

**THE U.S. NATIONAL  
NANOTECHNOLOGY INITIATIVE:  
*VISION AND BEST PRACTICES***

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**Lisa E. Friedersdorf, PhD**

Director

National Nanotechnology Coordination Office

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# THE U.S. NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

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

## **Goals:**

- Advance a world-class nanotechnology research and development program.
  - Foster the transfer of new technologies into products for commercial and public benefit.
  - Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology.
  - Support responsible development of nanotechnology.
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# NATIONAL NANOTECHNOLOGY COORDINATION OFFICE (NNCO)

**Role of the NNCO as mandated in the: *21st Century  
Nanotechnology Research and Development Act (P.L. 108-153):***

- Provide technical and administrative support
- Serve as the point of contact for the NNI
- Provide public outreach for the NNI
- Promote commercialization of nanotechnology
- Coordinate and support the reviews and assessments of the NNI

# THE NNI'S NANOTECHNOLOGY SIGNATURE INITIATIVES

Intended to be dynamic; topical areas rotate/evolve over time.

Five current signature initiatives:

- Sustainable Nanomanufacturing
- Nanoelectronics for 2020 and Beyond
- Nanotechnology Knowledge Infrastructure
- Nanotechnology for Sensors and Sensors for Nanotechnology
- Water Sustainability through Nanotechnology



# NANOTECHNOLOGY GRAND CHALLENGES

Create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain

## A Federal Vision for Future Computing: A Nanotechnology-Inspired Grand Challenge

Collaborating Agencies: Department of Energy (DOE), National Science Foundation (NSF), Department of Defense (DOD), National Institute of Standards and Technology (NIST), Intelligence Community (IC)

### Introduction

This white paper presents a collective vision from the collaborating Federal agencies of the emerging and innovative solutions needed to realize the nanotechnology-inspired Grand Challenge for Future Computing. It describes the technical priorities shared by multiple Federal agencies, highlights the challenges and opportunities associated with these priorities, and presents a guiding vision for the research and development needed to achieve key near-, mid-, and long-term technical goals. By coordinating and collaborating across multiple levels of government, industry, academia, and nonprofit organizations, the nanotechnology and computer science communities can look beyond the decades-old approach to computing based on the von Neumann architecture and chart a new path that will continue the rapid pace of innovation beyond the next decade.

### Background

On October 28, 2013, the White House announced "A Nanotechnology-Inspired Grand Challenge" to develop transformative computing capabilities by combining innovations in multiple scientific disciplines. The Grand Challenge addresses three Administration priorities—the National Nanotechnology Initiative (NNI),<sup>1</sup> the National Strategic Computing Initiative (NSCI),<sup>2</sup> and the brain research through Advancing Innovative Neurotechnologies (RAIN) initiative<sup>3</sup> (i).

**Create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain.<sup>4</sup>**

While it continues to be a national priority to advance conventional digital computing—which has been the engine of the information technology revolution—current technology falls far short of the human brain in terms of the brain's sensing and problem-solving abilities and its low power consumption. Many experts predict that fundamental physical limitations will prevent transistor technology from ever matching these characteristics.

### Call for a Coordinated Approach

In the announcement, the White House challenged the nanotechnology and computer science communities to look beyond the decades-old approach to computing based on the von Neumann architecture and chart a new path that will continue the rapid pace of innovation in information technology beyond the next decade. There are growing problems facing the Nation that the new computing capabilities envisioned in this challenge might address, from delivering individualized

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## Nanotechnology-Inspired Grand Challenges

Grand challenges are an element of the President's Strategy for American Innovation that help catalyze breakthroughs needed to advance national priorities. A nanotechnology-inspired grand challenge is an ambitious but achievable goal that harnesses nanoscience, nanotechnology, and innovation to solve important national or global problems and has the potential to capture the public's imagination.

In an October 2014 assessment of the NNI, the President's Council of Advisors on Science and Technology (PCAST) recommended that agencies engage research, development, and industrial communities in the identification and selection of grand challenges in order to focus and amplify the impact of Federal nanotechnology activities.

In June 2015, OSTP, working with the Federal agencies that participate in the NNI, issued a Request for Information seeking suggestions from the public for nanotechnology-inspired grand challenges. After considering over 100 responses, on October 28, 2015, OSTP announced the first such grand challenge—one that addresses three Administration priorities: the National Nanotechnology Initiative, the National Strategic Computing Initiative (NSCI), and the BRAIN initiative.


