NNI INFRASTRUCTURE & FUNDING

Moderator: Minoo Dastoor (NASA)

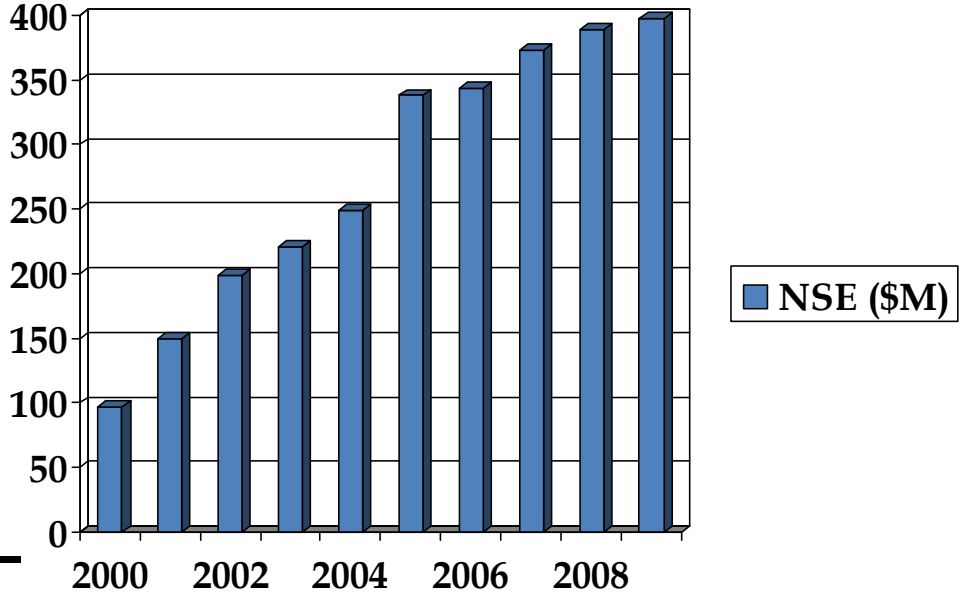
Short statements:
Mike Roco (NSF funding)
Marty Fritts (NIH funding)
Dianne Poster (NIST funding)
Bill Mullins (DOD funding)
Stephen Streiffer (DOE research centers)
Krish Mathur (DOEd activities)

NNI Infrastructure & Funding: NSF FY 2009 $397M

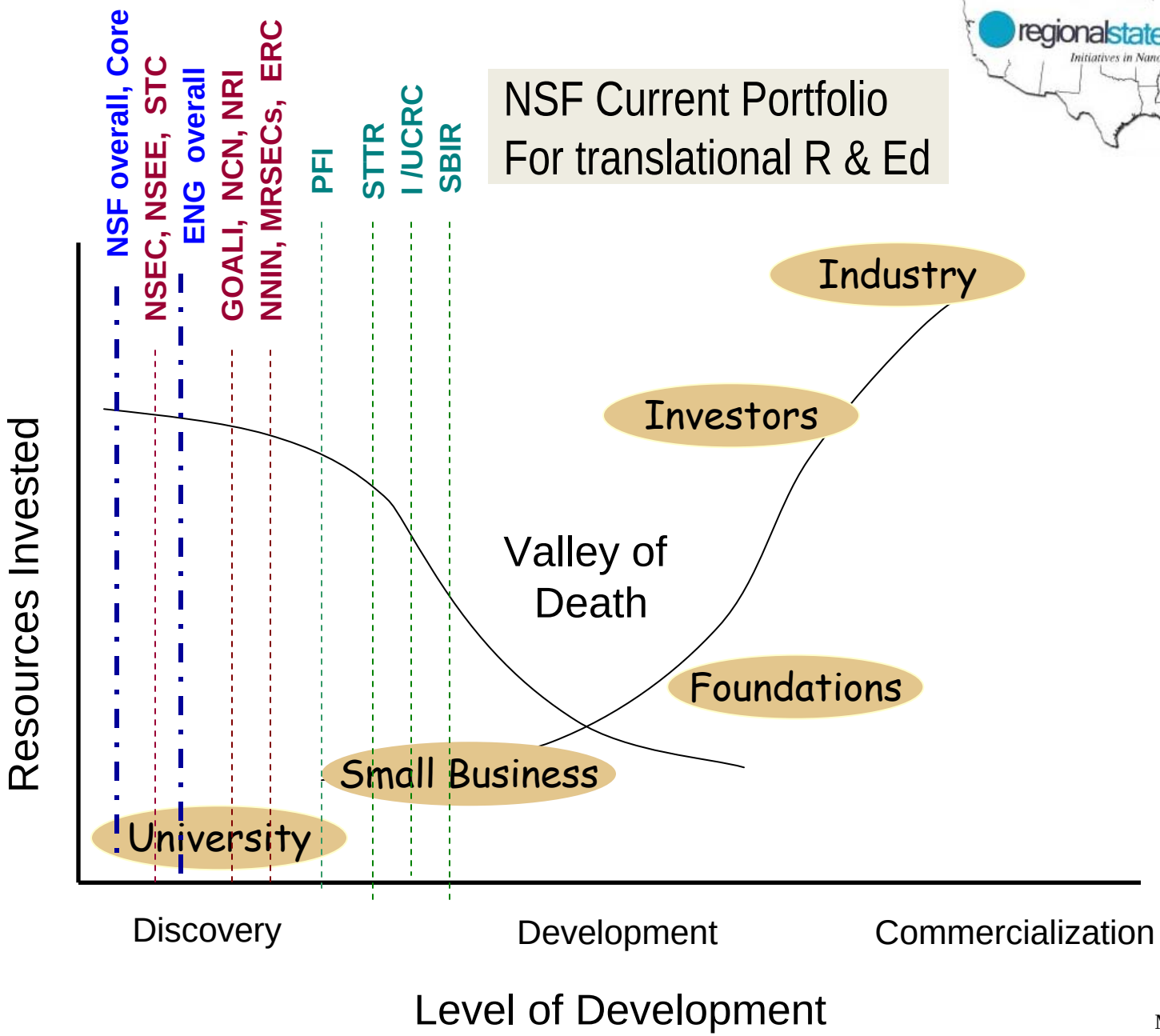
Investments (search all projects and abstracts on www.nsf.gov/nano):

