

The National Institute for Nano-Engineering

A Public-Private partnership for innovative research and workforce development



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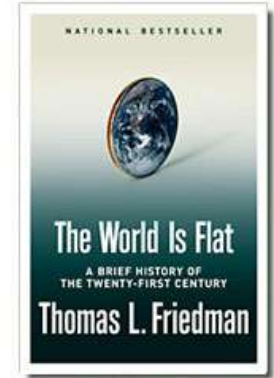
Sandia is a Multiprogram Laboratory Operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy Under Contract DE-ACO4-94AL85000.

Significant change in science & technology world

➤ Globalization: The world is increasingly competitive

Government, university, industry partnerships are addressing key technical topics in other countries

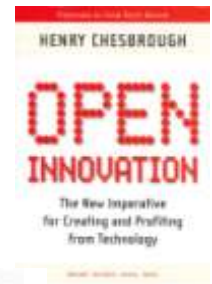
Global competition for talent



➤ Complexity of technical issues: The need to partner effectively

We must taking advantage of the best resources available

- New partnership models
- New approaches to intellectual property management
- People must learn strong teamwork early in their careers



➤ Significant reductions in U.S. industrial R&D Industrial research labs can no longer drive the breakthrough science & engineering in the U.S.



Bell Laboratories



U.S Department of Energy is in a position to play a bigger role

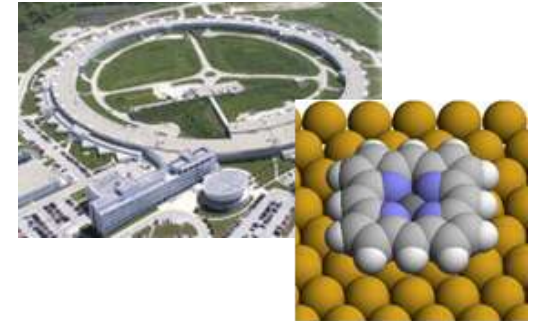
Assuring a sustainable energy future



Ensuring National Security



Nurturing the nation's S&T base



- Important national missions
- Unique national facilities around the country
- >21,000 DOE scientists & engineers
- The largest supporter of physical science research
- Ability to integrate technology
- Strong academic partnerships

All the R&D sectors recognize a few key challenges

Accelerating Engineering Innovation Summit, Sandia National Labs Albuquerque, May 31st - June 2nd, 2006



Participants

Corning	Harvard	Harvey-Mudd
Exxon-Mobil	U Florida	RPI
Goodyear	U Michigan	MIT
Hewlett Packard	U Wisconsin	Notre Dame
IBM	U Illinois	Yale
Intel	UC Davis	U New Mexico
Lockheed Martin	UC Santa Barbara	U Texas Austin
Microsoft	Rose-Hulman	Oak RidgeNL
Monsanto	Los Alamos NL	DOE

A few key issues were identified

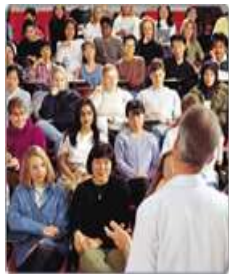
- 1) **Partnerships will be the key to future breakthroughs.**
 - Engineers need to know how to partner effectively.
 - Partnering among U.S. institutions must be simpler.
- 2) **Engineers need broader experience.**
 - Multi-disciplinary education is important, but the challenges are great.
- 3) **A concerted effort is needed to attract, inspire & retain top US students.**
 - Bright minds want important problems and capabilities to solve them.

