Civil, Mechanical, and Manufacturing Innovation Division

CMMI Division Overview

Steven H. McKnight
Division Director
CMMI Reorganization & Merger History*

**CMMI FY 2009**
$232.6 Million**
4 Clusters
20 Programs
18 Program Directors
17 Staff Members
2,923 Proposals

**CMS (FY 2006)**
$88.4 Million
12 Programs
10 Program Directors
~1400 Proposals

**DMI (FY 2006)**
$66.1 Million
7 Programs
7 Program Directors
1,126 Proposals

*Just completed third year  **Includes ARRA
Current CMMI Organization

**Division Director**
Steven McKnight  
Deputy Director  
George Hazelrigg

**Program Support Mgt.**
Betty Person

**Current CMMI Organization**

**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

**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

**Interdisciplinary and Cross-Divisional Activities**
- Bruce Kramer

**AAAS Fellow**
- Phil King

**Systems Engineering and Design**
- John Daniels
- Clark Cooper
- Lawrence Bank
- Dennis Wenger
- Joy Pauschke
- M.P. Singh
- Christina Bloebaum
- Robert Smith
- Shih Chi Liu
- Cerry Klein

**AAAS Fellow**
- Phil King

**Program Support Mgt.**
- Betty Person

**Division Director**
- Steven McKnight
  - Deputy Director
  - George Hazelrigg

**Interdisciplinary and Cross-Divisional Activities**
- Bruce Kramer

**AAAS Fellow**
- Phil King
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

Discovery, learning, research infrastructure, and stewardship
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

Discovery, learning, research infrastructure, and stewardship

Cyberinfrastructure
Data repository
Telepresence
Simulation tools
Hybrid simulation
Collaborative tools
Cybersecurity
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

Discovery, learning, research infrastructure, and stewardship
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

Discovery, learning, research infrastructure, and stewardship
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

*Discovery, learning, research infrastructure, and stewardship*
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