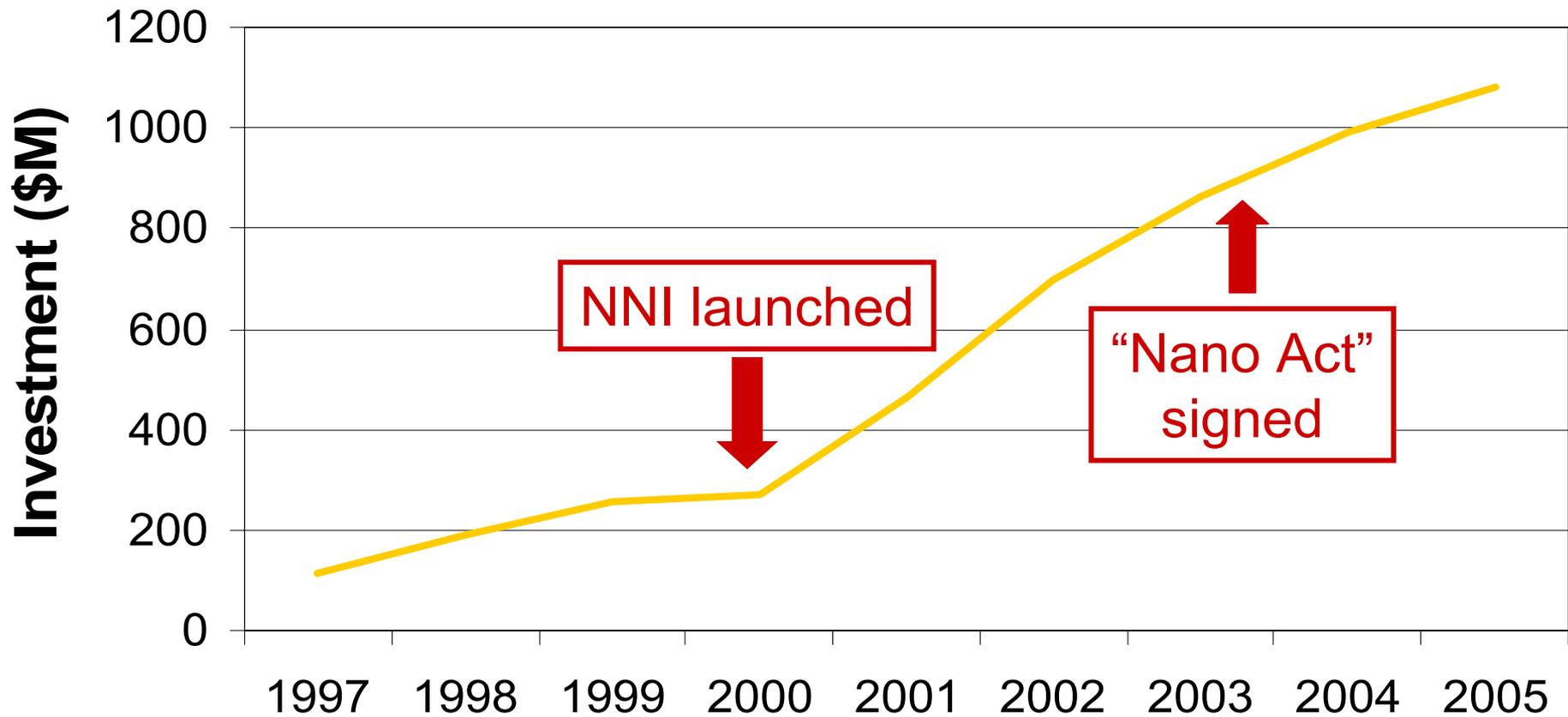


# NNI Participating Agencies See Widespread Applications





# U.S. Nanotech R&D spending





# 21st Century Nanotechnology Research & Development Act of 2003

- Signed by the President on Dec. 3, 2003
- Put into law ongoing activities
- Authorized \$3.7 billion in FY2005-FY2008 among 5 agencies
- “Established” a National Nanotechnology Coordination Office
- Calls for periodic planning and reporting by the NSET Subcommittee
- Calls for the President to establish or designate a National Nanotechnology Advisory Panel
- Calls for a triennial review by the National Research Council

One Hundred Eighth Congress  
of the  
United States of America

AT THE FIRST SESSION

*Begun and held at the City of Washington on Tuesday,  
the seventh day of January, two thousand and three*

## An Act

To authorize appropriations for nanoscience, nanoengineering, and nanotechnology research, and for other purposes.

