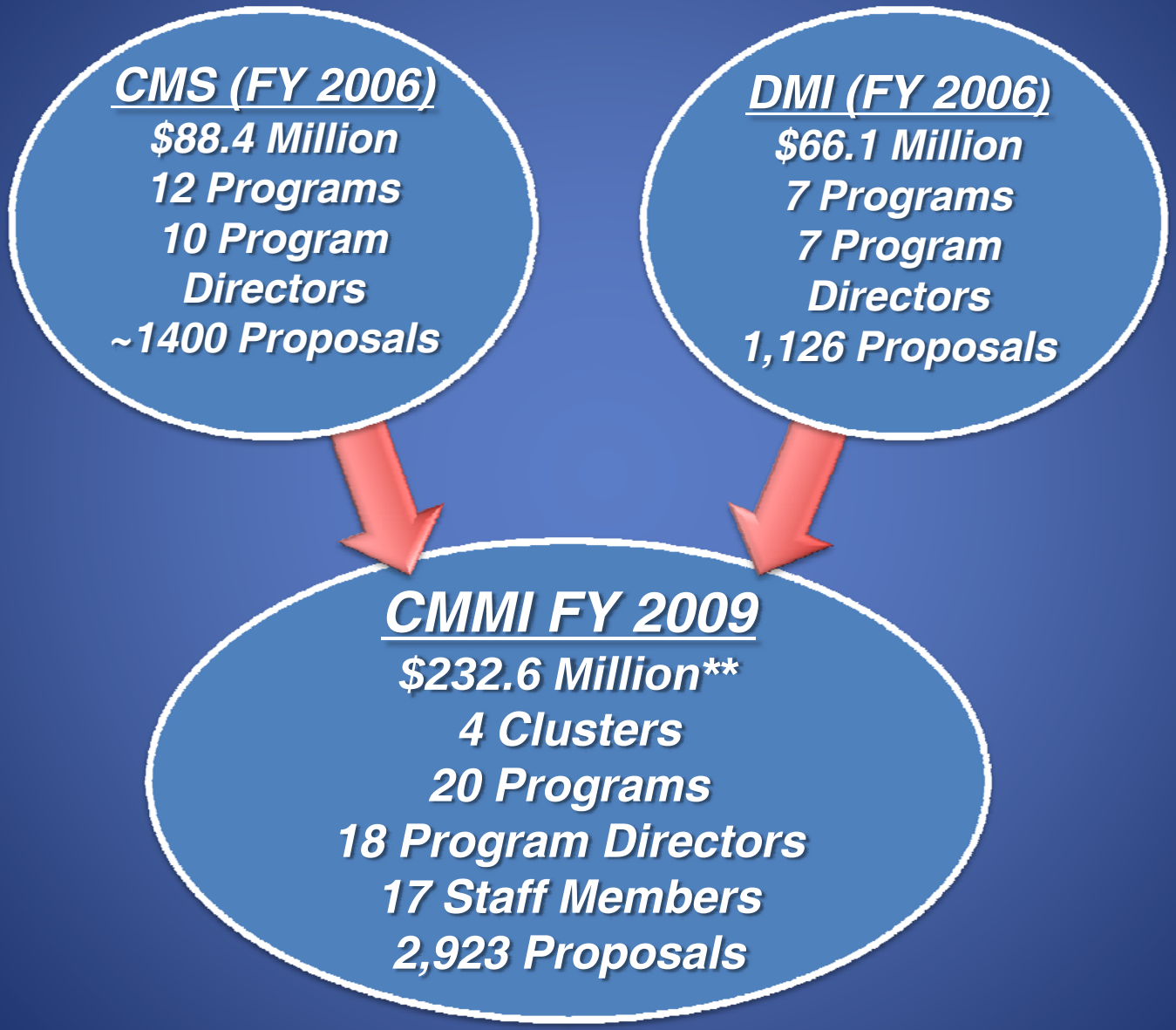
Civil, Mechanical, and Manufacturing Innovation Division