### Related Resources

- A Federal Vision for Future Computing: A Nanotechnology-Inspired Grand Challenge (White Paper)
- A Nanotechnology-Inspired Grand Challenge for Future Computing (OSTP Blog)
- A Call for Nanotechnology-Inspired Grand Challenges (OSTP Blog)
- White House 21st Century Grand Challenges
- National Strategic Computing Initiative
- BRAIN initiative

### A Nanotechnology-Inspired Grand Challenge for Future Computing:

Create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain.

While it continues to be a national priority to advance conventional digital computing—which has been the engine of the information technology revolution—current technology falls far short of the human brain in terms of both the brain's sensing and problem-solving abilities and its low power consumption. Many experts predict that fundamental physical limitations will prevent transistor technology from ever matching these key characteristics. This grand challenge will bring together scientists and engineers from many disciplines to look beyond the decades-old approach to computing based on the von Neumann architecture as implemented with transistor-based processors, and chart a new path that will continue the rapid pace of innovation beyond the next decade. **Read more.**

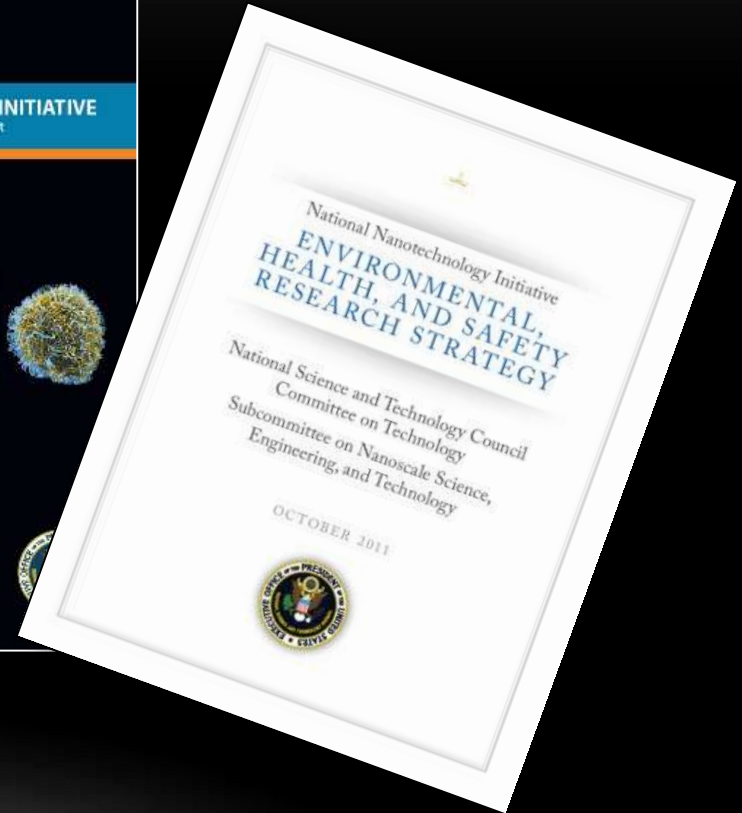
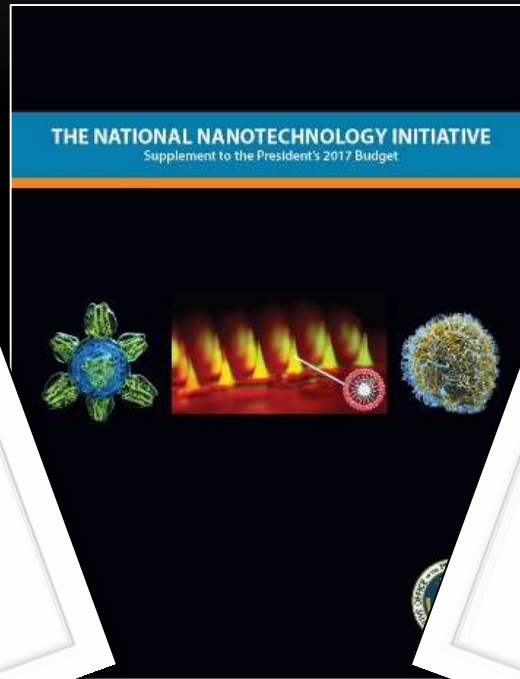
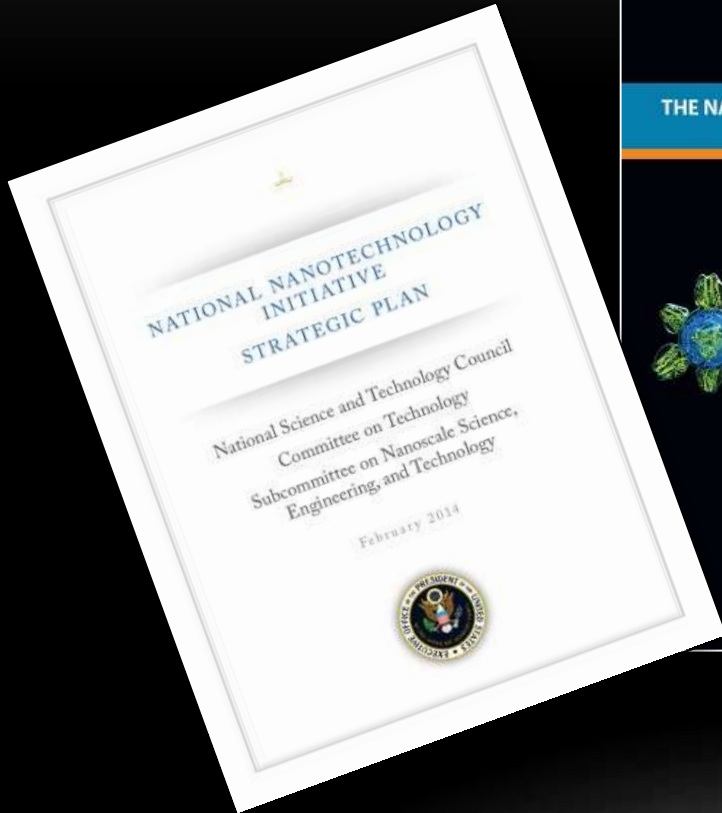


