National Lab-Centered Innovation Institutes for Creating the Next Generation of Innovation Leaders

SAND2013-6923C

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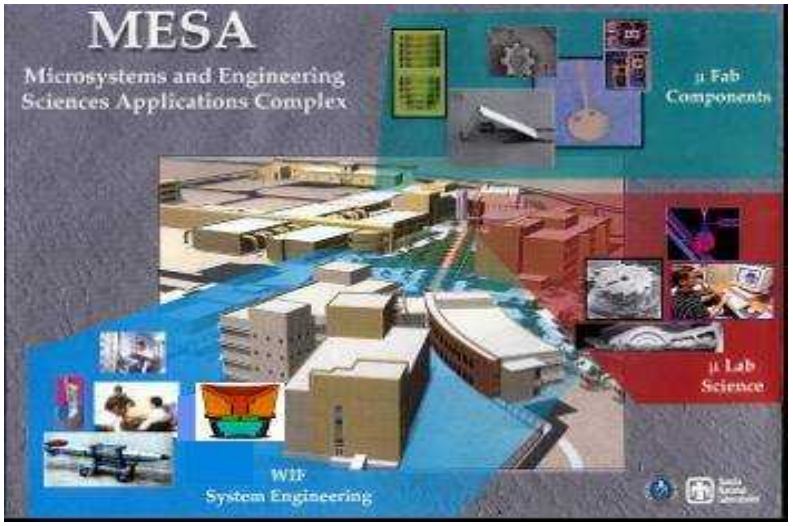
Two Approaches:

The MESA Institute

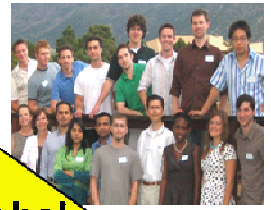


Goals: **2001-2005**

- **Training students/ New hires**
- **University Collaboration**
- **Micro/nano leadership**

The National Institute for Nano-Engineering (NINE)





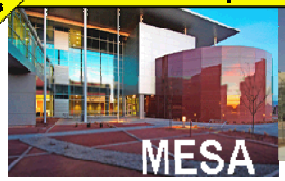
Students
Mentors
Facilities

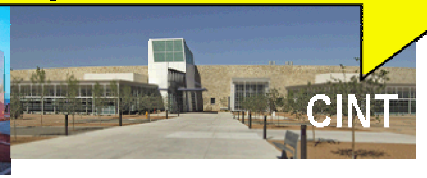
Technical Depth *Leadership* *Breadth* *Multi-disciplinary Teams*

Global Innovation Leaders

A new GUI approach!

A new result!





2007-2012

Create the next generation of Small Technology innovators and enable the nation to benefit from their innovations through work on nationally important projects with Sandia facilities and mentors.

Sandia National Laboratories

Microsystems Engineering and Sciences Applications

$462M

Microsystems Laboratory Building

391,000 SF

Complete in '07-'08

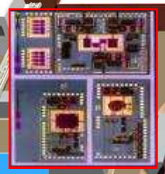
Weapons Integration Facility

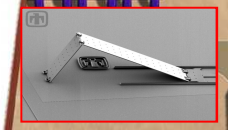
648 people

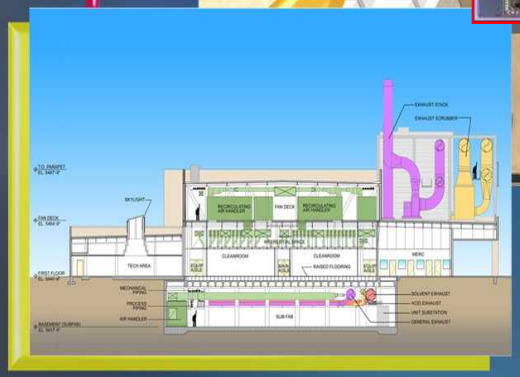
Science

System Engineering

Microsystems Fabrication Facility







Components

Complete Integrated Capability for Design, Fabrication, Packaging

MESA

Microsystems and Engineering Sciences Applications

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

NNSA National Nuclear Security Administration

Sandia National Laboratories

MESA's Micro-Nano Tech Deployment Is A Journey with Federal Agencies, Industry, Universities & Colleges

