Opportunities at the National Science Foundation

Suhada Jayasuriya

Control Systems Program
Division of Civil, Mechanical and Manufacturing Innovation
Directorate of Engineering
National Science Foundation

Kotzebue Professor, Mechanical Engineering
Texas A&M University

August 31, 2007
What is NSF?

- Established in 1950 by the “NSF Act” to promote and advance scientific progress in the United States by sponsoring scientific research and by supporting selected activities in science and engineering.


- Only agency authorized to provide funding for research across all science and engineering disciplines.

- NSF funds the best science and engineering proposals – projects that advance discovery, learning, and innovation.

- Does not conduct research itself.
Focus on academic institutions
All areas of science and engineering
Research and education
National Priorities

- INFORMATION
- ENVIRONMENT
- ENERGY

...... DREAMS
National Priorities

- National security
- Food
- Jobs
- Health
- Housing
- Transportation
- Education
- Communication
National Priorities

- Jobs
- Economic well being
- Defense
Modes of Support

- Individual projects (Unsolicited proposals, GOALI, CAREER, Initiatives)
- Instrumentation
- Large-scale facilities
- Fellowships, traineeships, research assistantships, post-doctoral funding
- Centers
  - Research (e.g. ERC, I/UCRC)
  - Science and engineering education
- Small Business Innovation
- International Collaboration
- Workshops, Conferences
President’s American Competitiveness Initiative

Double the NSF budget over 10 years

Cover image credit: Eric J. Heller, Harvard University
American Competitiveness Initiative

The centerpiece of the ACI is the commitment to double investment over 10 years in key Federal agencies that support basic research programs in the physical sciences and engineering.

Specifically, the ACI doubles funding for innovation-enabling research that supports the high-leverage fields of physical science and engineering at NSF, DOE Office of Science, and NIST.

These agencies have “… a strong track record of leading to scientific publications, patents and eventually to new products and technologies.”
American Competitiveness Initiative

- Total
- NIST Core
- DOE SC
- NSF

Billions of dollars

- $9.75 billion
- $10.66 billion
- $19.49 billion

Fiscal Year

<table>
<thead>
<tr>
<th>Appropriations Account</th>
<th>FY 2008 Request</th>
<th>Change from FY 2007 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research &amp; Related Activities</td>
<td>$5,131.69</td>
<td>$365.74 (7.7%)</td>
</tr>
<tr>
<td>Education &amp; Human Resources¹</td>
<td>$750.60</td>
<td>$34.38 (4.8%)</td>
</tr>
<tr>
<td>Major Research Equipment &amp; Facilities Construction</td>
<td>$244.74</td>
<td>$4.29 (1.8%)</td>
</tr>
<tr>
<td>Agency Operations &amp; Award Management</td>
<td>$285.59</td>
<td>$3.77 (1.3%)</td>
</tr>
<tr>
<td>National Science Board</td>
<td>$4.03</td>
<td>$0.12 (3.1%)</td>
</tr>
<tr>
<td>Inspector General</td>
<td>$12.35</td>
<td>$0.49 (4.1%)</td>
</tr>
<tr>
<td>TOTAL, NSF</td>
<td>$6,429.00</td>
<td>$408.79 (6.8%)</td>
</tr>
</tbody>
</table>

Totals may not add due to rounding.
*Funding for EPSCoR is moved to EPRA in FY 2008.
NSF’s FY 2008 Budget Request

- American Competitiveness Initiative: requested budget increase: 6.8%
- International Polar Year: $59M
- Cyber-enabled Discovery and Innovation: $52M (increase by $50M/year planned for next 5 years)
- Networking and Information Technology R&D (NITRD): total of ~$1B (increase by $90M)
- Nanotechnology: ~$390M (increase by $17M)
- Ocean Research: $17M
- Advanced Laser Interferomete Gravitational Wave Observatory: $32.75M
- EPSCoR: $107M (increase by 7%)
- International Activities: $45M (increase by 11%)
## NSF Research and Related Activities