*Be it enacted by the Senate and House of Representatives of  
the United States of America in Congress assembled,*

### SECTION 1. SHORT TITLE.

This Act may be cited as the “21st Century Nanotechnology Research and Development Act”.

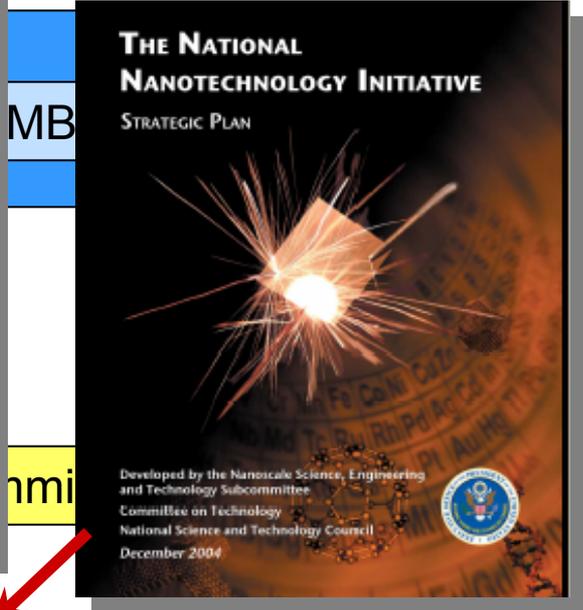
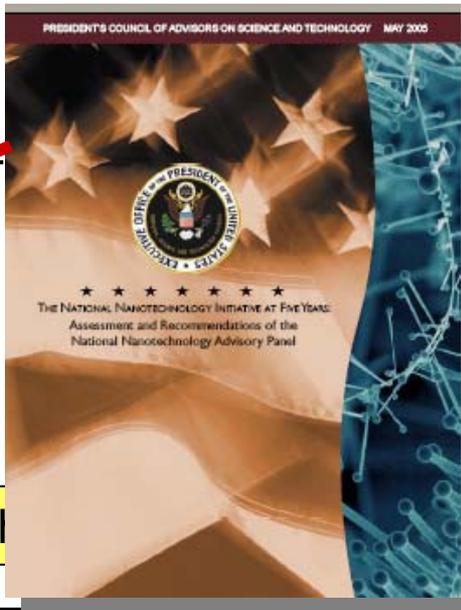


industry.  
(C) make use of existing expertise in nanotechnology in their regions and nationally;  
(D) make use of ongoing research and development at the micrometer scale to support their work in nanotechnology; and

**National Research Council Review**

Expected release: 2006

PCAST (NNAP)