Innovation Hubs: A future vision

OUTCOMES

- Develop future science & engineering leaders \Rightarrow depth & breadth, diversity, experience
- Create new breakthroughs & reduce the innovation cycle time
- Expand lab outreach & partnerships \Rightarrow capitalize fully on existing infrastructure & investments
- Enhance economic competitiveness & lab vitality

University



Education Innovation



Infrastructure

Government



Industry



Innovation Institutes could be formed at DOE National Laboratories throughout the country



**America COMPETES Act:
Discovery Science & Engineering Innovation Institutes**

Building from the best aspects of successful models

International Innovation Institutes



KIST Korea Institute of
Science and Technology



**BECOME ONE OF THE
MOST WANTED ENGINEERS
IN THE UNIVERSE**

DOE User Facilities



National Science Foundation Centers

Research Consortia



Semiconductor
Research Corp.

'Our members state that SRC students are worth ~\$100k more when hired because of the broadening experience we provide'. Steve Hillenius, SRC

Internships, fellowships, K-12 outreach

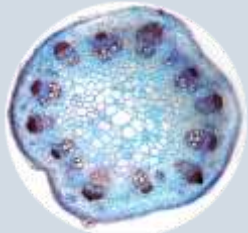


Prototyping the Innovation Institute concept: The National Institute for Nano-Engineering

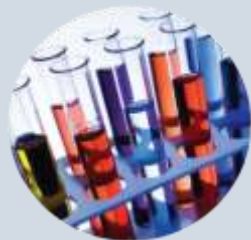
NINE Mission: *Drive new innovations and develop the next generation of engineering leaders in micro- and nano-technology*



Inherently interdisciplinary



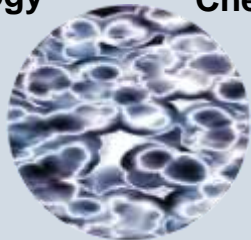
Biology



Chemistry



Theory & Modeling



Materials Science



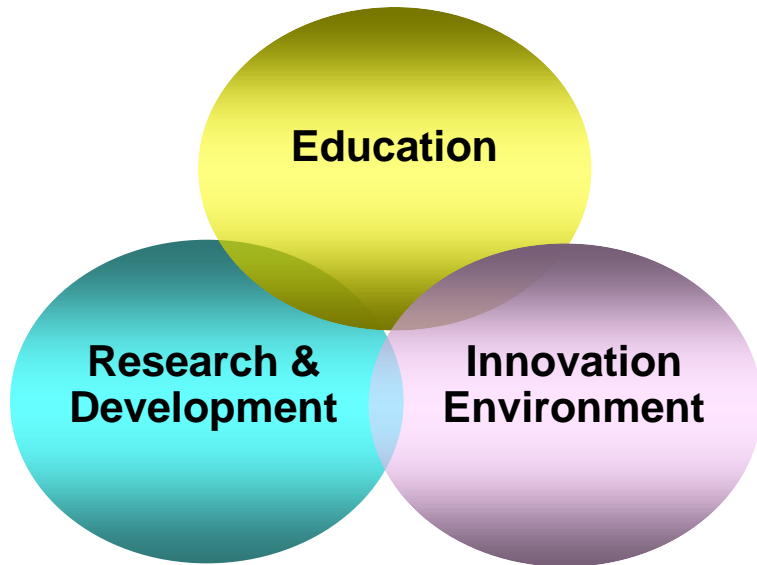
Physics

High-leverage applications

- New electronics
- Sensors
- Catalysts
- High-performance materials
- Energy storage
- Optics
-