- Fundamental research (discovery, innovation) - by 8 PCAs
- Establishing the infrastructure - over 4,000 active projects; 9 networks including 26 large centers, 2 user facilities (NNIN, NCN), multidisciplinary teams
- Training and education – over 10,000 students and teachers/yr
- Translational research and education: PFI, IUCRC, SBIR, STTR

Fiscal Year	NSF
2000	$97M
2001	$150M
2002	$199M
2003	$221M
2004	$254M
2005	$338M
2006	$344M
2007	$373M
2008	$389M
2009	**$397M**



NNI Infrastructure & Funding: NSF



NNI Infrastructure & Funding: NSF

- reference slides

NSF Program Notations

- NSF – Core: all NSF research directorates cover nanotechnology in their topical programs

- NSEC – Nanoscale Science and Engineering Centers
- NSEE – Nanoscale Science and Engineering Education networks (NCLT, NISE)
- STC – Science and Technology Centers
- GOALI – Grant Opportunities for Academic Liaison with Industry
- MRSEC – Materials Research Science & Engineering Centers
- NCN – Nanotechnology Computational network
- NNIN – National NanoInfrastructure Networks
- MRSEC – Materials Research Science and Engineering Centers
- NRI – Nanoelectronics Research Initiative
- ERC – Engineering Research Centers

- PFI – Partnerships for Innovation
- I/UCRC – Industry/University Cooperative Research Centers
- STTR – Small Business Technology Transfer
- SBIR – Small Business Innovation Research

Nine Nanoscale Science and Engineering networks with national outreach

TOOLS

Network for Computational Nanotechnology (2002-) *> 80,000 users/ 2008*
National Nanotechnology Infrastructure Network (2003-) *4,600 users/ 2008*

Nationwide Impact

TOPICAL

Nanotechnology Center Learning and Teaching (2004-) *1 million students/ 5yr*
Center for Nanotechnology Informal Science Education (2005-) *100 sites/ 5yr*
Network for Nanotechnology in Society (2005-) *Involve academia, public, industry*
National Nanomanufacturing Network (2006-) 4 NSETs , DOD centers, and NIST
Environmental Implications of Nanotechnology (2008-) with EPA

GENERAL RESEARCH AND EDUCATION

NSEC Network (2001-) *19 research & education centers*
MRSEC Network (2001-) *6 new research & education centers since 2000*

NSEC network

Nanoscale Science and Engineering Centers (NSEC) -19

http://www.nsecnetworks.net/

Electron Transport in Molecular Nanostructures, Columbia
Nanoscale Systems, Cornell
Directed Assembly of Nanostructures, RPI
Science for Nanoscale Systems and their Device Applications, Harvard
Institute for Nanotechnology, Northwestern
Biological and Environmental Nanotechnology, Rice
Scalable and Integrated Nanomanufacturing, UCLA
Nanoscale Chem-Electr-Mechanical Manufacturing, U Illinois-Urbana Champ.
Integrated Nanomechanical Systems, UC Berkeley
High Rate Nanomanufacturing, Northeastern
Affordable Nanoengineering, Ohio State
Molecular Function at the Nanoscale, U Pennsylvania
Probing the Nanoscale, Stanford
Templated Synthesis and Assembly at the Nanoscale, U Wisconsin
Nanotechnology in Society Network (2), ASU, UCSB
Network for Hierarchical Manufacturing, U Mass-Amherst
Environmental Implications of Nanotechnology (2), UCLA, Duke