CMMI Division Overview

Steven H. McKnight
Division Director

CMMI Reorganization & Merger History*



*Just completed third year

**Includes ARRA

Current CMMI Organization

Division Director
Steven McKnight
Deputy Director
George Hazelrigg

- Interdisciplinary and Cross-Divisional Activities — Bruce Kramer
- AAAS Fellow — Phil King
- Program Support Mgt. — Betty Person

Advanced Manufacturing

- Manufacturing and Construction Machines and Equipment — George Hazelrigg
- Manufacturing Enterprise Systems — Cerry Klein
- Material Processing and Manufacturing — Mary Toney
- Nano Manufacturing — Shaochen Chen

Mechanics and Engineering Materials

- Geomechanics and Geotechnical Systems — John Daniels
- Materials and Surface Engineering — Clark Cooper
- Mechanics of Materials — Glaucio Paulino
- Nano/Bio Mechanics — Vacant
- Structural Materials and Mechanics — Lawrence Bank

Resilient and Sustainable Infrastructures

- Civil Infrastructure Systems — Dennis Wenger
- NEES — Joy Pauschke
- Geotechnical Engineering — John Daniels
- Hazard Mitigation and Structural Engineering — M.P. Singh
- Infrastructure Mgmt. and Extreme Events — Dennis Wenger

Systems Engineering and Design

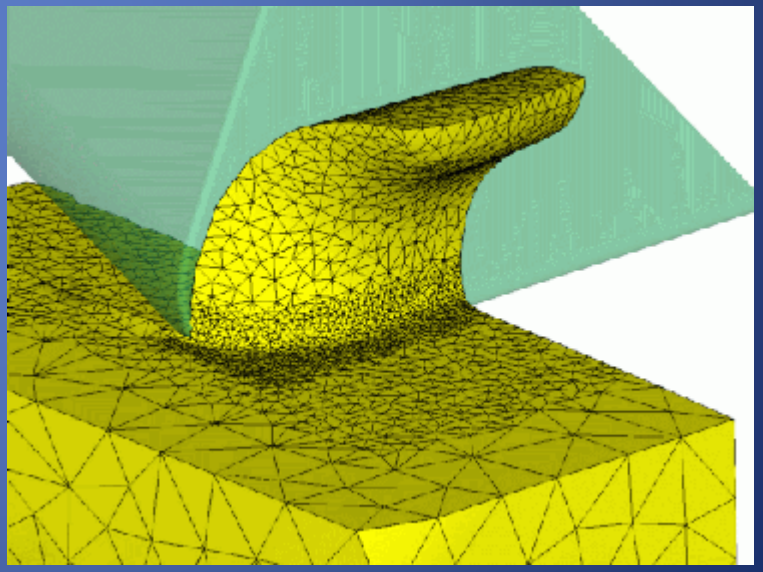
- Control Systems — Suhada Jayasuriya
- Dynamical Systems — Eduardo Misawa
- Engineering Design and Innovation — Christina Bloebaum
- Operations Research — Robert Smith
- Sensors and Sensing Systems — Shih Chi Liu
- Service Enterprise Systems — Cerry Klein

Current CMMI Research Clusters

Advanced Manufacturing

- *Research leading to transformative advances in manufacturing and building technologies, with emphases on efficiency, economy, and sustainability*

- *Supporting programs*
  - *Manufacturing and Construction Equipment*
  - *Manufacturing Enterprise Systems*
  - *Materials Processing and Engineering*
  - *Nanomanufacturing*