Sponsor projects

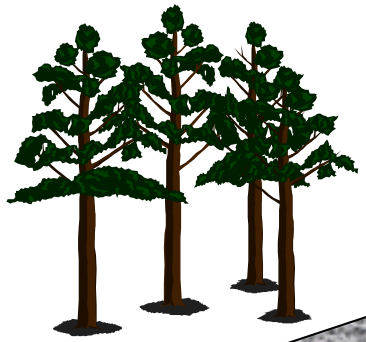
Federal Agencies

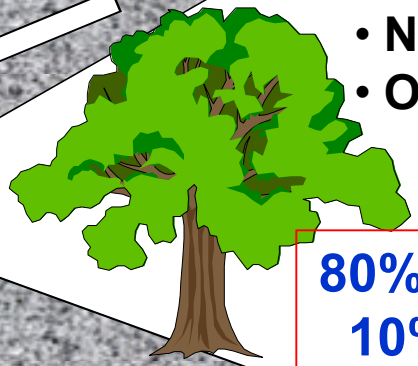
- DOE/NNSA
- DoD
- NSF
- Others

Industry connections made through the Sandia researchers

Industry

- Military Industrial
- Telecommunications
- Bio-tech & Healthcare
- Transportation
- Others





80% grad students
10% undergrads
10% CC students

34 Universities & Colleges

- NSF Centers of Excellence
- Research universities
- Bachelors/ Masters
- Community colleges

MESA

Sandia National Laboratories

MESA Institute – Goals, Strategies, Implementation

Goals:

1. Create and train a pipeline of top students in microsystems for Sandia's business units
2. Influence and be influenced by leading edge research in microsystems
3. Identify national needs for microsystems and encourage relevant micro-nano work by universities/industry/government in partnership with MESA

Strategies:

1. Engage US students and profs with Sandia microsystems staff & projects
2. Establish collaborative relationships with a broad range educational institutions whose interests match Sandia's
3. Involve MESA in leadership activities in micro-nano technologies

Implementation:

The MESA Institute shared the cost for students to come to Sandia to work with Sandia researchers in on-going projects. Classes provided for students. 189 students from 38 universities and colleges participated over five years. Total 5-year cost of $5M.

A simple, cost-effective program that produced new hires, collaborations, and cost effective research

Sandia National Laboratories

NINE - a nationwide network of partners…

… who joined together to support innovation, workforce development and economic competitiveness in Nano-Engineering.

$33.5M over 6 years from:

- **DOE - $5M**
- **Sandia National Labs - $28.5M**

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Sandia National Laboratories

Sandia began the first NINE projects in 2007

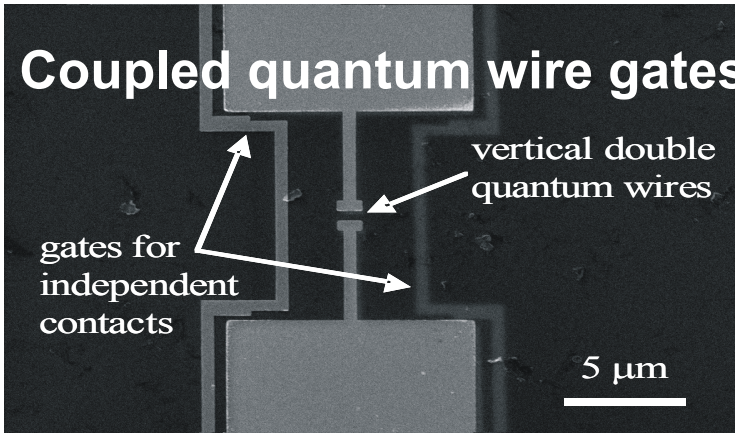
Accelerating Engineering Innovation Summit
Albuquerque, May 31st - June 2nd, 2006

- $23M seed funding (over 3 yrs)
- Dedicated NINE research projects
- 6 Industry partners, 12 univ partners