National Nanotechnology Initiative activities at NSF in FY 2009

Current plan budget (except SBIR/STTR): $397 M (www.nsf.gov/nano)

- Current program solicitations
  - Nano-EHS with EPA, NIOSH and EU
  - Nanotechnology Undergraduate Education (ENG and EHR)
- Research, education and infrastructure programs in all directorates

  Support in the unsolicited and solicited programs with focus on single investigator, teams, centers

  Interdisciplinary fellowships; NSEC, STC, MRSEC and ERC centers
  Instrumentation (MRI, others); Network for Computational Nanotechnology; National Nanotechnology Infrastructure Network; Nanoscale Informal Science and Education network; Collaboration industry (GOALI, PFI, I/UCRC)
  Interagency collaborations: Manufacturing, Societal Implic., EHS, . . .

SBIR/STTR (additional ~ $17 M/year)

Harnessing the Power of Nanotechnology for Human Health at the National Institutes of Health

Regional, State, and Local Initiatives in Nanotechnology
NNI nanoRegional Workshop
02 April 2009

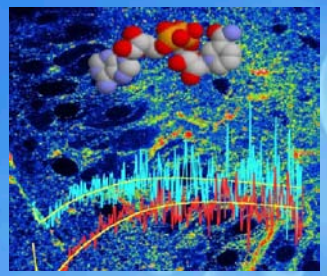
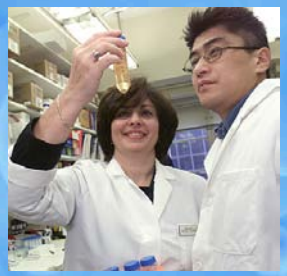
NIH Mission

NIH is the steward of

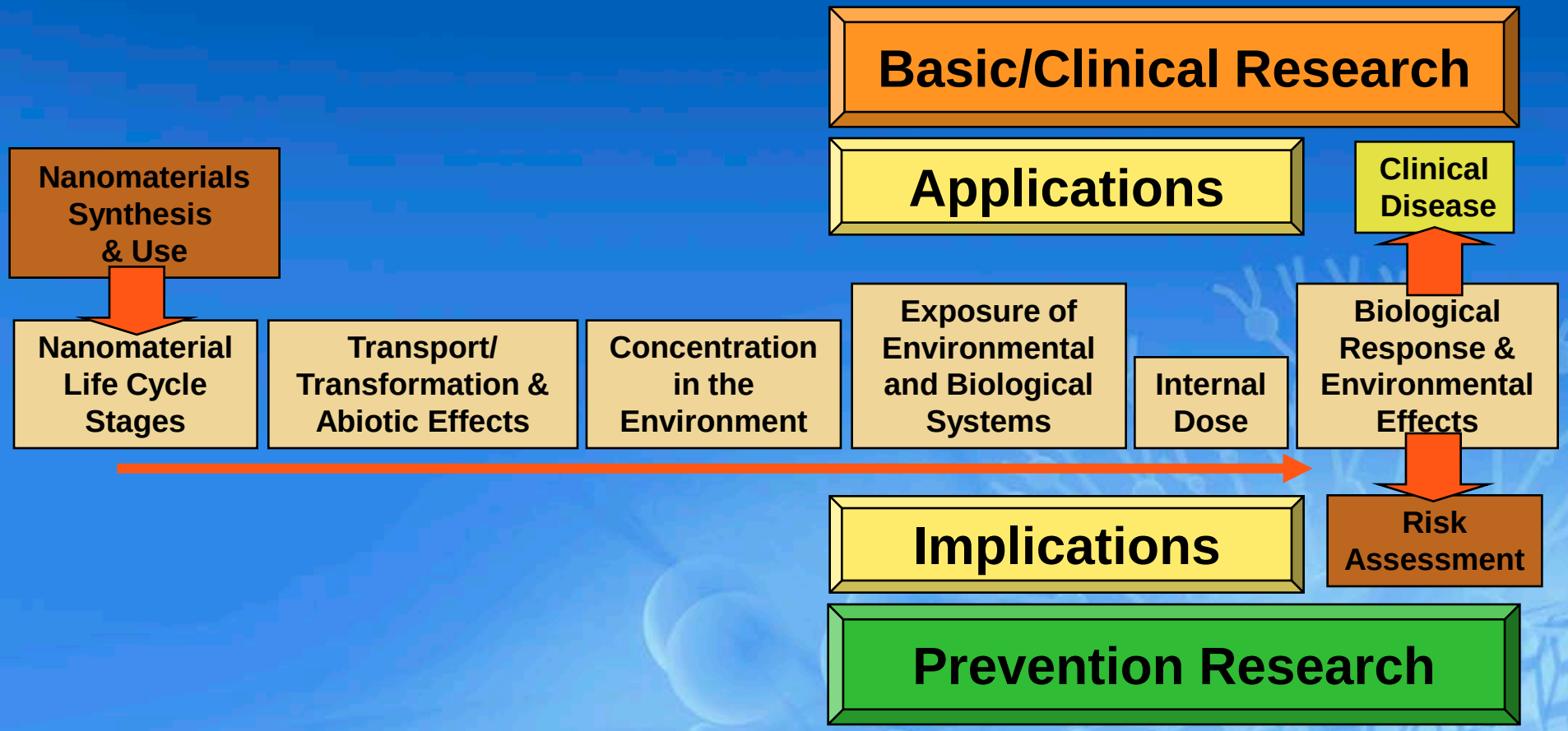
medical and behavioral research for the US.