This challenge will look beyond conventional computing based on the von Neumann architecture.

Read more about:

- A Federal Vision for Future Computing: A Nanotechnology-Inspired Grand Challenge (White Paper)
- Statements of support for this challenge from Federal agencies (DoD, DOE, DARPA, NIST, NSF)
- Statements of support for the challenge from other organizations (GCC, Moore Foundation, IBM, IEEE, Hewlett-Packard, SRC)
- Workshop reports and white papers relevant to this challenge
- Meetings and webinars relevant to this challenge
- Funding opportunities relevant to this challenge
- Frequently asked programmatic and technical questions about this challenge

# KEY NNI DOCUMENTS





# GUIDANCE DOCUMENTS ON THE SAFE USE OF NANOTECHNOLOGIES



*Examples of Guidance Documents Developed by NNI Agencies*

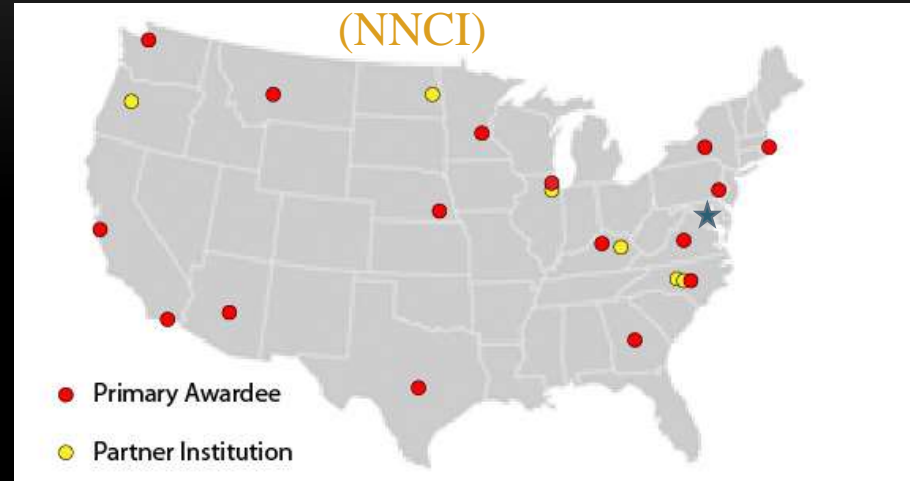


# NNI USER FACILITIES



*Dan Sears, the University of North Carolina at Chapel Hill*

## NSF National Nanotechnology Coordinated Infrastructure



★ NIST Center for Nanoscale Science and Technology (CNST)

## DOE Basic Energy Sciences User Facilities



Nanoscale Science Research Centers  
Electron-Beam Microcharacterization Centers  
Light and Neutron Sources