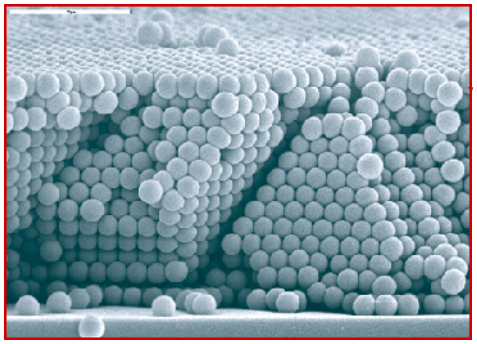
Three theme areas were selected by the NINE partners

Nano-based energy technologies

Next-generation Nanoelectronics



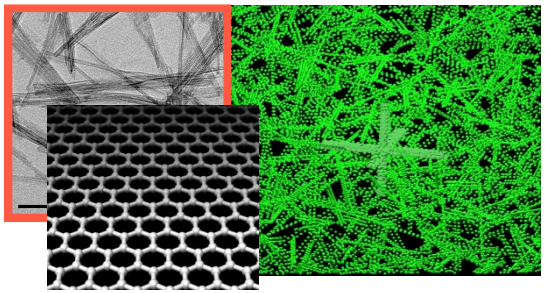
Nanomaterial processing & manufacturing



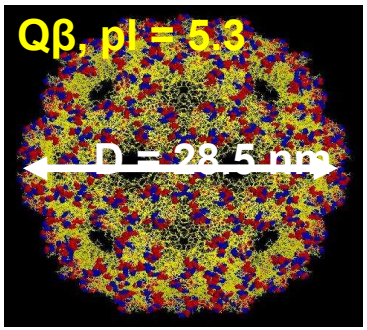
Sandia National Laboratories

NINE's Projects Support Collaborative Mission-Relevant Nano-Engineering Research

25 Technical Projects with more than 100 publications/presentations to date. Includes work of 155 students, 36 university faculty and 36 Sandians.

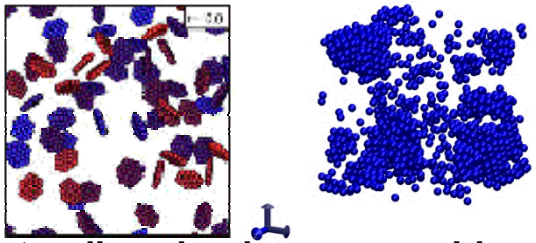


Interfacial Property Control of Elastomeric Nanocomposites

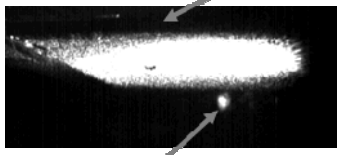


Time-Resolved Self-Assembly of 2D Virus-like Nano Particle Lattices

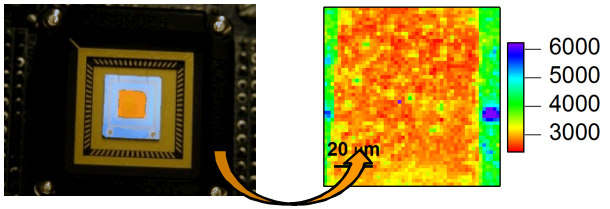
"Top Poster" Selection



Understanding rheology, assembly and functionality of nanocomposites.