Committee on Technology

Subcommittee

NSET Subcommittee

NNCO

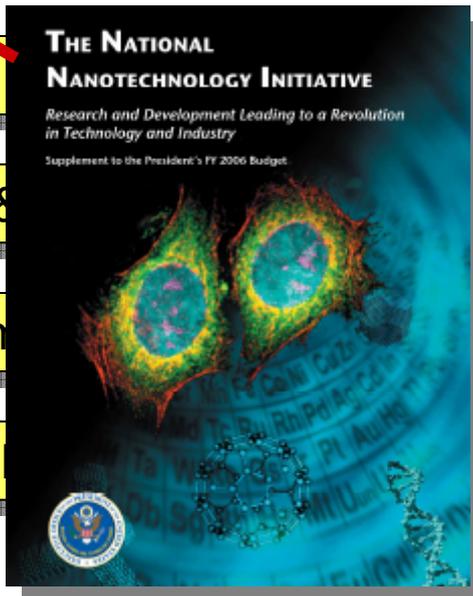
National Academies

Subcommittee

Innovation & Education

Nanotechnology

Public Awareness

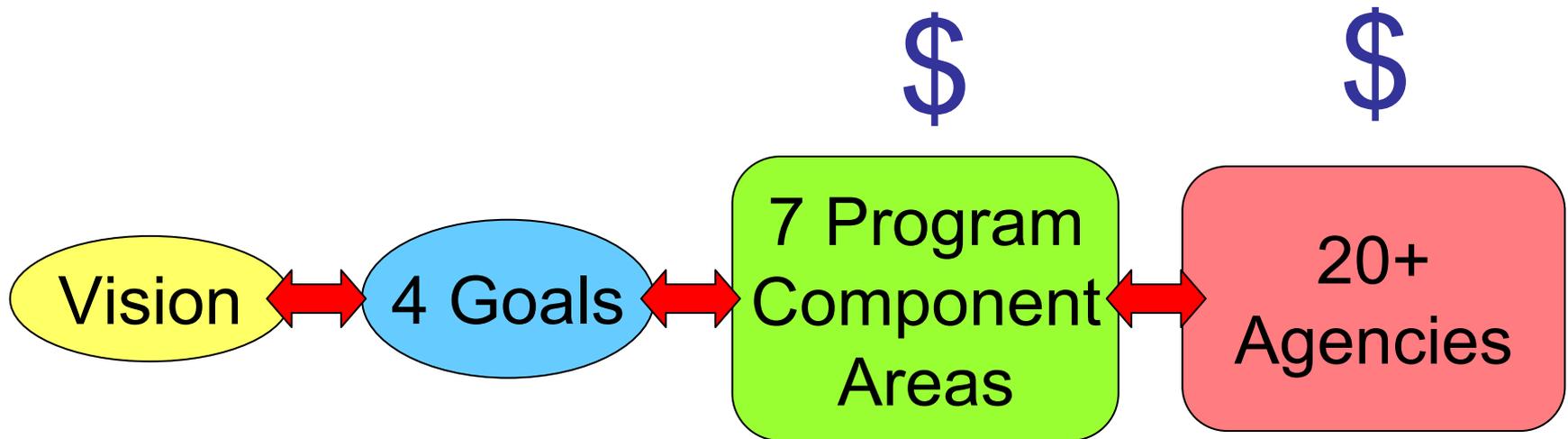


**Relationship**

- Formal reporting
- ..... Informal reporting
- - Administrative or contractual



# NNI Strategic Plan (Dec 2004)





# NNI Vision

*A future in which the ability to understand and control matter on the nanoscale leads to a revolution in technology and industry.*

Expedite discovery, development, and deployment of nanotechnology for:

- ❖ Economic benefit
- ❖ National & homeland security
- ❖ Improved quality of life



# NNI Goals

- ***Sustain world class R&D***
- ***Facilitate technology transfer***
- ***Develop infrastructure: education; workforce preparation; facilities & instrumentation***
- ***Support responsible development of nanotechnology***



# Areas of investment (aka Program Component Areas)

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1. Fundamental Nanoscale Phenomena and Processes
2. Nanomaterials
3. Nanoscale Devices and Systems
4. Instrumentation Research, Metrology, and Standards for Nanotechnology
5. Nanomanufacturing
6. Major Research Facilities and Instrumentation Acquisition
7. Societal Dimensions (EHS, ELSI, Educ.)

# Relationship of PCAs to Goals

## Program Component Areas:

	Goal 1: Maintain a world-class research and development program aimed at realizing the full potential of nanotechnology	Goal 2: Facilitate transfer of new technologies into products for economic growth, jobs, and other public benefit	Goal 3: Develop educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology	Goal 4: Support responsible development of nanotechnology
Fundamental Nanoscale Phenomena and Processes	Secondary	Secondary	Primary	Secondary
Nanomaterials	Secondary	Secondary	Secondary	Secondary
Nanoscale Devices and Systems	Primary	Primary	Secondary	Secondary
Instrumentation Research, Metrology, and Standards for Nanotechnology	Secondary	Primary	Secondary	Secondary
Nanomanufacturing	Secondary	Primary	Primary	Primary
Major Research Facilities and Instrumentation Acquisition	Primary	Secondary	Primary	Secondary
Societal Dimensions	Secondary	Secondary	Primary	Primary