Science in pursuit of

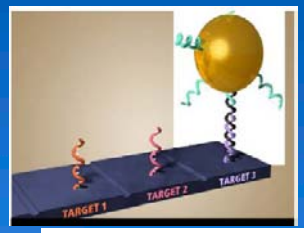
- **fundamental knowledge about the nature and behavior of living systems.**
- **application of that knowledge to prevent, detect, diagnose, and treat disease and disability.**

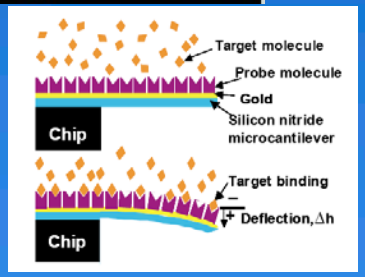



Expanding the NNI EHS Research Framework to Encompass the NIH Mission

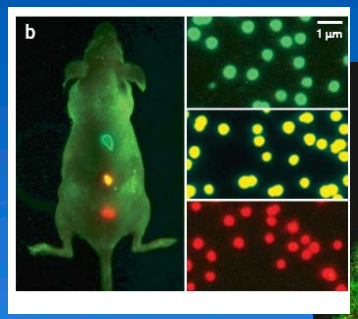


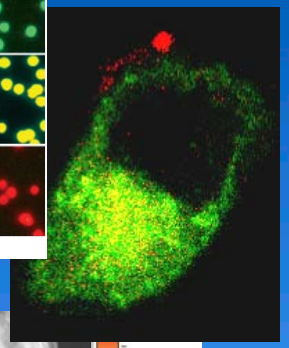
Nanotechnology at NIH Enables New Biomedical Solutions