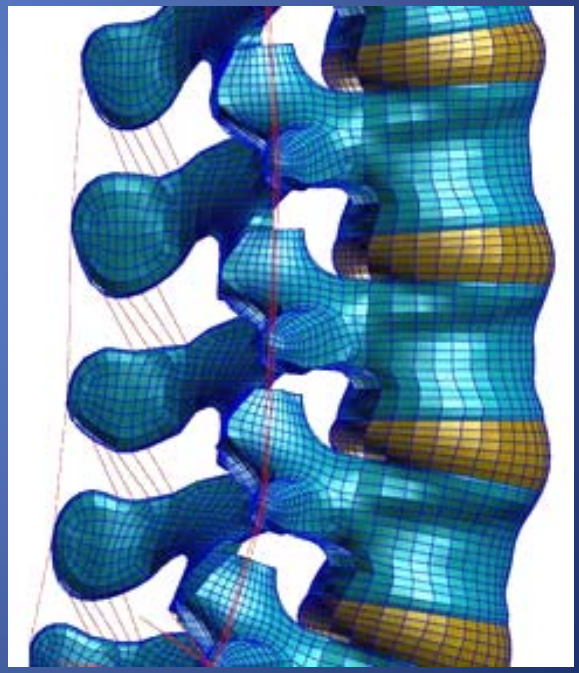


Current CMMI Research Clusters

Mechanics and Engineering Materials

- *Research aimed at advances in the transformation and use of engineering materials efficiently, economically, and sustainably*

- *Supporting programs*
  - *Geomechanics and Geomaterials*
  - *Materials and Surface Engineering*
  - *Mechanics of Materials*
  - *Nano/Bio Mechanics*
  - *Structural Materials and Mechanics*