	critical to goal
	primary relevance
	secondary relevance

# Relationship between PCAs and NNI Agency Missions

● Primary  
 Secondary  
 Agencies w/  
 nano R&D \$\$

	Fundamental Nanoscale Phenomena and Processes	Nanomaterials	Nanoscale Devices and Systems	Instrumentation Research, Metrology, and Standards for Nanotechnology	Nanomanufacturing	Major Research Facilities and Instrumentation Acquisition	Societal Dimensions
CPSC	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>			<span style="color: red;">●</span>
DHS	<span style="color: red;">●</span>		<span style="color: red;">●</span>	<span style="color: red;">●</span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	
DOC (BIS)	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>		
DOC (NIST)	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>
DOC (TA)	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>
DOC (USPTO)		<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>		
DOD	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>
DOE	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>
DOJ			<span style="color: red;">●</span>				
DOS							<span style="color: red;">●</span>
DOT	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>		<span style="color: red;">●</span>		
DOTreas		<span style="color: red;">●</span>	<span style="color: red;">●</span>				
EPA	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>		<span style="color: red;">●</span>
HHS (FDA)		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>				<span style="color: red;">●</span>
HHS (NIH)	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>
HHS (NIOSH)		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>			<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>		<span style="color: red;">●</span>
IC	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>
ITC		<span style="color: red;">●</span>	<span style="color: red;">●</span>		<span style="color: red;">●</span>		<span style="color: red;">●</span>
NASA	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	
NRC			<span style="color: red;">●</span>				
NSF	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>
USDA	<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>	<span style="color: red;">●</span>	<span style="color: red;">●</span>		<span style="border: 1px solid blue; display: inline-block; width: 1em; height: 1em; vertical-align: middle;"></span>		<span style="color: red;">●</span>

## FY 2006 Budget Request (\$ millions) by Agency

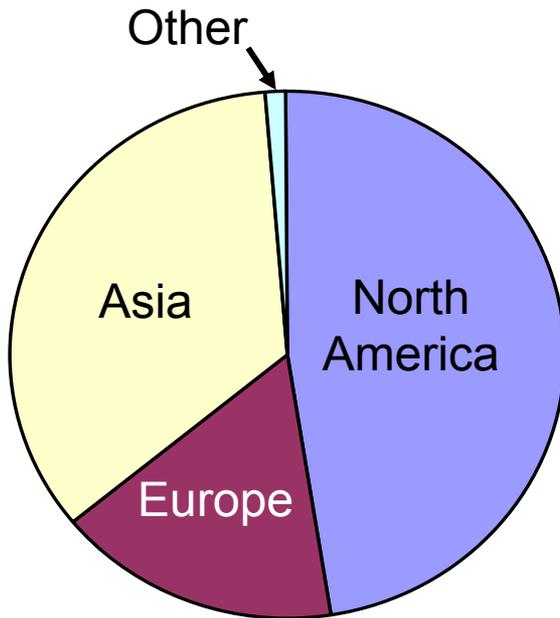
	<b>2004 Actual</b>	<b>2005 Estimate</b>	<b>2006 Request</b>	<b>Change 2005 to 2006</b>
NSF	256	338	344	6
DOD	291	257	230	-27
DOE	202	210	207	-3
NIH	106	142	144	2
NIST	77	75	75	0
NASA	47	45	32	-13
USDA	2	3	11	8
EPA	5	5	5	0
NIOSH		3	3	0
DOJ	2	2	2	0
DHS	1	1	1	0
<b>TOTAL</b>	<b>989</b>	<b>1,081</b>	<b>1,054</b>	<b>-27</b>

# FY 2006 Budget Request (\$ millions) by Agency and Program Component Area

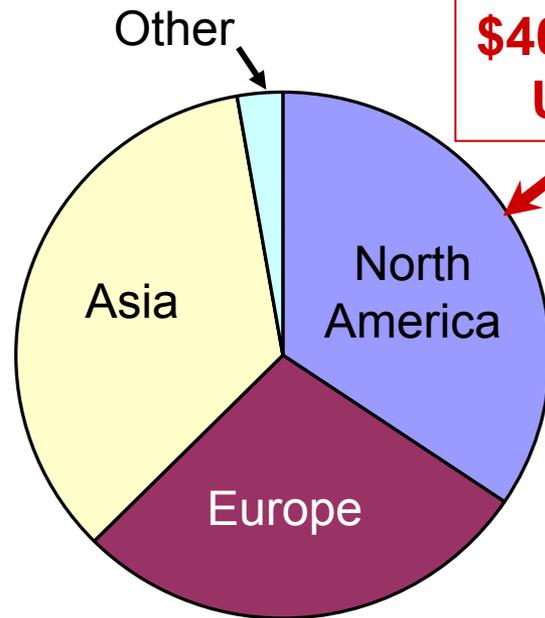
	Fundamental Nanoscale Phenomena and Processes	Nano-materials	Nanoscale Devices and Systems	Instrumentation Research, Metrology, and Standards for Nanotechnology	Nano- manufacturing	Major Research Facilities and Instrumentation Acquisition	Societal Dimensions	NNI Total
NSF	95	75	54	12	24	24	60	<b>344</b>
DOD	35	83	99	3	2	6	2	<b>230</b>
DOE	48	33	5	11	0	109	1	<b>207</b>
NIH	46	17	67	6	0	1	8	<b>144</b>
NIST	5	1	2	39	19	8	1	<b>75</b>
NASA	5	17	9	0	1	0	0	<b>32</b>
USDA	1	2	6	0	1	0	1	<b>11</b>
EPA	<0.5	0	<0.5	0	0	0	4	<b>5</b>
NIOSH	0	0	0	0	0	0	3	<b>3</b>
DOJ	0	0	0	0	0	0	2	<b>2</b>
DHS	0	0	1	0	0	0	0	<b>1</b>
<b>TOTAL</b>	<b>234</b>	<b>228</b>	<b>244</b>	<b>71</b>	<b>47</b>	<b>148</b>	<b>82</b>	<b>1,054</b>