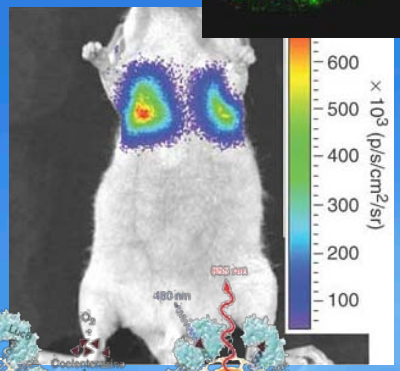


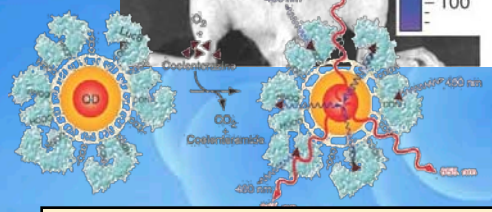


Early Detection

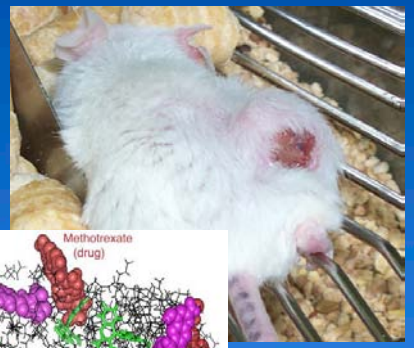


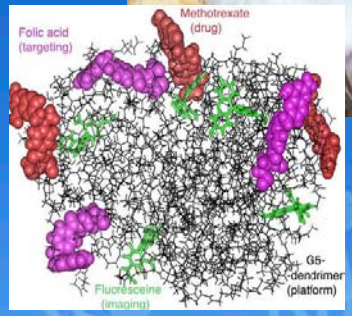


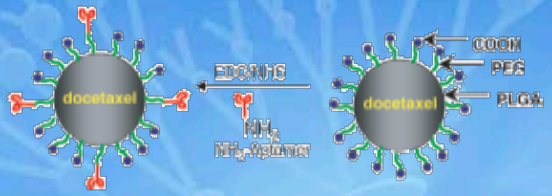




Feedback on cellular/organ function



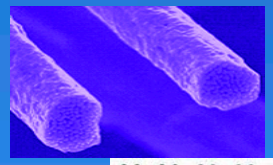


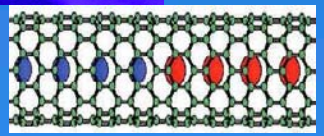


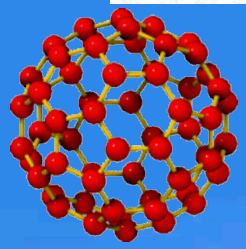
Therapy
Intervention
Manipulation

NIH Protects Public Health Through Safety Research: Current NIEHS Portfolio

NIEHS Partners with NIH Institutes, EPA, NIOSH, NSF







INITIAL ASSESSMENT

Internal Dose → **Biological Response**

Absorption and Transport

Mechanisms of Interaction

e.g., Membrane dynamics
Systemic transport
Subcellular localization
Phenotypes

American Recovery and Reinvestment Act: NIH Funding Opportunity Announcements for Nanomaterials

- **Challenge Grants in Health and Science Research (RC1)**
  - Goal: develop methods to evaluate the health and safety of nanomaterials (physical and chemical characterization and biology)
  - Two years, not to exceed $500K total costs per year
  - Receipt date: 04/27/2009
  - http://grants.nih.gov/grants/guide/rfa-files/RFA-OD-09-003.html
- **Grand Opportunity Grant Program in Engineered Nanomaterial Environmental Health and Safety (RC2)**
  - Goal: develop reliable and reproducible methods and models to assess exposure, exposure metrics, and biological response to nanomaterials.
  - Two years, not to exceed $600K total costs per year
  - Receipt date: 05/27/2009
  - http://www.niehs.nih.gov/recovery/nanomaterial-go.cfm

Contact: Srikanth Nadadur, Nanotoxicology Program Administrator (nadadur@niehs.nih.gov)

Nanotechnology at NIST: Maximizing the Benefits and Minimizing the Risks of Nanotechnology

NIST develops measurements, standards, and data crucial to industry's development of products for a nanotechnology market that could top $2.5 trillion within the next decade—or about 15 percent of global manufacturing output. Worldwide sales of nano-enabled products approach $90 billion. NIST is clearing technical obstacles to open the way for a range of prospective payoffs.

More than 150 nanotechnology-related research projects are under way in the NIST laboratories. A few examples of where NIST's nanotechnology research is leading are:

- New measurement tools for ensuring the quality of nanoscale particles[1], nanotubes[2], and other nanomaterials that will be the building blocks of new technologies.
- Powerful new imaging[3] and diagnostic tools that exploit the unusual properties of quantum dots and magnetic nanoparticles to "see" and "analyze" cancer[4] and other diseases at the level of individual cells, enabling earlier detection and less invasive treatment with greater specificity.
- Nanowires[5] only a few atoms across, graphene[6] films, and other nanostructured materials for future generations of computers, sensors, batteries, lasers, and more.
- Data storage devices that employ precisely controlled arrays of magnetic nanoparticles[7] to achieve capacities that will dwarf those of today's most advanced hard disk drives.
- Improved formulations of cement[8]—that perform better and last longer through better nanostructure control. Improvements include reduced emission of greenhouse gases during production which accounts for 5 to 10 percent of global releases of carbon dioxide.

NIST participates in the federal government's National Nanotechnology Initiative (NNI), which coordinates nanotechnology-related activities of 25 agencies. NIST Nanotechnology-related efforts are aligned with seven of the NNI's eight categories of research and other activities:

Instrumentation research, metrology, and standards—This research area is NIST's nanotechnology strong suit, a natural fit for an agency that serves as the nation's measurement authority and its link to the international measurement system. NIST accomplishments in this area—ranging from measurement reference materials, to electron counters, to single-molecule measurements—contribute to nearly every nanotechnology-related pursuit.

Nanomaterials—Engineering matter on the nanoscale makes it possible to tailor-make materials optimized for specific uses. To study these new materials, NIST is developing new instruments to probe their properties and three-dimensional atomic structures, and devising high-speed screening methods so that future "nanoengineers" can quickly evaluate their creations.