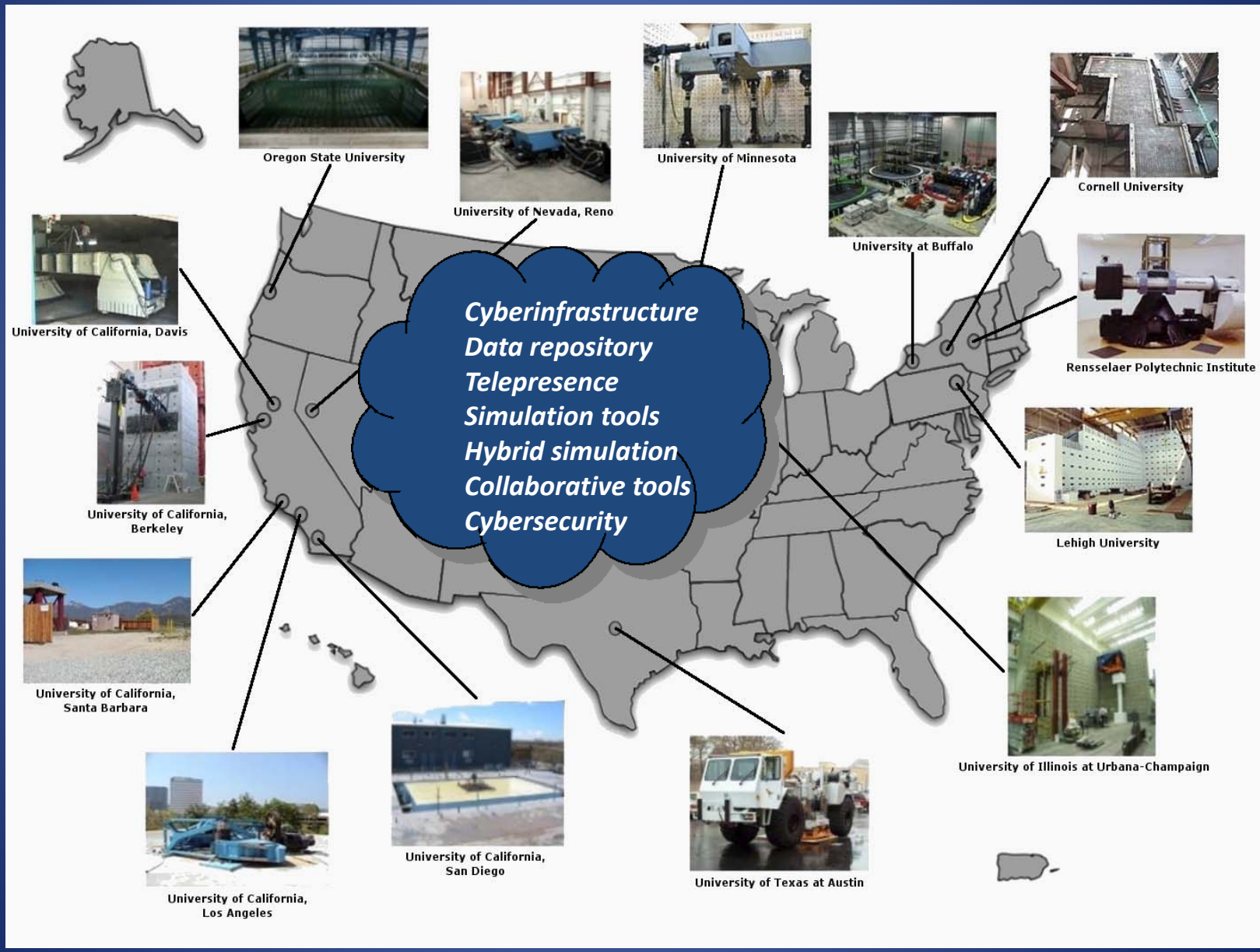
Current CMMI Research Clusters

Resilient and Sustainable Infrastructures

- *Research to advance fundamental knowledge and innovation for resilient and sustainable civil infrastructure and distributed infrastructure networks*

- *Supporting programs*
  - *Civil Infrastructure Systems*
  - *NEES – Ops and Research*
  - *Geotechnical Engineering*
  - *Hazard Mitigation and Structural Engineering*
  - *Infrastructure Mgt. and Extreme Events*

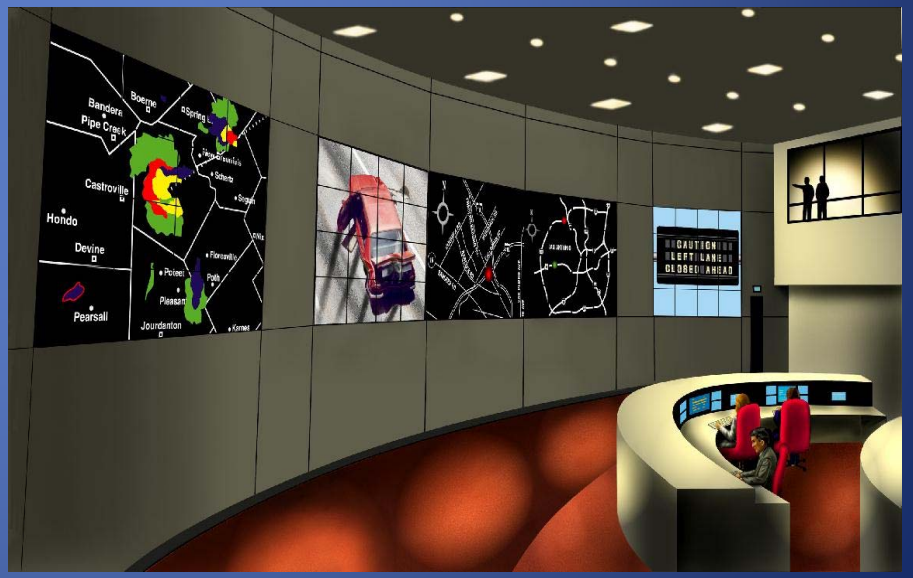
NEES for the Engineering Community:
New Award FY2010 – FY2014



Current CMMI Research Clusters
Systems Engineering and Design

- *Research on the decision-making aspects of engineering, including design, control, and optimization*

- *Supporting programs*
  - *Control Systems*
  - *Dynamical Systems*
  - *Engineering Design and Innovation*
  - *Operations Research*
  - *Sensors and Sensing Systems*
  - *Service Enterprise Systems*



CMMI Collaborations

- *Internal collaborations within CMMI*
  - *Between programs and within clusters*
- *Collaborations within ENG and across NSF*
- *Interagency collaborative ventures*
  - *Create special initiatives*
  - *Co-fund research*
  - *Leverage unique capabilities for research use*
- *International collaborations*
  - *NEES Research & Japan's MEXT*
  - *Nanotechnology*
  - *International workshops with ESF*

Collaborations with E-Defense Miki, Japan

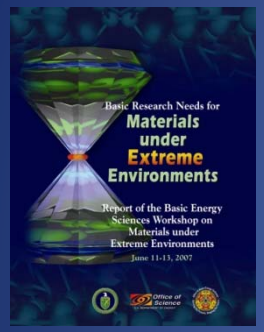
CMMI Broadening Participation Activities