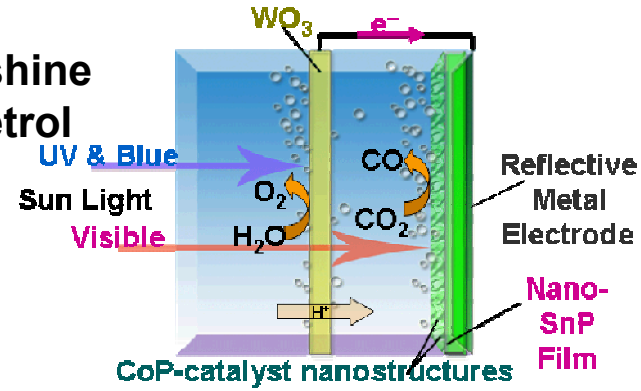
Quantum Information Processing

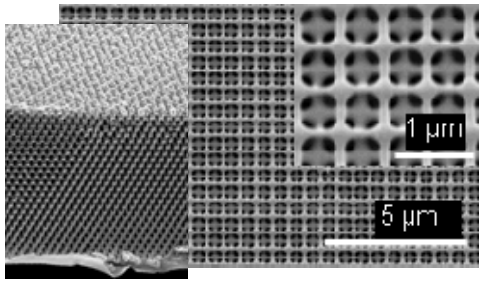


2D Free-standing and Functional Monolayer NP/Polymer Array

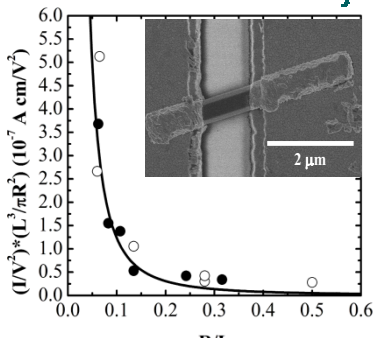
"Top Poster" Selection

Sunshine to Petrol

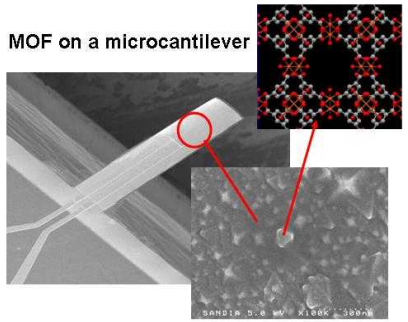




Proximity-field Patterning of 3D Nanostructures including Si photonic crystal



New scaling law for conduction in nanowires



First use of Nanoporous Metal-Organic Framework in a sensor

Sandia National Laboratories

Self-Powered Ferroelectric Nanosensors: Fundamental Science of Interfacial Effects in Extreme Environments

Jon Ihlefeld, Geoff Brennecka, Chris Apblett, & Bruce Tuttle
Sandia National Laboratories

Krishna Nittala, Sung Wook Mhin, Katherine Dunnigan,

Jacob Jones, University of Florida

Leo Small, Steve Calabrese, David Duquette, Rensselaer Polytechnic Institute

Joe Graham, Paulo Ferreira, Sheldon Landsberger
University of Texas at Austin

Materials Science & Integ

Ferroelectrics diagnostics

Corrosion Studies

Radiation Effects

Sandia National Laboratories

Team Workshop
Gainesville, FL
January 18, 2011

UF UNIVERSITY of FLORIDA

ExxonMobil

THE UNIVERSITY OF TEXAS AT AUSTIN

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Sandia National Laboratories

2007 - 2012 NINE Summer Programs

A spectrum of opportunities for students

- 224 students from 29 universities have participated in the NINE program
- 165 (80% grad students) did nano-engineering research with mentors in 10 Sandia Centers, resulting in >100 publications & presentations to date
- NSF-SNL collaboration – 33 NSF-sponsored students in NINE's 2007-12 programs
- NINE's Innovation Institute 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, nanotech markets, social issues, entrepreneurship
  - NINE Student Workshop and Community Meeting

80% grad students, 20% undergrad students

Sandia National Laboratories

Things NINE accomplished …

- Cost-effective work on nationally important, mission-relevant projects, selected and refined by industry input, using nationwide teams of top faculty and students
- Training top grad students to become global innovation leaders
  - Top facilities, large, multi-disciplinary projects, multiple mentors
  - Broad learning including non-technical areas; business, law, social, …
- Motivating undergraduates to get advanced degrees
- Exciting undergrads about science and engineering, nanotechnology, and the chance to make a difference
- Building collaborative relationships with universities and industry

Common Lessons Learned Through NINE and the MESA Institute:

- **National Lab – University Relationships**
  - University faculty and national lab researchers like to work together and students are the best glue for these collaborations
  - Graduate students are a great match to federal lab R&D projects. Grad students working on federal lab projects should spend time yearly at the federal lab working with their mentor/PI – both benefit
  - The use of graduate students as part of federal lab projects is very cost-effective, provides a vetted talent pipeline, and enables intellectual engagement by university faculty
  - Engagement of faculty in Sandia programs provides valuable new perspectives and great technical input to our projects
  - Must focus on a specific technical area to be effective
  - The program must enable line organizations to do something they already want to do, like work with university faculty and students in areas of mutual interest.

