ENGINEERING $683,300,000

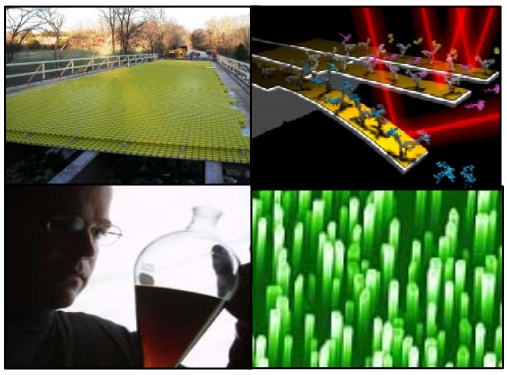
The FY 2008 Budget Request for the Directorate for Engineering (ENG) is $683.30 million, an increase of $54.75 million, or 8.7 percent, over the FY 2007 Request of $628.55 million.

Engineering Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Chemical, Bioengineering, Environmental and Transport Systems (CBET)	$125.09	$124.44	$144.97	$20.53	16.5%
Civil, Mechanical and Manufacturing Innovation (CMMI)	148.82	152.16	174.08	21.92	14.4%
Electrical, Communications and Cyber Systems (ECCS)	77.91	80.90	93.96	13.06	16.1%
Industrial Innovation and Partnerships (IIP)	109.65	120.08	128.39	8.31	6.9%
SBIR/STTR	*99.07*	*108.88*	*116.41*	*7.53*	*6.9%*
Engineering Education and Centers (EEC)	123.99	125.97	116.90	-9.07	-7.2%
Emerging Frontiers in Research and Innovation (EFRI)	-	25.00	25.00	-	-
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

Engineering research and education are the cornerstones of innovation. They provide the tools necessary to secure our continued economic growth, energy independence, and national security, while helping our Nation achieve the broad goals and objectives outlined in the President's American Competitiveness Initiative.

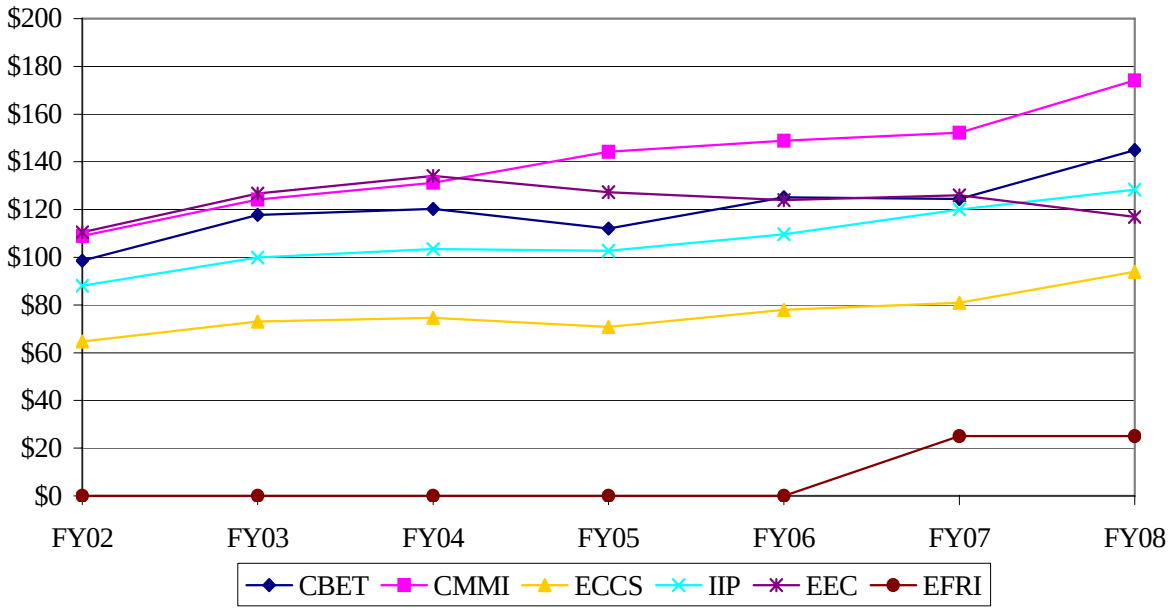
Through its investments in cutting-edge and transformative research, the Directorate for Engineering is a vital link in this process – enabling engineers to design the innovative systems that have the potential to improve our standard of living, environmental stewardship, and industrial productivity.



Engineering spans the frontiers – from designer materials and nanotechnology to alternative energy and understanding complex engineered and natural systems.