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[1] http://www.nist.gov/public_affairs/techbeat/tb2008_0108.htm#gold
[2] http://www.nist.gov/public_affairs/techbeat/tb2008_0513.htm#nanotubes
[3] http://www.nist.gov/public_affairs/techbeat/tb2007_0201.htm#magnets
[4] http://www.nist.gov/public_affairs/techbeat/tb2008_0219.htm#her2
[5] http://www.nist.gov/public_affairs/techbeat/tb2007_1025.htm#nanowire
[6] http://www.nist.gov/public_affairs/techbeat/tbx2007_0712.htm
[7] http://www.nist.gov/public_affairs/techbeat/tb2007_0119.htm#nanodots
[8] http://www.nist.gov/public_affairs/techbeat/tb2007_0330.htm#cement

Fundamental nanoscale phenomena and processes—NIST research contributes fundamental knowledge and theoretical frameworks to aid our understanding of nanoscale structures, processes, and mechanisms, pointing the way to new opportunities and future applications.

Nanomanufacturing—NIST research is furthering the development of reliable, cost-effective methods for processing nanomaterials and for producing, assembling, and integrating commercially viable nanoscale materials, devices, and systems.

Nanoscale Devices and Systems—NIST is developing measurement tools and methods necessary to improve and further miniaturize electronic, magnetic, and other types of devices and systems. NIST also leverages advances in nanotechnology to improve its measurement capabilities and services in a wide range of technical areas that underpin research and commerce.

Environment, Health, and Safety (EHS)—NIST research and services are essential to minimizing the potential risks of nanotechnology while maximizing its intended benefits. NIST is the coordinating federal agency under NNI for EHS work on the instrumentation, metrology, and analytical methods for identifying and preventing risks posed by engineered nanomaterials.

Major Research Facilities and Instrumentation Acquisition—NIST funds and manages facilities and a large assortment of world-class instruments, including custom-made equipment designed to tackle key measurement challenges. This collection of advanced tools is a valuable hub in the nation's evolving science and engineering infrastructure for nanotechnology research and development. The centerpiece in this collection is a new shared-use facility, the NanoFab[9]. Established in May 2007, this nanofabrication and nanomeasurement facility includes a 19,000-square-foot cleanroom featuring more than 50 state-of-the-art tools. The NanoFab is open to researchers on a cost-reimbursable basis, providing equipment, expert training, and flexibility.

NEW FUNDING OPPORTUNITIES IN 2009

The American Recovery and Reinvestment Act of 2009 (Recovery Act) was signed into law by President Obama on February 17, 2009. The Act includes measures to modernize our nation's infrastructure, enhance energy independence, and expand educational opportunities. The Act provides a total of $610 million in funding to NIST, including:

- $220 million for NIST laboratory research, measurements, and other services supporting economic growth and U.S. innovation through funding of such items as competitive grants; research fellowships; and advanced measurement equipment and supplies;
- $360 million to address NIST's backlog of maintenance and renovation projects and for construction of new facilities and laboratories, including $180 million for a competitive construction grant program for funding research science buildings outside of NIST;
- $20 million in funds transferred from the Department of Health and Human Services for standards-related research that supports the security and interoperability of electronic medical records to reduce health care costs and improve the quality of care; and
- $10 million in funds transferred from the Department of Energy to help develop a comprehensive framework for a nationwide, fully interoperable smart grid for the U.S. electric power system.

Applications for funding will be accepted once instructions are posted for specific competitions on the NIST website, www.nist.gov/recovery.

[9] http://www.cnst.nist.gov/nanofab/nanofab.html

NNI Infrastructure & Funding

- **Dept. of Energy Participation: see nano.energy.gov**
  - Nanotechnology Application Area: Energy
  - FY07 $236M (actual)
  - FY09 $311M (proposed)
  - Now includes Office of Science, Fossil Energy, and Energy Efficiency & Renewable Energy

- **Dept. of Energy, Office of Science, Basic Energy Sciences**
  - Two support streams:
    - Major Research Facilities & Instrumentation Acquisition: DOE supports major user facilities that are available to the scientific community free of charge for nonproprietary research, accessed by peer-reviewed proposal mechanisms
      - Light Sources (ALS, NSLS, SSRL, APS, LCLS*, NSLSII*): 8492 users
      - Neutron Sources (SNS, LANCE, HFIR): 770 users (includes 89 from IPNS, now closed)
      - Electron Beam Characterization Centers (EMC, NCEM, SHaRE): 449 users
      - Nansoscale Science Research Centers (CNM, CNMS, CINT, CFN, MF): 1278 users (user statistics for FY08, from http://www.science.doe.gov/bes/users.htm)
    - Fundamental Nanoscale Phenomena and Processes, Nanomaterials, and other Program Component Areas as secondary priorities. Direct support via DOE's broad solicitation for the core program, occasional specific solicitations on particular topics, and through ongoing programs such as SBIR and EPSCoR