# Global investments in 2004 (Total=\$8.6 billion)



Private (Corp. + VC)  
Total = \$4 billion



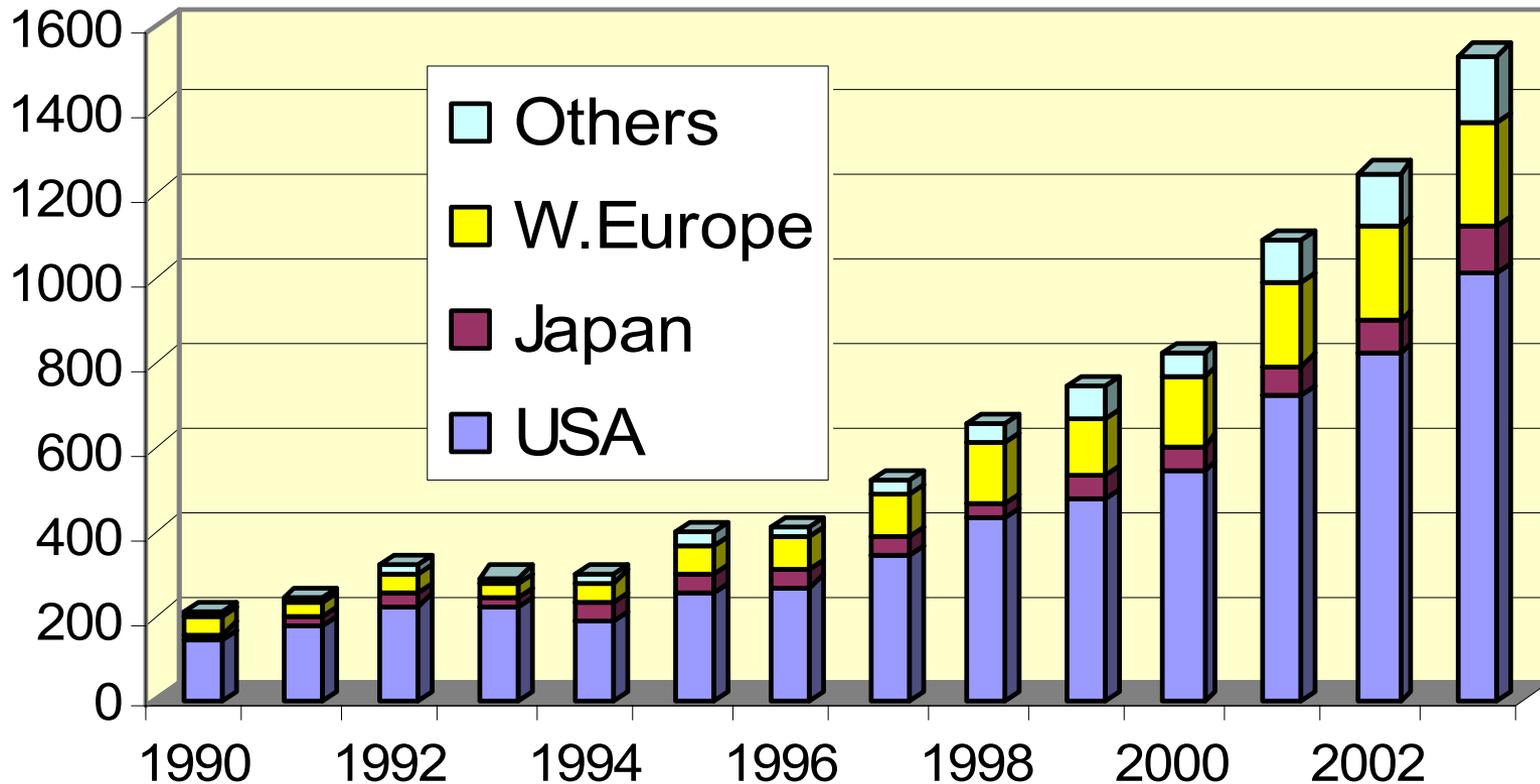
Public (National, regional, state)  
Total = \$4.6 billion