Engineering brings together imagination and ingenuity to create the fundamental knowledge and resources necessary to rise above today's pressing demands as well as strategically align our resources to address tomorrow's grand challenges. Many of these frontier challenges are already in the national spotlight, as recent news reports communicate the urgent need for engineering solutions. Protecting our homes and communities from natural disasters, making meaningful strides toward alternative energy sources, and educating a future workforce that leads the world in innovation, are just some of the areas where engineers are working toward solutions.

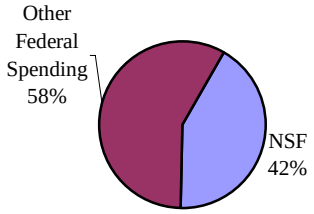
ENG Subactivity Funding
(Dollars in Millions)



RELEVANCE

The Engineering Directorate is the single largest source of federal funding for university-based, fundamental engineering research – providing 42 percent of the total federal support in this area.

Federal Support of Basic Research in Engineering at Academic Institutions



These investments in research and education have continually borne fruit, as evidenced by our Nation's perennial global leadership in innovation. ENG-supported research runs the gamut of high-impact, emerging technologies, such as hybrid communications systems, complex engineered systems, metabolic and cellular engineering, manufacturing frontiers, computer hardware, cyberinfrastructure, and nanotechnology.

Specific ENG research themes for FY 2008 and their relevance to the American Competitiveness Initiative (ACI) include:

- *Complex Engineered and Natural Systems* addresses unifying principles that enable modeling, prediction, and control of emergent behavior in complex systems ranging from critical infrastructure to the intersection of the life sciences and bioengineering. Whether exploring the neural processes that give rise to human intelligence, predicting global weather patterns, designing aircraft, or planning for catastrophic scenarios for our nation's infrastructure – an enabling body of knowledge on complex systems is essential. This

research also directly relates to a number of specific ACI research goals, including: materials for improving structural performances during natural disasters; overcoming barriers to quantum information processing; and world-leading automation and control technologies.

- *Energy and the Environment* will drive frontier research to find the essential breakthroughs necessary for radical improvements in the cost, sustainability, and security of our nation's energy system. ENG currently is engaged in research on energy and the energy supply chain. These areas include biofuels, hydrogen production, solar cells, energy scavenging, and fuel cells. Several programs address environmental issues, power distribution, carbon sequestration, and process and system design for energy conversion. This research is closely tied with the ACI goals of: use of hydrogen and solar energy through basic research in materials; and research critical to nanotechnology, biotechnology, alternative energy, and the hydrogen economy through essential infrastructure.

- *Innovation* is a principal objective of engineering research and pervasive in ENG investments. ENG – through its investments in discovery and innovation – continues to create the knowledge base and the intellectual capital essential for technological innovation. ENG is uniquely able to integrate research, education, and innovation through three existing programs: Grant Opportunities for Academic Liaison with Industry (GOALI), Industry/University Cooperative Research Centers (I/UCRC), and Partnerships for Innovation (PFI).

- *Manufacturing Frontiers* focuses on research that catalyzes multiscale manufacturing, from fundamental metrology through atomic-scale control of raw materials. ENG's investments in manufacturing will help to create quality-engineered nanomaterials in quantities sufficient to meet future needs; perfect manipulation and manufacturing on the atomic and molecular scale; enable the design and assembly of predictable integrated systems; and facilitate the transfer of nanoscience discoveries in the laboratory to practical industrial applications. This area also directly impacts the ACI research goals of: world-class capabilities in nanofabrication and nanomanufacturing; improved sensor and detection capabilities resulting in world-leading automation and control technologies; and manufacturing innovations for more efficient production practices.

- *Nanotechnology* supports the ACI goals of: world-class capabilities in nanofabrication and nanomanufacturing; research critical to nanotechnology through essential infrastructure; and is applicable to most of the other ACI, Administration, and NSF research goals. ENG leads the nation in fundamental nanoscale science and engineering research. This leadership is both in NSF's launching and subsequent support of the interagency National Nanotechnology Initiative (NNI), and through its own investments in nanoscale research. The long-term objectives of this broad initiative focus on building a foundation of fundamental research to understand nanoscale concepts, and applying novel principles to the most promising opportunities in measuring and manipulating matter on the nanoscale.

The national engineering community helps guide the research process through ongoing interactions, including conferences and workshops, and most significantly through the Engineering Advisory Committee, which provides near- and long-term recommendations to help ENG advance the frontiers of discovery, enable technological innovation, and transform education to serve the current and future demands of society.