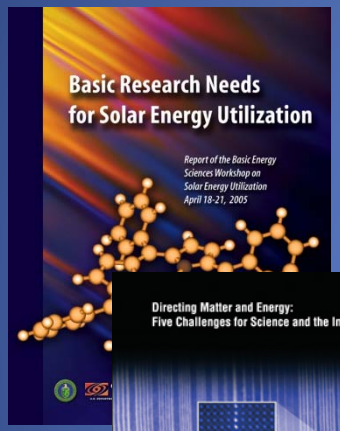
- CAREER Proposal Writing Workshops
  - Sponsored & participated in by CMMI PDs
- BRIGE program
  - Increased BRIGE awards from 8 in 2008 to 14 awards in 2009
- Graduate Research Supplements (GRS)
  - doubled the level of funds and increased the number of supplements to 9 awards in 2009
- REU supplements to existing awards
  - Two undergraduate student supplements if one is a woman/underrepresented group member

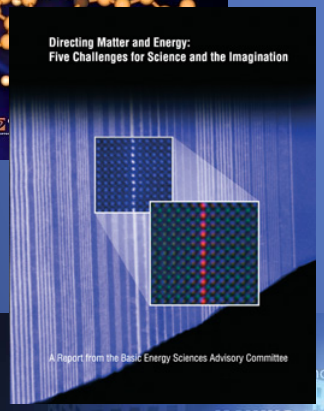
Future Directions for CMMI

Influence of Community and Context

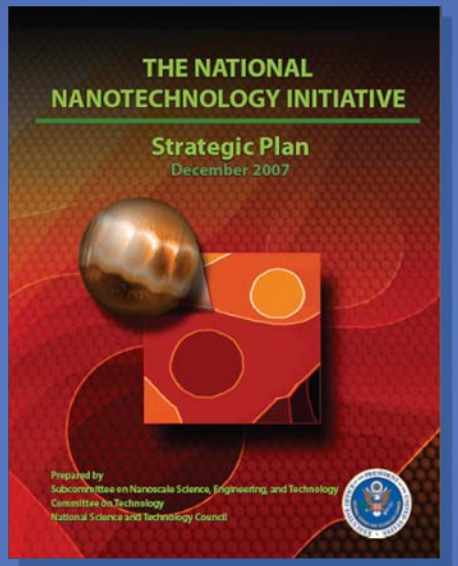
Interagency Studies, Workshops, And Coordination

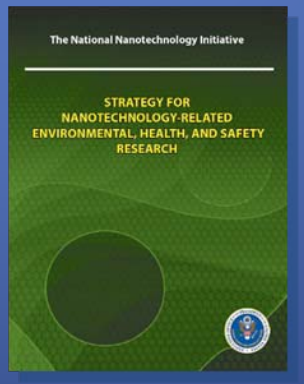




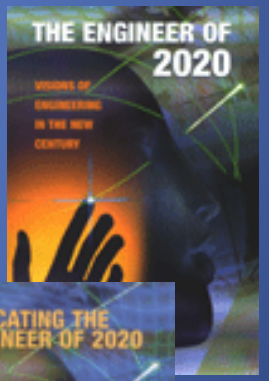


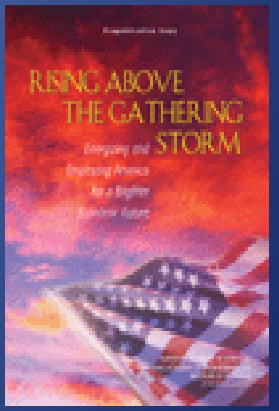
National Initiatives





NRC / NAS / NAE





Future Directions for CMMI

Influence of Community and Context

- *Emerging areas of opportunity*
- *Areas of critical need (big contributions possible)*
- *Disciplinary research (core programs)*
- *Cross-disciplinary advances (clear opportunities)*

CMMI Participation in EFRI

(CMMI Led in Red)