### FY 2008 Request by Directorate (Dollars in Millions)

<table>
<thead>
<tr>
<th>Directorate</th>
<th>FY 2007 Current Plan</th>
<th>FY 2008 Request</th>
<th>Amount Change</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Sciences</td>
<td>$607.85</td>
<td>$633.00</td>
<td>$25.15</td>
<td>4.1%</td>
</tr>
<tr>
<td>Computer &amp; Information Science &amp; Engineering</td>
<td>526.69</td>
<td>574</td>
<td>47.31</td>
<td>9.0%</td>
</tr>
<tr>
<td>Engineering (includes SBIR/STTR)</td>
<td>628.55</td>
<td>683.3</td>
<td>54.75</td>
<td>8.7%</td>
</tr>
<tr>
<td>Geosciences</td>
<td>744.85</td>
<td>792</td>
<td>47.15</td>
<td>6.3%</td>
</tr>
<tr>
<td>Mathematical &amp; Physical Sciences</td>
<td>1,150.30</td>
<td>1,253.00</td>
<td>102.7</td>
<td>8.9%</td>
</tr>
<tr>
<td>Social, Behavioral &amp; Economic Sciences</td>
<td>213.76</td>
<td>222</td>
<td>8.24</td>
<td>3.9%</td>
</tr>
<tr>
<td>Office of Cyberinfrastructure</td>
<td>182.42</td>
<td>200</td>
<td>17.58</td>
<td>9.6%</td>
</tr>
<tr>
<td>Office of International Science and Engineering</td>
<td>40.61</td>
<td>45</td>
<td>4.39</td>
<td>10.8%</td>
</tr>
<tr>
<td>U.S. Polar Research Programs</td>
<td>438.1</td>
<td>464.9</td>
<td>26.8</td>
<td>6.1%</td>
</tr>
<tr>
<td>Integrative Activities</td>
<td>231.37</td>
<td>263</td>
<td>31.63</td>
<td>13.7%</td>
</tr>
<tr>
<td>Arctic Research Commission</td>
<td>1.45</td>
<td>1.49</td>
<td>0.04</td>
<td>2.8%</td>
</tr>
<tr>
<td><strong>Total, R&amp;RA</strong></td>
<td><strong>$4,765.95</strong></td>
<td><strong>$5,131.69</strong></td>
<td><strong>$365.74</strong></td>
<td><strong>7.7%</strong></td>
</tr>
</tbody>
</table>
# Engineering Budget

## ENGINEERING

<table>
<thead>
<tr>
<th>Category</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>Change</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEMICAL, BIOENGINEERING, ENVIRONMENTAL &amp; TRANSPORT SYSTEMS</td>
<td>$125.09</td>
<td>$124.44</td>
<td>$144.97</td>
<td>$20.53</td>
<td>16.5%</td>
</tr>
<tr>
<td>CIVIL, MECHANICAL &amp; MANUFACTURING INNOVATION</td>
<td>148.82</td>
<td>152.16</td>
<td>174.08</td>
<td>21.92</td>
<td>14.4%</td>
</tr>
<tr>
<td>ELECTRICAL, COMMUNICATIONS &amp; CYBER SYSTEMS</td>
<td>77.91</td>
<td>80.90</td>
<td>93.96</td>
<td>13.06</td>
<td>16.1%</td>
</tr>
<tr>
<td>INDUSTRIAL INNOVATION &amp; PARTNERSHIPS</td>
<td>109.65</td>
<td>120.08</td>
<td>128.39</td>
<td>8.31</td>
<td>6.9%</td>
</tr>
<tr>
<td>SBIR/STTR</td>
<td>[99.07] [108.88]</td>
<td>[116.41] [7.53]</td>
<td>[6.9%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGINEERING EDUCATION &amp; CENTERS</td>
<td>123.99</td>
<td>125.97</td>
<td>116.90</td>
<td>-9.07</td>
<td>-7.2%</td>
</tr>
<tr>
<td>EMERGING FRONTIERS IN RESEARCH &amp; INNOVATION</td>
<td>25.00</td>
<td>25.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total, ENG</td>
<td>$585.46</td>
<td>$628.55</td>
<td>$683.30</td>
<td>$54.75</td>
<td>8.7%</td>
</tr>
</tbody>
</table>
Research Proposal Funding Rate Drops as NSF Budget Increases

<table>
<thead>
<tr>
<th>Year</th>
<th>NSF Budget (Millions)</th>
<th>R&amp;RA Budget (Millions)</th>
<th>Funding Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>3,298</td>
<td>2,433</td>
<td>30%</td>
</tr>
<tr>
<td>1998</td>
<td>3,425</td>
<td>2,572</td>
<td>30%</td>
</tr>
<tr>
<td>1999</td>
<td>3,690</td>
<td>2,821</td>
<td>30%</td>
</tr>
<tr>
<td>2000</td>
<td>3,923</td>
<td>2,979</td>
<td>30%</td>
</tr>
<tr>
<td>2001</td>
<td>4,459</td>
<td>3,372</td>
<td>27%</td>
</tr>
<tr>
<td>2002</td>
<td>4,774</td>
<td>3,616</td>
<td>27%</td>
</tr>
<tr>
<td>2003</td>
<td>5,369</td>
<td>4,054</td>
<td>24%</td>
</tr>
<tr>
<td>2004</td>
<td>5,652</td>
<td>4,293</td>
<td>21%</td>
</tr>
<tr>
<td>2005</td>
<td>5,480</td>
<td>4,234</td>
<td>20%</td>
</tr>
<tr>
<td>2006</td>
<td>5,645</td>
<td>4,351</td>
<td>21%</td>
</tr>
</tbody>
</table>
Research proposal funding rates decreased as NSF budget, average award size, and proposal submission rates increased.