Summary of Major Changes by Division ***(Dollars in Millions)***

FY 2007 Request, ENG…..……....$628.55

Chemical, Bioengineering, Environmental and Transport Systems +$20.53

The Division will increase support in key applications of the physical sciences, such as catalysis, chemical process design, environmental engineering, advanced materials, fuel cells, fluid flow, combustion, heat transfer, and particulate processes. These investments contribute to advances that are important for energy, the environment, transportation, information technologies, health-related products, and other areas to sustain and enhance US competitiveness and impact our daily lives.

Current high-emphasis applications of the life sciences include post-genomic engineering, tissue engineering, biophotonics, nano-biosystems, and biotechnology. Increased support will lead to improved biosensors, biomaterials, controlled drug release, bioimaging, medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, bioremediation, water and waste treatment, and food engineering.

Civil, Mechanical and Manufacturing Innovation +$21.92

Increased support in the areas related to analyzing, modeling, designing, building, and securing the nation's critical infrastructure, and manufacturing and service enterprise. CMMI will continue to increase investments in engineering education to foster a world-class engineering workforce. Support will also be increased for projects utilizing the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) and for hazard-related research.

Electrical, Communications and Cyber Systems +$13.06

Increased support for innovative research in nano and micro systems, communication systems and cyber systems that integrate physical devices and components with computational intelligence and networks. This will aid in the design, development, and implementation of new complex and hybrid systems with engineering solutions for a variety of domain-specific applications for the benefit of society. Additional funds will also support unsolicited proposals in the emerging areas of diagnostic and implantable devices; flexible electronics; neuromorphic engineering; quantum electronics; energy scavenging and alternative energy technologies, and interdependencies of critical infrastructure in power and communications.

Industrial Innovation and Partnerships +$8.31

IIP is home for the two congressionally mandated small business research programs, the Small Business Innovation Research (SBIR) program (+$6.73 million) and the Small Business Technology Transfer (STTR) program (+$800,000). In addition, IIP leverages industrial support through two research programs, the Industry/University Cooperative Research Centers (I/UCRC) program (+$480,000) and the Grants Opportunities for Academic Liaison with Industry (GOALI) program (+$300,000).

Engineering Education and Centers -$9.07

Support for Engineering Education and Nanoscale Science & Engineering Centers increases while support for the Engineering Research Centers (ERC) program decreases. The total number of ERCs will be reduced from 19 to the historical level of 15 as ENG moves into the next generation of ERCs.

Emerging Frontiers in Research and Innovation +$0.00

EFRI support remains level at $25.0 million and will foster transformative opportunities with high potential payoff leading to: new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge. EFRI was established in FY 2007 as part of the Engineering Directorate reorganization.

Subtotal, Changes +$54.75

FY 2008 Request, ENG…….……...…….$683.30

Summary of Major Changes in Directorate-wide Investments ***(Dollars in Millions)***

FY 2007 Request, ENG….……....$628.55

Discovery Research for Innovation +$51.85

Disciplinary and Interdisciplinary Research ($50.77 million).

The ENG research areas seamlessly interlace with the key areas outlined in the FY 2008 Administration Research and Development Budget Priorities; they align with the NSF Strategic Plan; and directly address the goals and programs contained in the American Competitiveness Initiative (ACI).

Support for core ENG research disciplines will be increased by $40.77 million. With these additional resources, ENG estimates a 3 percent increase in the research grant funding rate in FY 2008. ENG will continue to build on its strong system of merit review and investigator-initiated proposals, which advance the frontiers of knowledge and innovation by working across traditional boundaries and encouraging multidisciplinary, cutting-edge, and high-impact research. ENG's core represents a broad and synergistic convergence of fields, disciplines, and frontier opportunities and may be either newly emerging fields or long-standing challenges that are poised for major advancement. The Office of Emerging Frontiers in Research and Innovation (EFRI) will continue to identify, prioritize, and fund emerging frontier areas in engineering research, innovation, and education.

ENG also has a vital role to play in advancing a new NSF-wide investment area for FY 2008, Cyber-enabled Discovery and Innovation ($10.0 million). ENG broadly supports research in advanced cyber-enabled engineering to broaden the Nation's capability for innovation. This research focuses on a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems. Investment in this area will enable new avenues of support in emerging areas such as modeling of the electric power grid, computational fluid dynamics, and research to create virtual environments for innovation. It also will expand education and research capabilities through supplements to graduate students in supercomputer and petascale computer centers, and through ENG's participation in the Network for Computational Nanotechnology (NCN), making available research and educational software for nanotechnology.

