Civil and Mechanical Systems (CMS)

NATIONAL SCIENCE FOUNDATION

A. Galip Ulsoy, Ph.D.
Director, Division of Civil and Mechanical Systems
aulsoy@nsf.gov (703) 292-4613
The structures and machines that we encounter in our daily lives are related to the areas funded by CMS.

The Mission of CMS is:

- to expand the fundamental knowledge underpinning for the engineering profession in application to mechanical systems and the constructed environment, and
- to support the rapid development and deployment of research in service to society and to reduce risks induced by natural and technological hazards.
The CMS Division Funds Research Through:

- **Unsolicited proposals to programs.** Twice per year, plus CAREER. Roughly 50% of funds.

- **Participation in various solicitations** throughout the year. These include NSE, BE, HSD, Math, Sensors, NSF/HUD, NEES Research, MRI, ADVANCE, DLR, NEESR, etc. Roughly 50% of funds.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>No. Res. Proposals</th>
<th>No. Res. Awards</th>
<th>Funding Rate</th>
<th>Supplements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1,310</td>
<td>182</td>
<td>14%</td>
<td>167</td>
</tr>
<tr>
<td>2003</td>
<td>1,412</td>
<td>208</td>
<td>15%</td>
<td>200</td>
</tr>
<tr>
<td>2002</td>
<td>1,270</td>
<td>188</td>
<td>15%</td>
<td>181</td>
</tr>
<tr>
<td>2001</td>
<td>1,202</td>
<td>174</td>
<td>14%</td>
<td>156</td>
</tr>
<tr>
<td>2000</td>
<td>1,010</td>
<td>236</td>
<td>23%</td>
<td>137</td>
</tr>
<tr>
<td>1999</td>
<td>868</td>
<td>217</td>
<td>25%</td>
<td>178</td>
</tr>
</tbody>
</table>

Average award size and duration is approx. $110k/year and 3 years.
CMS Organization: 3 Clusters of 4 Programs Each

- **Engineered Materials and Mechanics (EMM) Cluster**
  - Mechanics and Structure of Materials  Ken Chong (kchong@nsf.gov)
  - Materials Design and Surface Engineering  Yip-Wah Chung (ychung@nsf.gov)
  - Infrastructure Materials and Structural Mechanics  Jorn Larsen-Basse (jlarsenb@nsf.gov)
  - Nano and Bio Mechanics of Materials  Vacant

- **Intelligent Civil and Mechanical Systems (ICMS) Cluster**
  - Infrastructure and Information Systems  Jesus de la Garza (jgarza@nsf.gov)
  - Sensor Technologies for Civil and Mechanical Systems  Shih-chi Liu (sliu@nsf.gov)
  - Control Systems  Mario Rotea (mrotea@nsf.gov)
  - Dynamic Systems  Eduardo Misawa (emisawa@nsf.gov)

- **Infrastructure Systems and Hazard Mitigation (ISHM) Cluster**
  - Structural Systems and Hazard Mitigation of Structures  Steven McCabe (smccabe@nsf.gov)
  - Geotechnical and GeoHazards Systems  Richard Fragaszy (rfragasz@nsf.gov)
  - Infrastructure Systems Management and Hazard Response  Dennis Wenger (dwenger@nsf.gov)
  - George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)  Joy Pauschke (jpauschk@nsf.gov)
Engineered Materials and Mechanics Cluster

- Solid and biomechanics of deformation, fracture, fatigue, friction, wear, and corrosion
- Computational materials engineering - integrated experimental and analytical investigations and simulation modeling of material nano- and micro-structures and connections
- Smart materials, advanced polymer materials and high-performance steel and concrete materials.
- Durability, safety and reliability of construction materials in constructed facilities.