- 2006 Competition
  - Auto-Reconfigurable Engineered Systems (ARES)
  - Cellular and Biomolecular Engineering (CBE)
- 2007 Competition
  - Cognitive Optimization and Prediction (COPN)
  - Resilient and Sustainable Infrastructures (RESIN)
- 2008 Competition
  - BioSensing and BioActuation (BSBA)
  - Hydrocarbons from Biomass (HyBi)
- 2009 Competition
  - Large-Scale Energy Storage
  - Science in Energy and Environmental Design (SEED)

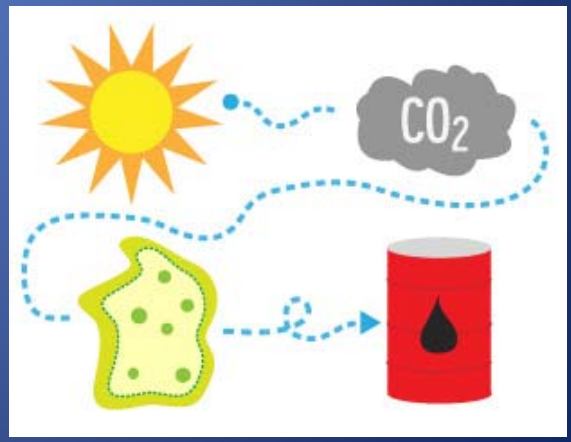
Selected CMMI Supported Worships:

Setting Future Research Agendas

- *Workshop: Roadmap for Additive Manufacturing (RAM): Identifying the Future of Freeform Processing: March 2009*
- *Workshop on Energy Efficiency via Better Materials and Manufacturing; June 2009*
- *Humanitarian Service Science and Engineering Workshop; October 2007*
- *The Cell as a Machine: Mechano-, Controls, Systems Engineering Approach to Cell/Molecular Biology; January 2008*
- *Healthcare Engineering and Health Services Research: Building Bridges, Breaking Barriers; April 2008*
- *Workshop Series: Interdisciplinary Design as an Instructional Discipline, 2008-2009*
- *Engineering Complexity in Aerospace Systems (w/DARPA), September 2009*
- *Neuromechanical Engineering, September 2009*

Energy and manufacturing

- *U.S. moving towards new prospects in manufacturing sector*
- *Highly volatile energy prices*
- *Research to support energy manufacturing offers opportunities*

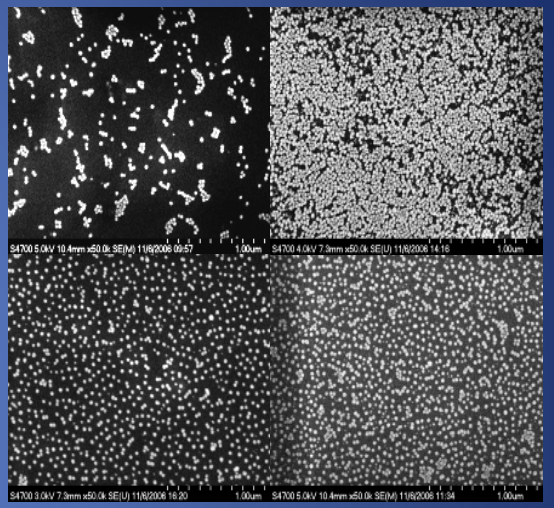


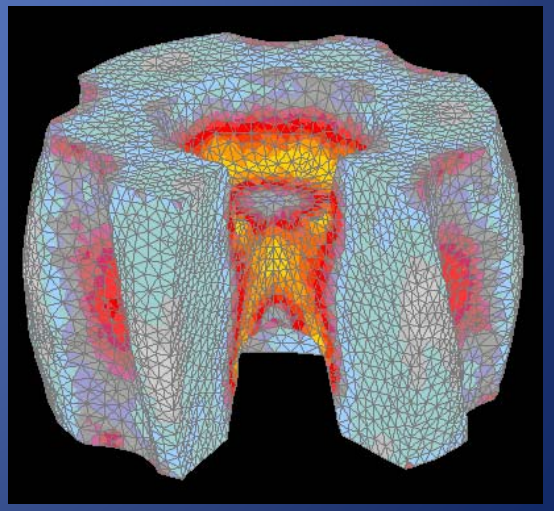
The challenge: to support advances in manufacturing technologies to accelerate the emergence of energy manufacturing