**\$400 million by  
U.S. states**

Source: Lux Research



# Measures of U.S. Competitiveness: Patents

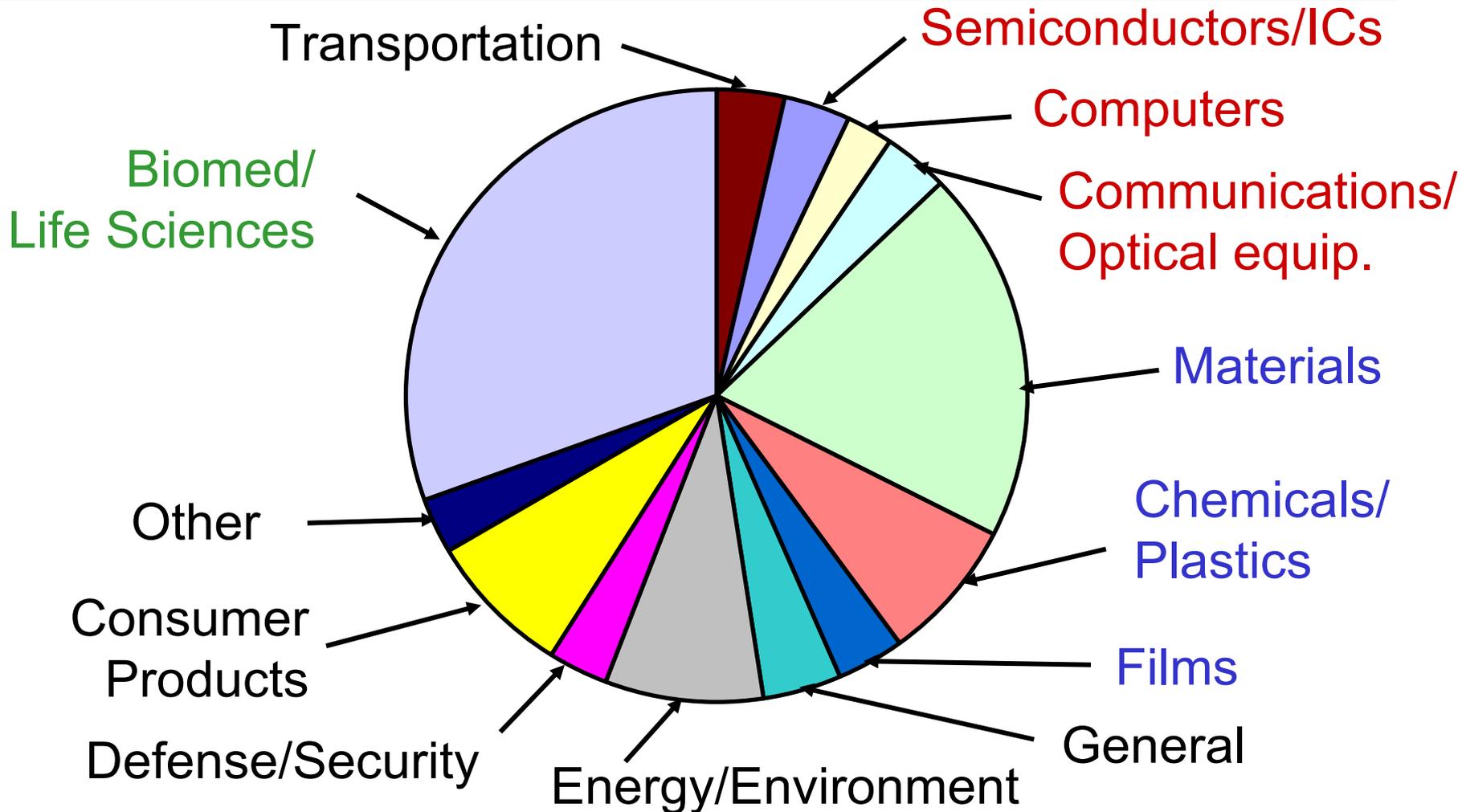


Source: Huang et al. (2004) J. Nanoparticle Research  
Nanotechnology keyword search of titles and claims of patents in USPTO database