Bending of Carbon Nanotubes

Computational Modeling of Normal (left) vs. Osteoporotic (right) Bone

I. Jasiuk, GA Tech
Intelligent Civil and Mechanical Systems Cluster

- structural dynamics, damping, vibrations, acoustics, and kinematics
- sensors for fundamental science and engineering, verification of models, performance evaluation.
- integration of sensors, actuators, controllers, and power sources for adaptive and intelligent system applications.
- smart materials, smart structures and control strategies for them.
- mechatronic systems
- bridges, buildings, infrastructure and other CMS systems impacted by aging or extreme events.
- design, fabrication, and control of micro- and nano- dynamic systems.
- management and use of large quantities of distributed and discrete sensed information.

Vibration of Disk-Spindle Systems - I.Y. Shen
Univ. of Washington

Semi-active structural control with Magnetorheological (MR) dampers (CMS - 9900234)
Infrastructure Systems and Hazard Mitigation Cluster

- New technologies for structural systems.
- Application of sensor systems to structure health monitoring and structural control.
- Impact of extreme events on the performance of constructed facilities.
- Enhanced experimental and computational research that takes advantage of the NEES equipment and collaboratory.
- Integration of Earthquake and Tsunami Research with NEES
- Foundation/structure interaction. Intrusive and Non-Intrusive Site Characterization. Urban Excavations, Foundations and Tunneling
- Enhanced Robustness of Geomaterials and Geostructures
• MREFC project, FY00 - FY04, $82M

• World-class experimental facilities and a cyberinfrastructure to support earthquake engineering research

• NAE study, NRC report, NEES brochure

• Operations, FY05 through FY14, $20M/yr funds NEES Consortium Inc.

• NEES Research solicitation $10M per year; developing partnerships
Certain atomic nuclei such as hydrogen act like magnets, which line up in the presence of an external magnetic field. When excited by pulses of radio waves of the correct frequency (resonant absorption), these magnets change orientation. After the pulse, these nuclei return to their original state, and radio waves of the same energy are emitted. By introducing magnetic field gradients, one causes predictable changes in the resonance absorption frequency.

With such field gradients, Prof. Paul C. Lauterbur showed how one transforms the detected radio signals quickly into two-dimensional images of structures containing such nuclei. In 1973, he demonstrated this idea by imaging tubes of water. Since water constitutes 70% of the human body, magnetic resonance imaging (MRI), as the technique is called, provides an ideal noninvasive method for medical diagnostics that involves no ionizing radiation.

Prof. Lauterbur was funded by the CMS division of NSF in the early 1980’s to refine nuclear magnetic resonance into a routine diagnostic technique. In 2002, about 22,000 MRI machines were in use worldwide, and more than 60 million MRI examinations were performed. For this contribution, Prof. Paul Lauterbur, now with University of Illinois, was awarded the 2003 Nobel Prize in Physiology or Medicine.
A 3 day workshop held in September 2003 at NSF for "The Advancement and Retention of Under-represented Engineering Educators" (WEE). This is the fourth such workshop supported by CMS during the past 8 years. The WEE workshop brought together approximately 70 tenure-track faculty and doctoral students from under-represented groups. They were joined by more experienced faculty mentors and program managers from several federal agencies including NSF, ARO, DARPA, FHWA, NASA and ONR. The workshop provides information on a range of topics, selected by workshop participants, aimed at helping junior faculty succeed in their careers.
NSF/ENG Always Needs Reviewers

- NSF uses all variations of review: panels, mail, both.
- Benefits for the individual
  - See range of proposals and assess how yours stacks up.
  - On panels in particular, learn how clarity and conciseness are key.
  - Possible trip to NSF to meet program officers face-to-face.
- Benefits to NSF
  - New reviewers are usually very conscientious.
  - Broader and more diverse reviewer base.
- Volunteer by sending a short email to a Program Director with a one page resume attached.

Typical NSF Panel Review Meeting
NSF/ENG Always Needs Program Officers

- All Divisions are looking for Program Directors.
- In CMS we currently have 5 searches underway.
- Mutually beneficial:
  - Broadens individual’s view, develops leadership skills and provides visibility.
  - Helps NSF understand issues in academe and brings new ideas.
  - University & department have a connection to keep up-to-date on NSF.
- Check the NSF ENG Website at: http://www.eng.nsf.gov/jobopportunities/

CMS Program Officers, 2004