NINE: complementing universities & coupling to industry

Interdisciplinary teams focused on nanoengineering solutions



A hub and spoke model

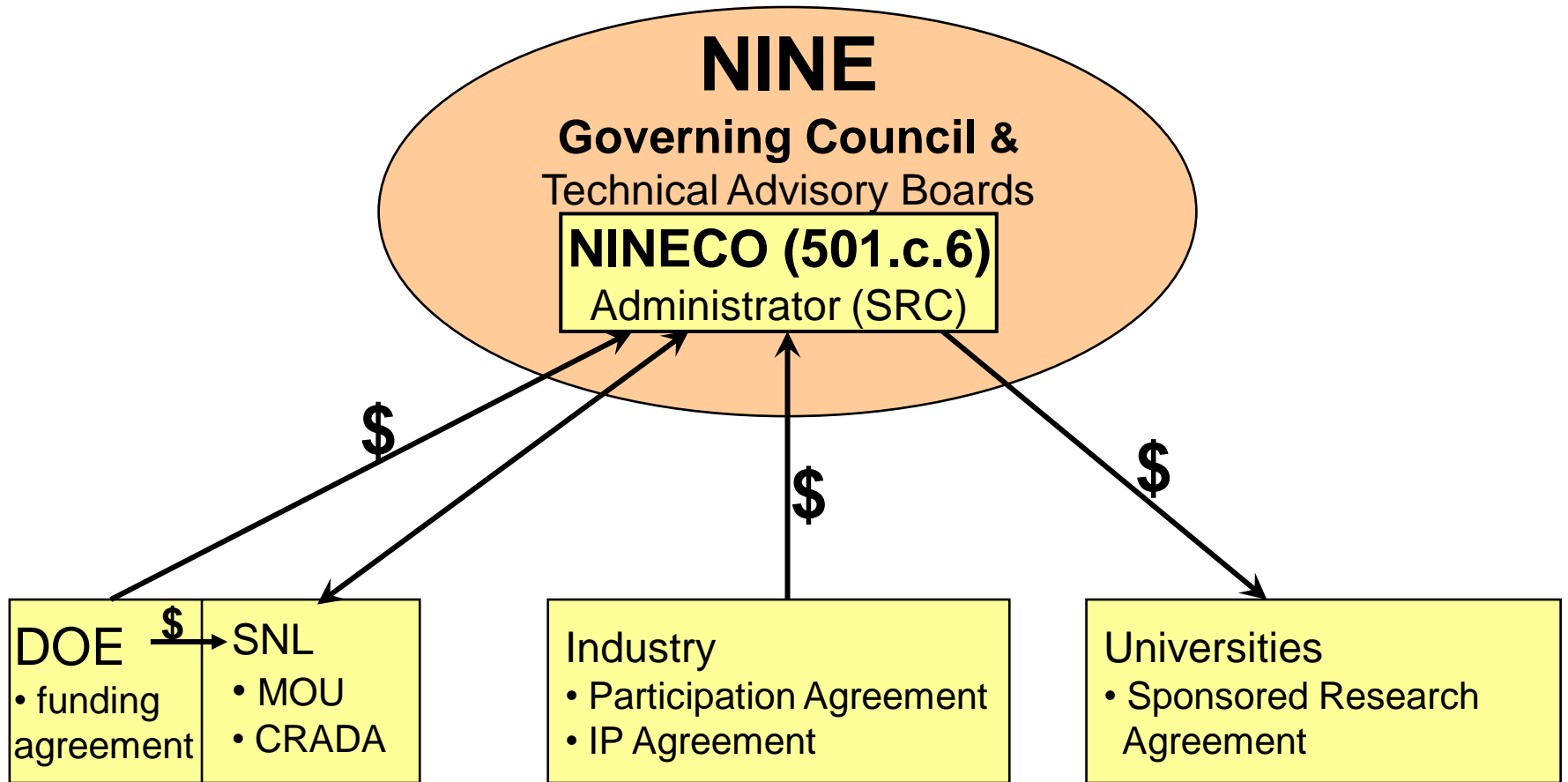
- **Broad, experiential learning**
 - ✓ Multi-disciplinary research team
 - ✓ Involvement in the full product cycle
 - ✓ Significant problems
 - ✓ Mentoring
- **Experience with state-of-art S&E tools**
 - ✓ MEMS and μ -fabrication
 - ✓ high-performance computing
 - ✓ nano-engineering integration tools
- **Innovation Lecture Series**
 - ✓ Entrepreneurism, IP, business
- **Access to partner university courses**
 - ✓ Graduate & undergraduate
- **Jointly developed target area courses**