# Target industries for nano suppliers

## Survey of 600 companies in U.S.



I just want to say one word to you.  
Just one word... **Nanotechnology!**

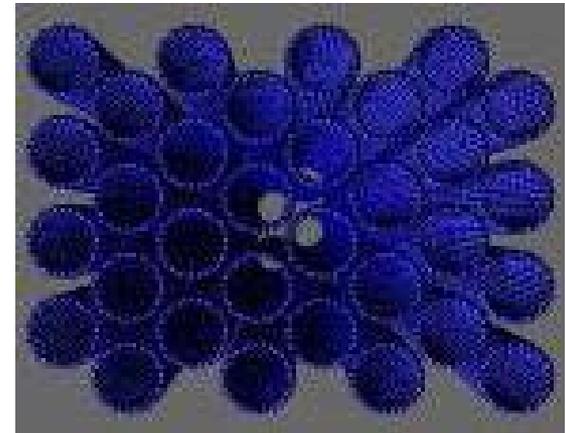


With apologies to Mike Nichols, Director, *The Graduate* (1967)



# Nanotechnology standards

- Required for communication; accurate measurement and testing; reliability and quality control.
  - IEEE Nanotechnology Council est. Oct. 2003
  - ANSI Nanotechnology Standards Panel est. Aug 2004
  - ASTM E56 Committee on Nanotechnology Standards est. Jan 2005
  - ISO Technical Committee on Nanotechnology--decision June 2005





# Existing regulations apply to nano

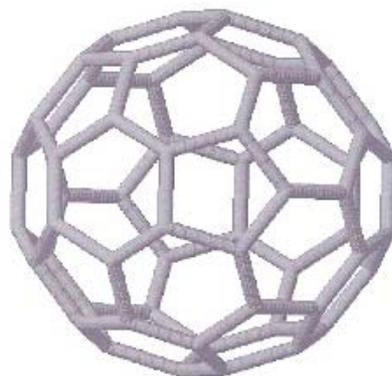
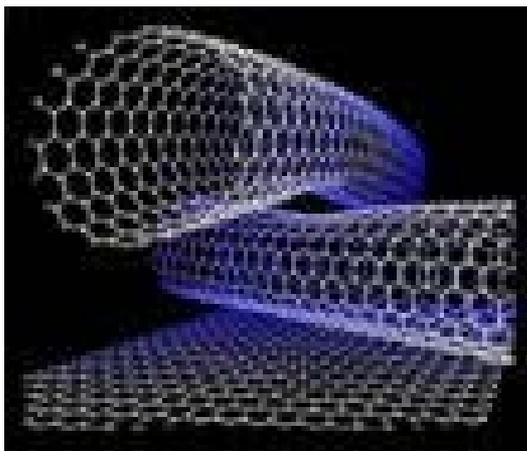




# NNI research on health effects



- National Toxicology Program Nanotechnology Safety Initiative initiating toxicology studies of:
  - Nanocrystalline fluorescent semiconductors (aka "quantum dots")
  - Carbon nanotubes (CNTs) & fullerenes
  - Nanoscale metal oxide particles (e.g.  $\text{TiO}_2$ )



**NNI 2006 Investments (\$ millions)  
under PCA on Societal Dimensions**

	<b>EHS</b>	<b>Other</b>
NSF	24	35.5
DOD	1	1
DOE	0.5	0.5
NASA	0	0
NIH	3	5
NIOSH	3.1	0
DOC	0.9	0
USDA	0.5	0.5
EPA	4	0
DOJ	1.5	0
DHS	0	0
<b>TOTAL</b>	<b>38.5</b>	<b>42.6</b>



# Nanotechnology Environmental and Health Implications (NEHI) Working Group

- Subgroup of the NSET Subcommittee
- Co-chaired by FDA and NIOSH
- Members from research and regulatory agencies
- Purposes
  - Provide for exchange of information
  - Facilitate identification, prioritization, and implementation of EHS research on nanotechnology
  - Promote communication of information related to EHS research on nanotechnology