# COLLABORATION FOR GREATER IMPACT IN EDUCATION AND OUTREACH



**Webcast: November 24, 2015**  
**For Students in Grades 6-8**

How smart is smart? How can nanoscale matter improve our lives? **Innovative WorkShop: Nanotechnology** explores the cutting-edge science and engineering of nanoscale matter. Nanotechnology involves manipulating and controlling matter from one nanometer to 100 nanometers. From airplanes to baseball bats, nanomaterials offer a variety of desirable properties such as strength and conductivity. Graphene and carbon nanotubes are wonder materials made entirely from carbon atoms. **Innovative WorkShop** explores their structure of matter and how engineers can build with these new materials.

Students will learn about moving atoms, electron clouds, and how temperature affects matter from Joseph Bonito at the **National Institute for Standards and Technology**. **Innovative WorkShop** student reporter takes students into the National Institute for Standards and Technology's **Nanofab** where scientists work in a clean room to build highly structured nanoelectronic circuits. Nanoelectronics is a field of study where researchers are still creating new methods to build.

Nanotechnology is an innovation with big potential even though it's small in size. So small, it can't be seen with the human eye or even your school's microscope. In 1981, the scanning tunneling microscope (STM) launched the age of nanotechnology. It can see individual atoms and even move them to create advanced nanostructures.

Scientists use physical and chemical properties to describe and classify matter. Things like color, shape or texture can tell us about the matter and how that matter behaves. Well, nanotechnology isn't just exciting because it's small but also because of the new properties that emerge.

Nanotechnology is more than just one innovation. It's a movement that's revolutionizing the materials we build with and shows us how humans push for new ways of thinking and doing.

**Standards of Learning**

The content for **Innovative WorkShop: Nanotechnology** was guided by National Institute of Standards and Technology staff, National Nanotechnology Coordination Office staff, FCPS curriculum specialists, and FCPS Information Technology staff.



**NBC LEARN**

Free Resources > Nanotechnology: Super Small Science

**NANOTECHNOLOGY**  
super small science

**Nanotechnology: Super Small Science**

Watch 1 of 10

Watch 2 of 10

Watch 3 of 10

Watch 4 of 10

Watch 5 of 10

Watch 6 of 10

Watch 7 of 10

Watch 8 of 10

Watch 9 of 10

Watch 10 of 10



**community idea stations**

WE'VE GOT • WHITE PEG • MOVIE PEG • BE'S WEVE

HOME WATCH LISTEN LEARN SUPPORT CONTACT ABOUT

**What's a Quantum Dot?**

The 10/20/2015 • 04:00pm • Video Player

Science Matters 10/20/2015 4:00pm

Left to Right: Al Burke (animator), Ray Forbes (narrator), Dr. Bruce Frazier (Music faculty), Mary Anna LaPrade (Graphic Design faculty), Dr. Williams (narrator), and Brittany Johnson (composer).

New Showing: Dr. Alex Hone at the Science Museum of

# RESOURCES FOR TEACHERS AND STUDENTS

## Nano.gov

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### Education

A highly skilled and motivated workforce with increasingly more knowledge of science, technology, engineering, and mathematics (STEM) will be required to ensure America's global competitiveness. Over the past 15 years, the Federal government has invested over \$22 billion in R&D under the auspices of the National Nanotechnology Initiative (NNI) to understand and control matter at the nanoscale and develop applications that benefit society. As these nanotechnology-enabled applications become a part of everyday life, it is important for students to have a basic understanding of material behavior at the nanoscale, and some states have even incorporated nanotechnology concepts into their K-12 science standards. Furthermore, application of the novel properties that exist at the nanoscale, from gecko-inspired climbing gloves and invisibility cloaks, to water repellent coatings on clothes or cellphones, can spark students' excitement about STEM fields.

The educational efforts of the NNI span from pre-K to gray with information ranging from that for the general public to formal lesson plans and degree programs. This section of Nano.gov provides resources for students and teachers, information about nanotechnology programs from community colleges to PhD's, a description of the growing Nano and Emerging Technologies Student Network, and links to multimedia content, videos, and animations.

Additionally, a searchable database of nanotechnology education resources can be found at [nanosHE.org](http://nanosHE.org).

#### For K-12 Students



From textbooks to online games, this section for students provides new and exciting ways to learn about nanotechnology.