Learning from the MESA Institute

National Lab-University Collaborations

- The availability of on-going projects at national laboratories provides a simple-to-implement opportunities for national laboratories to engage with university professors and students.
- Student engagement should be multi-year to enable high benefit/cost. A graduate student works at 50% the speed of a advanced degreed researcher but has a labor cost of 25%, resulting in a x2 benefit/cost. This means that using students is a direct net financial benefit to a program!
- Involving two or more students of a professor automatically engages them and their technical insights with the project.
- Sandia researchers believe that they benefit from having graduate students in their program. Part of this is the connection with student's faculty advisor.
- Students value the availability of technical classes relevant to their work.
- Undergraduate and community college students also benefit from connection with Sandia projects but provide less direct value to the project.

Learning from NINE

- **National Laboratory – Student and University Relationships**
  - Universities value collaboration with national labs and will help support student & faculty involvement in return for engagement.
  - Universities and faculty value to opportunity to interact with companies; they are potential customers
  - Universities and faculty value both intellectual property and minimal interference in their ability to publish their student's work. Avoid complex collaborations that compromise these.
  - Students involved in projects should work at Sandia during summers to ensure alignment and benefit.
  - NSF also values the opportunity for its grantees to work with Sandia on important projects and benefit from innovation institutes
  - It is simple and low cost to create a summer Innovation Institute to provide broad training in technology readiness, IP, business, legal, and social issues for students while they are at the lab in summers. This is a key to training next generation innovators!

Learning from NINE

- **National Laboratory – Industry Relationships**
  - National Labs benefit from the industry's value perspective. Industry values the broad and deep capabilities of the federal labs and the chance to leverage federally funded R&D to gain insight on promising technologies
  - Industry technology scouts are interested in technology advances at the labs and can pay modest (<$50k) dues to participate. Industry is reluctant to pay for pre-competitive research – that's government's job!
  - Significant industry funding for projects requires that they have control over project selection and Intellectual Property.
  - Intellectual property is key to industry investment in research. When IP is involved in government-university-industry collaborations, things get complicated due to both government regulations and company lawyer involvement. Fairness of opportunity, Government rights and other requirements also cause serious complications. This is a big problem.

Based on NINE and the MESA Institute …

Keys to an implementable & effective collaboration program:

- Focus on a technical area of lab strength.
- Leverage existing, multi-year lab projects to provide student opportunities, the foundation for university collaborations. The Lab should encourage such project opportunities, i.e. make it a minor consideration in funding.
- Government-University-Industry collaboration is best implemented in 100% federally funded projects that are designed to include students and faculty and the opportunity for limited industry input with no IP.
- Industry participation and input on projects is very desirable. They provide a pragmatic focus that is usually absent. Companies pay dues in exchange for early access to data, students and faculty. These dues pay for the Innovation Institute and semiannual meetings.
- Student involvement must be justified based on the benefit/cost to the project. Bonuses are access to vetted new hires, engagement by faculty.
- Funding from the federal agency level for innovation training at national labs is unlikely unless there is a specific national initiative. Support for innovation activities must come from the lab, justified by direct value.

Quantitative assessment of program value is necessary to evaluate effectiveness

- Survey produced (by S. Walsh) to gather information on students who participated in the MESA Institute and NINE Programs
  - Follow-up on educational achievements
  - Employment choices and outcomes
  - Value of participation to the student – self assessed by the student
- Survey distributed to students June-August 2013
  - 300 surveys sent out, 60 returned
  - Follow-up discussions held with 20 students
  - Results tabulated and comments abstracted

Results of Survey

Selected comments from students