NNI Infrastructure & Funding

- **DOE through different program branches has developed a structure that supports discovery research and use-inspired basic research, through to applied research and technology maturation & deployment**
  - Office of Science Basic Energy Sciences supports discovery research and use-inspired research
  - DOE Applied Energy Offices (EERE, NE, FE, OE, EM, RW,…. through programs such as Nanomanufacturing) support applied research, tech maturation and deployment
  - New kid on the block: ARPA-E

- **Pre-competitive and proprietary use of DOE facilities: a component of the path to commercialization**
  - Standardized pre-competitive institutional agreements that streamline access
    - Don't have to get each individual user agreement cleared through DOE, as is generally necessary e.g. for CRADAs
  - Light sources currently have approximately 3% proprietary use with cost recovery
  - NSRCs welcome industrial users, either pre-competitive R&D or proprietary
    - CNM had six industrial users in FY08 – plenty of room to grow

NNI Infrastructure & Funding – Department of Education

Fund for the Improvement of Postsecondary Education (FIPSE) in the Office of Postsecondary Education (OPE) provides a variety of grants.

Purpose: Innovation in educational issues from teaching, learning, curriculum development, educational technology, etc to access, affordability and accountability. Grants by invitational priority, that is, open to all disciplines.

Any number of awards can be made in the area of nano-education.

Various programs under which these grants are made are:

- The Comprehensive Program: Open to all institutions of higher education (IHEs) in the U.S. – given to a single institution or to a consortium of institutions. Generally 30 awards are made each year (Expected 100 in 2009).
- The Atlantis Program: Bilateral educational cooperation between IHEs in the U.S. and IHEs in the European Union. On average 12 awards each year.
- The U.S.-Brazil Program: Bilateral educational cooperation between IHEs in the U.S. and IHEs in Brazil. On average 10 awards each year.
- North America Program: Trilateral educational cooperation between an IHE in the U.S., IHE in Canada and IHE in Mexico. On average 10 awards each year.
- The U.S.-Russia Program: Bilateral educational cooperation between IHEs in the U.S. and IHEs in the Russian Federation. On average 3 awards each year.

NNI Infrastructure & Funding – Department of Education

The DOEd grants support efforts from development stage through to implementation stage.

- Development and testing of new ideas
- Implementation of the new product (curriculum, pedagogy, educational technology, evaluation technique, etc) in the proposed programs
- Institutionalization in grantee's institution
- Dissemination to other IHEs are important aspects(commercialization in educational sense)

From this perspective, and considering the small size of the grant funds, DOEd is primarily providing seed funding to support development of ideas that are novel but of importance to the educational community at large.