***NINE*: A three-year journey**

- **NINE, started in 2006, has been guided by an industry-university advisory group as a means to support university research in partnership with SNL researchers.**
- **Industry Partners who helped develop the NINE concept :**

Goodyear	Exxon Mobil	Corning
Intel	Lockheed Martin	IBM
- **Semiconductor Research Corporation worked with NINE to form NINECO to act as the administrative manager for the program.**
- **NINE's current university partners include:**
 - Harvard University
 - Harvey Mudd College
 - MIT
 - Notre Dame University
 - Rice University
 - Rensselaer Polytechnic Institute
 - University of California at Davis
 - University of Florida
 - University of Illinois
 - University of New Mexico
 - University of Wisconsin
 - University of Texas at Austin
 - Yale University

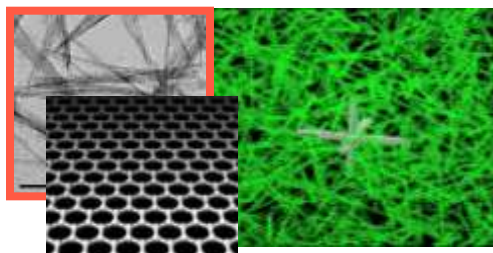
NINE's Structure & Agreements



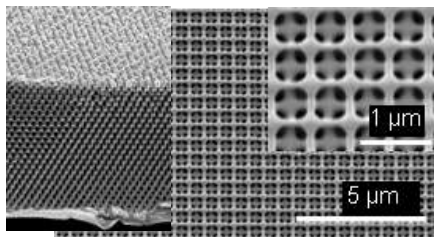
Sandia Roles: Select mission-relevant projects
Implement projects with university partners & students
Provide Sandia facilities, capabilities, mentors
Provide student opportunities to become innovators

Accomplishments of initial seed projects

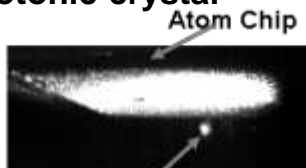
15 Technical Projects with more than 60 publications and presentations
Includes work of 40 students, 26 university faculty.



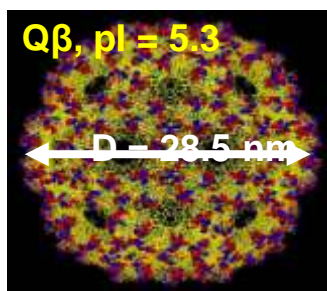
Interfacial Property Control of Elastomeric Nanocomposites



Proximity-field Patterning of 3D Nanostructures including Si photonic crystal

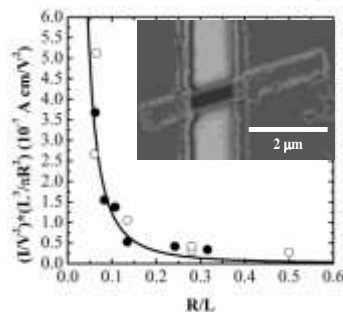
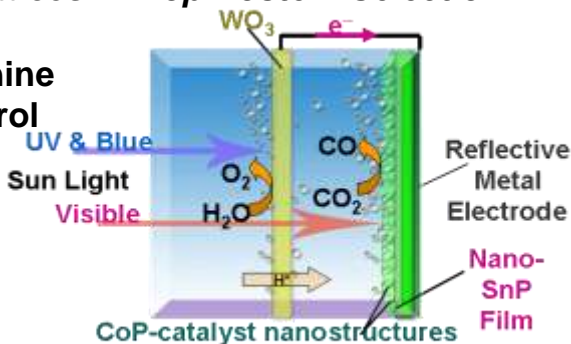