**NNI 2006 Investments (\$ millions)  
under PCA on Societal Dimensions**

	<b>EHS</b>	<b>Other</b>
NSF	24	35.5
DOD	1	1
DOE	0.5	0.5
NASA	0	0
NIH	3	5
NIOSH	3.1	0
DOC	0.9	0
USDA	0.5	0.5
EPA	4	0
DOJ	1.5	0
DHS	0	0
<b>TOTAL</b>	<b>38.5</b>	<b>42.6</b>

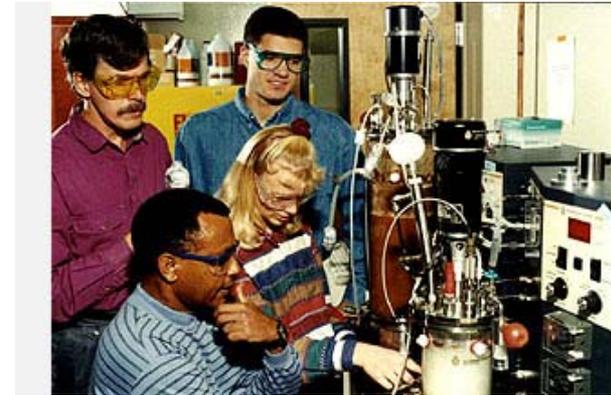


# NSF supports formal and informal nanotechnology education



- **Research Experience for Undergraduates and Research Experience for Teacher**

- **Center for Learning and Teaching in Nanoscale S&E** to introduce nanoscience and nanoengineering concepts into schools (grades 7-12) and undergraduate classrooms.



- Establish a network that links science museums and other informal science education organizations with nanoscale science and engineering research organizations.
- Develop interdisciplinary approaches for nano undergraduate education, particularly in the first two collegiate years.

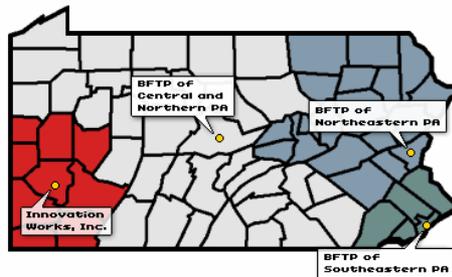


# Workforce preparation partners

- Federal Govt
- State Govts
- Community colleges
- Businesses
- Professional societies



Turning Pennsylvania  
Ideas  
and Pennsylvania  
Innovations  
into Pennsylvania  
Jobs



**WORK TEXAS**  
com

**TexasWorkforce**

**Businesses & Employers**  
Firms, corporations, and individuals who employ

**Job Seekers & Employees**  
Individuals looking for work, training and support services

**Service Providers**  
Training providers, educational institutions and child care providers

**Boards & Network Partners**  
Local Workforce Boards, Texas Workforce Centers and other partners

**Researchers & Policy Makers**  
Interested individuals, academics, elected officials, their staff and state agencies

Search  **Go!**

**Texas Workforce News**

- March 2005 Employment Statistics (pdf)
- Press Releases
- Upcoming Events
- Workforce News Around the State (pdf)
- Ninth Annual Texas Workforce Conference
- Texas Business Conference Austin - June 3, 2005
- New Alien Labor Certification Process
- Proposed Workforce Investment Act (WIA) State Plan 2005



# High Growth Job Training Initiative

- Launched in 2002 to prepare workers to take advantage of high growth, high demand, economically vital sectors.
  - ✓ Biotechnology
  - ✓ Information technology
  - ✓ Automotive
  - ✓ Health care
  - ✓ Advanced manufacturing
  - ✓ Transportation
  - ✓ Energy
  - ✓ Geospatial technology
  - ✓ Construction
- Leverages partnerships among public workforce system, economic development leaders, business and industry, and educators.





# Societal Dimensions: Public Engagement

## NCSU survey of >1500 adults finds...

- >50% haven't heard of nanotechnology
- >30% have heard "little"
- Nearly twice as many think benefits outweigh risks vs. the other way around
- 70% are "hopeful"; 80% are "not worried"
- 60% do not much trust business





# Summary

- NNI has a variety of goals & roles
- Responsible development means advancing benefits while addressing risks
- NNI is funding cutting edge nanoscale scientific research and technology development, including for EHS and...
- Is growing nanotech education, workforce preparation, and public engagement capacity

For up to date information, go to:

**[www.nano.gov](http://www.nano.gov)**



THE WHITE HOUSE  
WASHINGTON