#### For K-12 Teachers



From classroom resources to continuing education, this section is for teachers who want to know more about nanotechnology.

#### U.S. Nano and Emerging Technologies Student Network



Connecting student groups devoted to raising awareness of emerging technology and promoting opportunities for students involved in research, invention, and entrepreneurship.

#### Teaching Nano and Emerging Technologies Network



Connecting K-12 teachers who are or want to teach nano and emerging technologies to their students in order to excite them about STEM and prepare them for the future.

#### College, Grad School, and Post-Doc Opportunities



From a master in nanotechnology to a PhD, this section has a list of higher education programs available across the country.

#### Associate Degrees, Certificates, & Job Info



New jobs and training programs are being created to meet the market demand. Find 2-year degree, training programs, and career resources here.

#### Resources for Nanotechnology Laboratory Safety



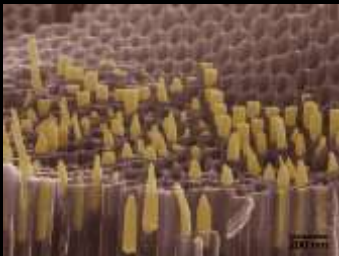
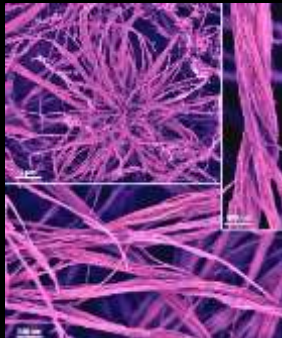
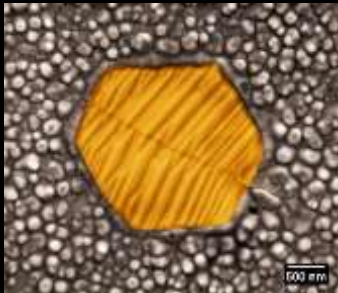
Learn to foster an effective culture of safety in the research laboratory.

#### Multimedia Resources and Content



Cool images, animations, and videos to learn more about nanotechnology. Also includes links to NNI multimedia content to give you the opportunity to tell your nanotechnology story!

# BUILDING THE NANOTECHNOLOGY COMMUNITY









## Communities of Research (CoRs)

### Databases & Computational Modeling for NanoEHS

Fred Klaessig Pennsylvania Bio Nano Systems, US

Barry Hardy, Douglas Connect, Switzerland

### Exposure through Product Life

Paul Westerhoff, Arizona State University, US

Christof Asbach, Institute of Energy and Environmental Technology, Germany

### Risk Management & Control

Vince Castranova, National Institute of Occupational Safety and Health (NIOSH), US

Ulla Vogel, National Research Centre for the Working Environment (NRCWE), Denmark

### Risk Assessment

Christine Hendren, Duke University, US

Janeck Scott-Fordsmand, Aarhus University, Denmark

### Characterisation

Anil Patri Food and Drug Administration, US

Kenneth Dawson, University College Dublin, Ireland

### EcoToxicity

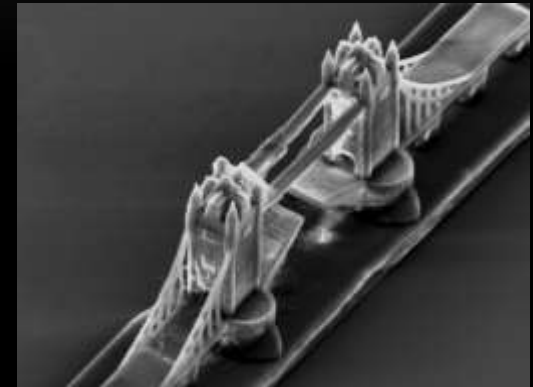
Elijah Petersen, National Institute of Standards & Technology, US

Nico van de Brink Wageningen University, Netherlands

### Human Toxicity

Gabriele Windgasse, Columbia University, US

Albert Duschl, University of Salzburg, Austria



[http://www.tuwien.ac.at/en/news/news\\_detail/article/7444/](http://www.tuwien.ac.at/en/news/news_detail/article/7444/)





# THANK YOU.

Lisa E. Friedersdorf, PhD  
Director  
National Nanotechnology Coordination Office

4201 Wilson Blvd  
Stafford II Room 405  
Arlington, VA 22230  
<http://www.nano.gov/>  
[lfriedersdorf@nnco.nano.gov](mailto:lfriedersdorf@nnco.nano.gov)  
703-292-8626