Atom Chip
Cloud of Laser Cooled Rb atoms
Quantum Information Processing

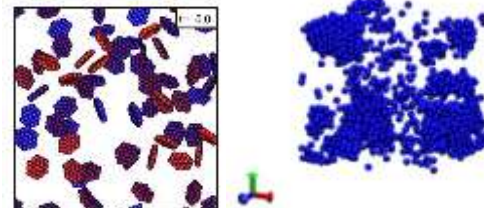


Time-Resolved Self-Assembly of 2D Virus-like Nano Particle Lattices "Top Poster" Selection

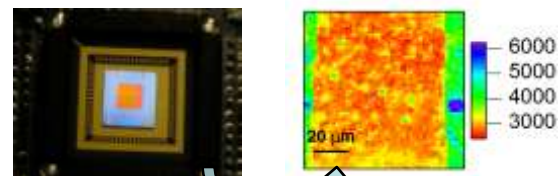
Sunshine to Petrol



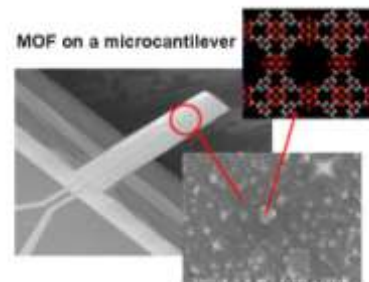
New scaling law for conduction in nanowires



Understanding rheology, assembly and functionality of nanocomposites.



2D Free-standing and Functional Monolayer NP/Polymer Array "Top Poster" Selection



First use of nanoporous Metal-Organic Framework in a sensor

Student summer programs: a spectrum of opportunities



- 122 students from 23 universities participating in the NINE program
- 76 (80% grad students) did nano-engineering research with mentors in 10 Sandia Centers and one industry site, with >60 publications & presentations to date
- NSF-SNL collaboration – 15 NSF-sponsored students in '08 & '09 programs
- NanoExpo Summer Program offers hands-on activities and broad experiences
 - Lab experiences – Making & measuring nanoparticles, work with AFM, SEM, TEM
 - Tours of technical facilities, presentations from other NINE students
 - Seminars on innovation, business, IP, markets, social issues in nanotech
 - NINE Student Workshop – presentations by students on their research
 - Nanofest: Nano-Engineering and our Global Energy Future

NINE leverages Sandia's S&T infrastructure

Workforce Development & Innovation Partnerships



“Sandia’s facilities are unique in combination and provide the ability to produce prototype nano-micro technology systems involving multiple facilities and capabilities, a difficult opportunity for universities to provide their students.” – David Duquette, RPI and Kevin Jones, Univ.of Florida.

Center for Integrated Nanotechnologies



Discovery science & user support

High performance computing



Platforms & codes

Microsystems & Engineering Sciences Applications



Technology development & product realization



Office of Basic Energy Sciences



NINE is designed to meet each partner's needs

■ Sandia, DOE, and the nation

- Innovative solutions to difficult national security problems, including defense, energy, workforce, economic security