Future Directions

Broad Opportunities

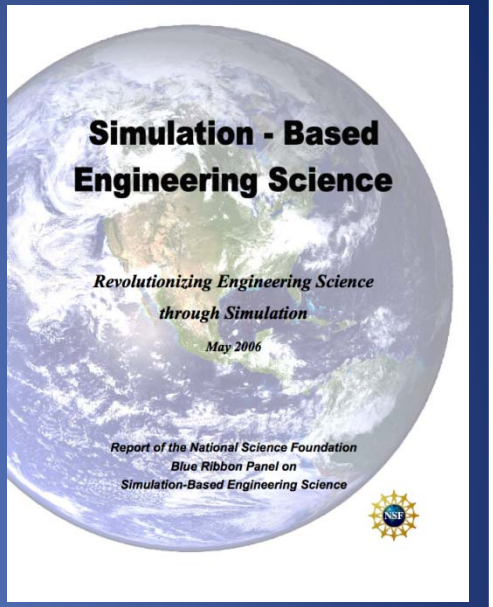
- ***Novel materials, processes, and manufacturing technologies***
- ***Engineering biology***
- ***Simulation-based engineering and science***
- ***Engineering applied to service-based enterprises and the human dimension***
- ***Innovative product and complex system design – underlying theories of design***

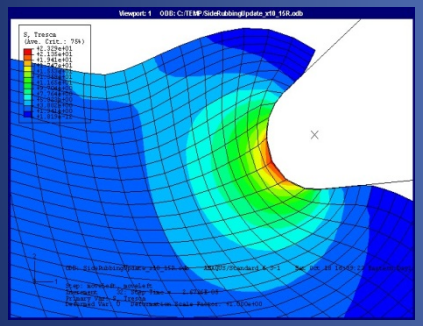




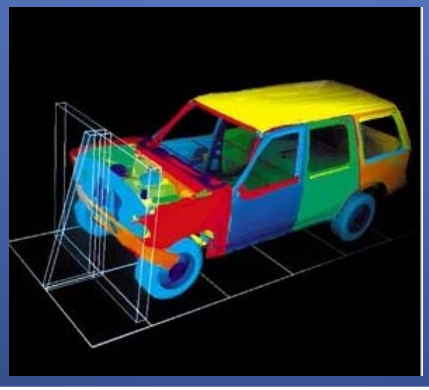
Research Challenges for Simulation-Based Engineering and Science

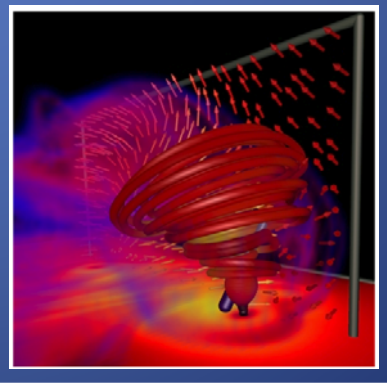
- *Links between physical and system level simulations are weak*
- *Treatment of uncertainty is inadequate*
- *Appropriate algorithms, software and data are needed*

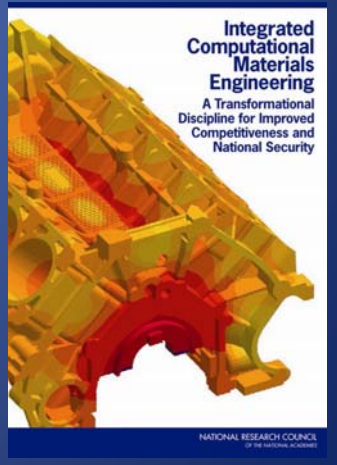




- *Software engineering challenges may hinder broader use*
- *Visualization of simulation outputs can advance understanding*
- *Training of engineers and scientists is crucial*







Closing Remarks

and

Questions