PI success rates (percentage of PIs that are funded) decreased as the number of PIs submitting to NSF increased.

Number of proposals submitted per PI to gain one award increased.

Directorate level trends show significant variability in rate of change, degree of change, and starting and end points of change.
Directorate Proposal Submission Trends

- MPS
- SBE
- CISE
- GEO
- BIO
- ENG

Number of Competitive Proposals by Fiscal Year: 1997 to 2006.
Funding Rate Trends for New and Prior PIs in Underrepresented Groups
Major Findings: Impacts

- NSF’s peer review system is overstressed
  - Reviewer workloads have increased
    - Reviewer pool increased 15%, proposal load increased 50%
  - Increased use of panel-only review
  - Time spent on each review, as well as the thoroughness and quality of reviews, may be diminishing (based on survey data)

- Timeliness of proposal decisions did not decline, however PIs are increasingly dissatisfied with turnaround time
Major Findings: Impacts

- Proportion of highly-rated proposals has not declined, however, the funding rate of highly-rated proposals has decreased.
- The decrease in funding rate has not had a disproportionate effect on women, minorities, beginning PIs, or PIs at particular types of institutions.
Major Findings: Causal Factors

- Increases in the overall NSF budget were absorbed by the growth in the average award size, leaving little flexibility to respond to growing proposal submissions.

- The increase in proposal submissions due to an increased applicant pool and to an increased number of proposals per applicant.
  - Increased size and capacity of the research community
  - Loss of funding from other sources
  - Increased use by NSF of targeted solicitations in new areas
  - External institutional pressures
Major Findings: Assessing NSF Efforts to Manage Proposal Submissions and Funding Rates

Limiting Proposal Submissions

- Most funding opportunities do not limit submissions.
- Of those that do, three primary mechanisms are used:
  - Preliminary proposals
  - Limiting proposals submitted by an institution
  - Limiting proposals listing a particular individual as PI
- Institution limits primarily used for solicitations focused on infrastructure, centers/facilities, and education/training.
- If submission limits are used by research programs, primarily limit submissions by PI.
Community Perceptions

Transformative research

- 56% believe to a great or moderate extent that NSF welcomes transformative research
- 42% believe to a great or moderate extent that NSF funds transformative research
- NSF is the predominant choice for submitting proposals with transformative research ideas
- Significant disconnect between proposer and reviewer perceptions
Community Perceptions

**Funding rates**

- More than 60% of respondents perceive that the level of competition at NSF is more intense than at other agencies.
- Nearly 49% of respondents estimate funding rates at 10% or lower.
ENG Organizational Structure

Office of the Assistant Director
Deputy Assistant Director (OAD)

Crosscutting Areas
- Emerging Frontiers in Research and Innovation (EFRI)
- Engineering Education and Centers (EEC)
- Industrial Innovation and Partnerships (IIP)

Disciplinary Areas
- Chemical, Biological Environmental and Transport Systems (CBET)
- Civil, Mechanical and Manufacturing Innovation (CMMI)
- Electrical, Communications and Cyber Systems (ECCS)

AD: Richard Buckius
DAD: Michael Reischman

DD: Judy Raper
DD: Adnan Akay
DD: Usha Varshney

NSF: $6,020M
ENG: $628.55M
(FY 07)
Civil, Mechanical and Manufacturing Innovation

Engineering Infrastructure Systems
- GeoEnvironmental Engineering and GeoHazards Mitigation
- George E. Brown, J r. Network for Earthquake Engineering Simulation Research
- Information Technology and Infrastructure Systems
- Infrastructure Management and Hazard Response
- Manufacturing Machines and Equipment
- Structural Systems and Hazards Mitigation of Structures

Innovation Sciences and Decision Engineering
- Control Systems Program
- Dynamical Systems
- Engineering Design
- Manufacturing Enterprise Systems
- Operations Research
- Sensor Innovation and Systems
- Service Enterprise Engineering

Materials Transformation and Mechanics
- GeoMechanics and GeoTechnical Systems
- Infrastructure Materials Applications and Structural Mechanics
- Material Design and Surface Engineering
- Materials Processing and Manufacturing
- Mechanics and Structures of Materials
- Nano and Bio Mechanics
- NanoManufacturing
Control Systems Program

**Goal**
- To enable research and education in the prediction and control of complex dynamic systems
- Focused on civil, mechanical, and aerospace systems

**Areas of Emphasis**
- **Control Theory:** mathematical frameworks and tools to analyze and design control systems
- **Control Technology:** integration of sensing, actuation, and computation; innovative actuation concepts
Dynamical Systems

Program Goal:

“Fundamental advances in the understanding, design and operation of dynamic systems, such as nonlinear, hybrid, time-varying, multi-energy domain and distributed dynamical systems.”