■ University students and faculty

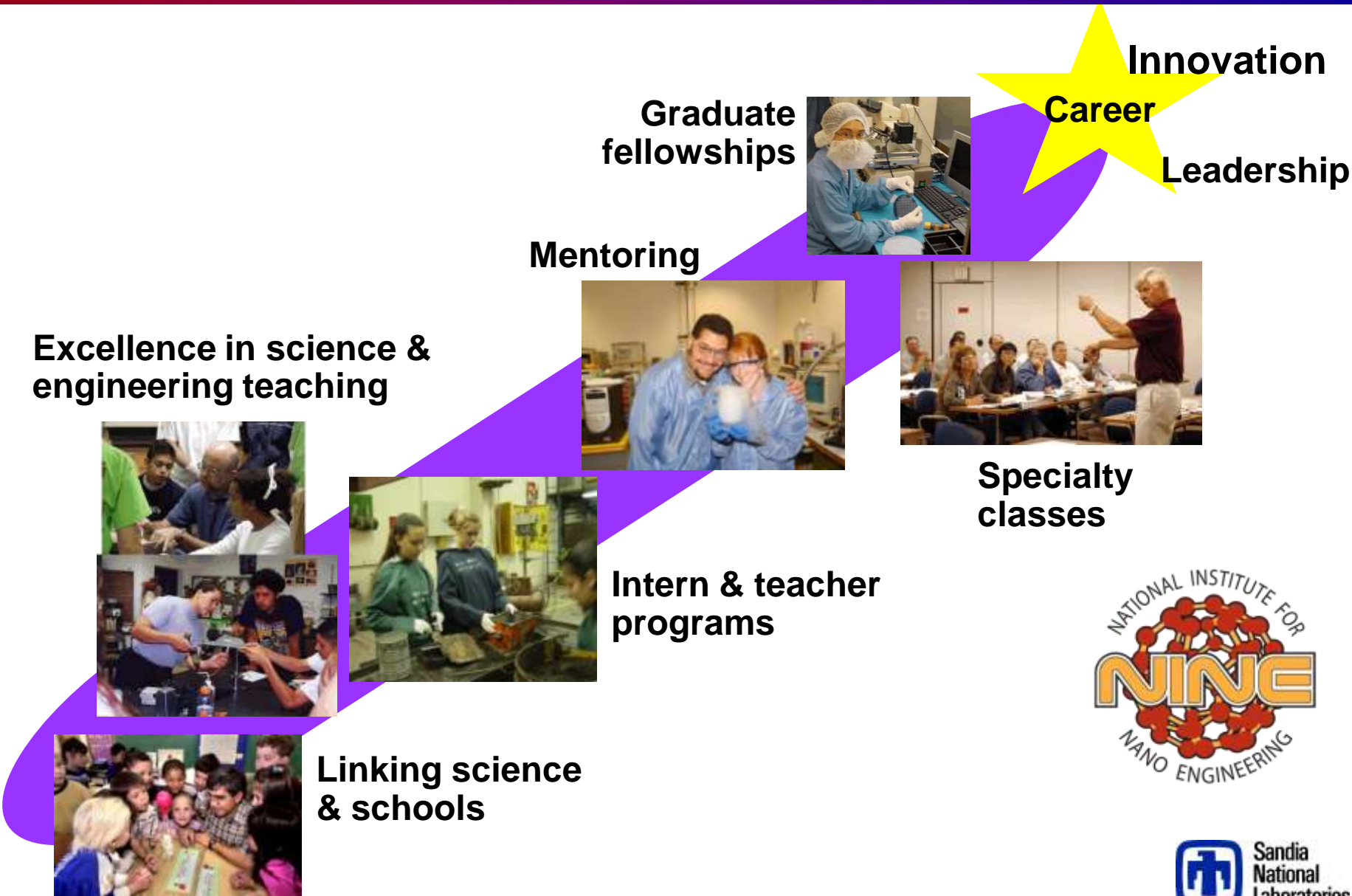
- Exciting large scale research opportunities for students & faculty
- Access to top facilities
- Intellectual Property ownership

■ Industry

- Financial leverage for innovative pre-competitive research
- IP in areas key to future markets
- Access to top new hires
- Part of a nationwide network of key companies



Innovation Institutes can connect the entire talent pipeline through full-spectrum outreach



NINE is transitioning to full consortium operations

NINE has just completed selection of new 3-year projects:

- *Responsive Nanocomposites*
- *Integration of Block-Copolymer with Nanoimprint Lithography*
- *Scalable Assembly of Patterned Ordered Functional Micelle Arrays*
- *Enabling Self-Powered Ferroelectric Nano-Sensors*
- *plus an additional energy-focused project (to be selected)*

Funding ~\$12M over 3 years:

- DOE - \$4.7M
- Sandia National Labs - \$6.6M
- Industry - \$100k/yr each

What's next?

Expand NINE's membership: industry, labs, universities, agencies

Offer NINE as a prototype Public-Private Partnership concept for federal labs

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