NASA and Nanotechnology

The NNI nanoRegional workshop

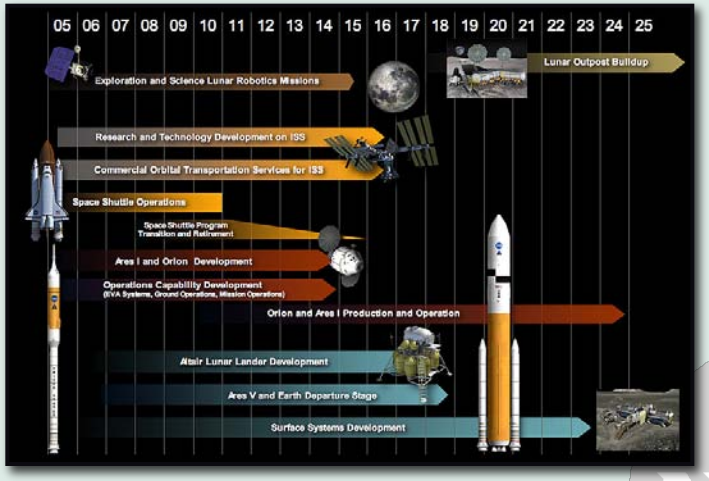
Oklahoma City, OK

April 2, 2009

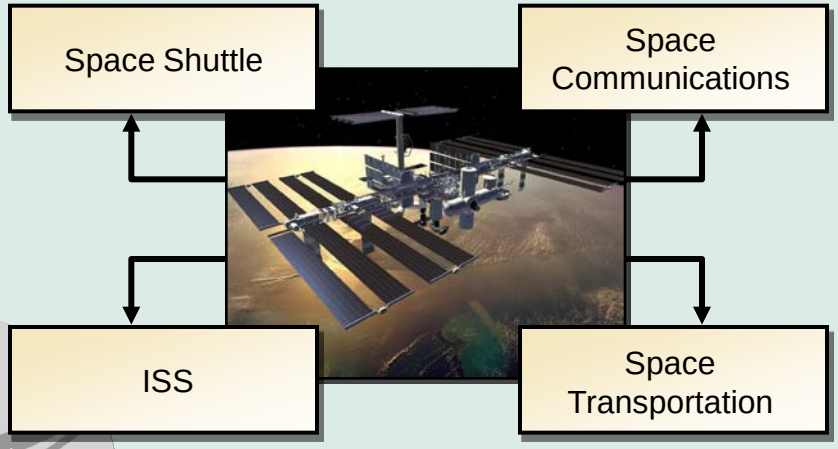
Minoo N. Dastoor, Ph.D.
Chief Technologist
IPP Office
NASA Headquarters

NASA Mission Directorates

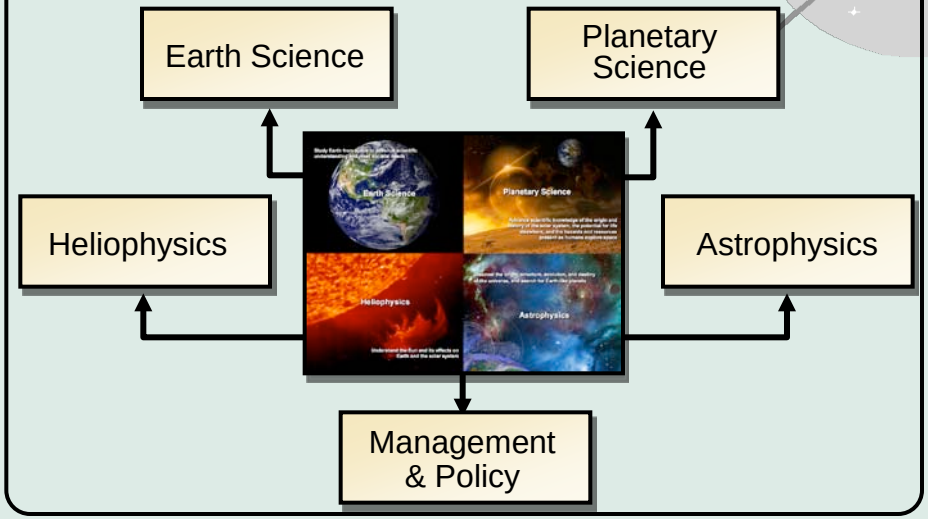
Exploration Systems



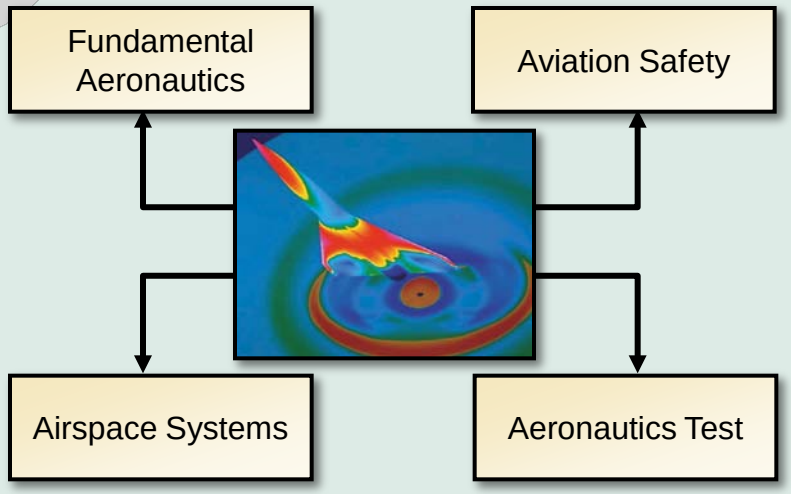
Space Operations



Science



Aeronautics Research



NASA & Nanotechnology

Benefits and Focus

Ten Most Significant Benefits

- Reduce vehicle structural weight by a factor of 3
- Application Tailored Multi-functional Materials
- Thermal Protection and Management
- Reliable Reconfigurable Radiation/Fault Tolerant Nano-electronics
- On-board Life Support Systems
- On-Board Human Health Management
- 30% lighter EVA Suit
- Micro-craft (< 1 kg) with functionality of current 100 kg spacecraft for science and inspection
- Ultra-Sensitive and Selective Sensing
- Modeling Fabrication Processes for Nano-to-Micro Interfaces

Focus of NASA Investment

- Nanostructured Materials
- Nano Electronics and Computing
- Sensors and Microspacecraft Components