Examples of application areas:

- biological systems
- micro and nano-scale systems
- multi-scale dynamic systems
- large-scale complex systems
- integrated analysis and design of dynamic systems
- simulation-based engineering and science.
- acoustics and vibration analysis
- noise and vibration control
Sensor Innovation and Systems

Current Program interests:

- Novel sensing devices and networks
- Sensor fusion & informatics
- Multi-functional material design & model
- Wireless and smart sensing technology
- Smart systems and structures
- Structural health monitoring & damage detection
- Intelligent use of sensed data

Future emphasis areas:

- Micro/ nano sensing & actuating devices
- Animation of human senses & control
- Human-centric & bio-inspired autonomous intelligence platform
- Novel imaging and display
- Power supply & harvesting
- Package, embedment and integration
- Cooperative protocols & algorithms
- Application in health, safety, and security

PD: Shih-Chi Liu
sliu@nsf.gov
Emerging Frontiers in Research and Innovation (EFRI)

- Focus on important emerging areas in a timely manner.
- Investments will represent transformative opportunities, potentially leading to: new research areas for NSF, ENG, and other agencies; new industries; significant progress on a recognized national need or grand challenge.

FY 2008 EFRI Solicitation: two research areas:
- Cognitive Optimization and Prediction- From Neural Systems to Neurotechnology (COPN)
- Resilient and Sustainable Infrastructure (RESIN)

EFRI awards will be up to 4 years in duration and up to $500,000 a year pending the availability of funds.

Key Dates:
- Letter of Intent Deadline Date: September 25, 2007
- Preliminary Proposal Deadline Date: October 26, 2007
- Full Proposal Deadline Date: April 30, 2008
Cyber-enabled Discovery for Innovation (CDI)
Cyber-enabled Discovery for Innovation

- **Knowledge extraction.**
- **Interacting elements.** CDI will improve our ability to predict and deduce interactions in complex systems to better understand, design and control them.
- **Computational experimentation.** Computational experimentation allows insight into complex, real-world systems such as hurricanes, nerve synapse activity, or the Big Bang, … CDI will provide new modeling techniques ranging from mathematical formulations to multiscale simulation techniques.
- **Virtual environments.** … They permit collaboration among diverse populations spread across geographic distances and at different times.
- **Educating researchers and students in computational discovery.**
- ~$750M over 5 years with FY08 request for $52M
Early ENG experience with gateways has been very positive
- nanoHUB.org for nanotechnology researchers
- NEES for earthquake engineering researchers

Primary purpose of this solicitation is to promote the development of VOs in ENG communities

EVO will provide seed grants to assist ENG communities in:
- Defining user needs for shared community resources
- Formulating organizing principles and VO structure
- Building a prototype and developing a plan for full-scale implementation

Program size: 10-15 awards, $100-200K
Letter of Intent: May 31, 2007; Full Proposal: July 3, 2007
Opportunities for Young Investigators

- Graduate Research Fellowship
- CAREER
- REU
Mechanisms for International Collaboration

- Program Funds
- Engineering Funds
- Office of International Science and Engineering
NSF Proposal & Award Process & Timeline

1. NSF Announces Opportunity
2. GPG Announcement Solicitation
3. Org. submits via FastLane
4. NSF Receives Proposal
5. Min. 3 Revs. Req.
6. Mail, Panel, Both
   & Recom.
8. DD Concur
9. Award via DGA
10. Decline
11. Organization

Timeline:
- Proposal Preparation Time: 90 Days
- Proposal Receipt at NSF: 6 Months
- DD Concur: 30 Days
- Award: 30 Days
- DGA Review & Processing of Award

Research & Education Communities

Returned Without Review/Withdrawn
NSF Proposal Review Criteria

NSB Approved Criteria include:

- What is the intellectual merit of the proposed activity?

- What are the broader impacts of the proposed activity?

Note: All proposals are peer-reviewed
Return Without Review

Per Important Notice 127, “Implementation of new Grant Proposal Guide Requirements related to the Broader Impacts Criterion” --

- Proposals that do not separately address both criteria within the one-page Project Summary will be returned without review.

- Examples of Broader Impacts
IREE: International Research and Education in Engineering

- Opportunity for international research and education for early-career researchers (undergraduates and graduate students, postdoctoral fellows, junior faculty members)
- Supplement for existing NSF awards
- Medium duration visits to collaborating institutions and laboratories outside the U.S.
- Research must be related to ongoing work
- Evidence of engagement in cultural activities in the countries visited