Engineering Research Centers (ERCs) and Other Centers (-$7.45 million).
Funding decreases by $9.93 million, to a total of $52.86 million. The total number of ERCs will be reduced from 19 to the historical level of 15 as ENG moves into the next generation of ERCs. The goal of Generation Three ERCs (Gen-3) is to create a culture of innovation in engineering research and education that links scientific discovery to technological innovation through transformational engineered systems research in order to advance technology and produce engineering graduates who will be creative innovators in a global economy. New features of Gen-3 include a translational small business component and the requirement that each center have an international partner. Nanoscale Science and Engineering Centers funding increases by $2.0 million, to a total of $23.79 million, and Industry/University Cooperative Research Centers (I/UCRC) increases by $480,000 to a total of $7.28 million

Small Business Innovation Research/Small Business Technology Transfer (+$7.53 million).
Funding increases by $7.53 million, to a total of $116.41 million to meet the mandated agency spending target of 2.80 percent of the agency's extramural research budget.

Faculty Early Career Development Program (CAREER) (+$1.0 million).
Funding increases for the CAREER program by $1.0 million, to a total for $38.40 million, for two additional awards.

Preparing the Workforce of the 21st Century +$1.50

Research Experience for Undergraduates (REU)
Support for the REU Supplements increases by $1.0 million, to a total of $5.30 million, providing support to approximately 65 additional students.

Research Experiences for Teachers (RET)
Support for the RET Supplements increases by $500,000, to a total of $4.60 million.

Transformational Facilities and Infrastructure +$0.90

Network for Earthquake Engineering Simulation (NEES)
Funding for operations and maintenance costs increase $900,000, to a total of $22.17 million.

Stewardship +$0.50

Provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing program support functions.

Subtotal, Changes +$54.75

FY 2008 Request, ENG……..……...…….$683.30

NSF-WIDE INVESTMENTS

In FY 2008, the Directorate for ENG will support research and education efforts related to broad, Foundation-wide investments in a number of areas including NSF's multidisciplinary priority areas and the Administration's interagency R&D priorities.

Engineering NSF-wide Investments

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Biocomplexity in the Environment	$6.00	$4.00	-	-$4.00	-100.0%
Climate Change Science Program	1.00	1.00	1.00	-	-
Cyber-enabled Discovery and Innovation	-	-	10.00	10.00	N/A
Cyberinfrastructure	52.00	54.00	58.00	4.00	7.4%
Human and Social Dynamics	2.00	2.00	1.50	-0.50	-25.0%
Mathematical Sciences	2.88	1.46	-	-1.46	-100.0%
National Nanotechnology Initiative	127.77	137.02	139.02	2.00	1.5%
Networking and Information Technology R&D	11.20	11.20	21.20	10.00	89.3%

Biocomplexity in the Environment: With the conclusion of this priority area in FY 2007, funds will return to core programs for continued support.

Climate Change Science Program: A total of $1.0 million to support basic research in the areas of carbon dioxide capture and the reduction of other greenhouse gases.

Cyber-enabled Discovery and Innovation: ENG's investment of $10.0 million in CDI will enable new avenues of support in emerging areas such as modeling of the electric power grid, computational fluid dynamics, and research to create virtual environments for innovation.

Cyberinfrastructure: ENG currently funds the operation and research program of NEES – the George E. Brown Jr. Network for Earthquake Engineering Simulation – NSF's first distributed-network cyberinfrastructure research facility. ENG also supports the National Nanotechnology Infrastructure Network (NNIN) and the Network for Computational Nanotechnology (NCN). In FY 2008, support increases by $4.0 million to a total of $58.0 million and will be used to fund ENG projects at the device, node, network, and system levels that will enable enhanced capabilities for the next generation cyberinfrastructure. Funding will also be used to support projects that use cyberinfrastructure to enable frontier research in ENG domain areas.

Human and Social Dynamics: A total of $1.50 million will be invested in Decision Making and Risk and Dynamics of Human Behavior components of this priority area.

Mathematical Sciences: With the conclusion of this priority area in FY 2007, funds will return to core programs for continued support.

National Nanotechnology Initiative: NSF leads the U.S. nanotechnology research effort, and ENG is the focal point within NSF for this critical national research endeavor. The goal is to support fundamental research and catalyze synergistic science and engineering research and education in emerging areas of

nanoscale science and technology. This research includes biosystems at the nanoscale; nanoscale structures, novel phenomena, and quantum control; nanoscale devices and system architecture; nanoscale processes in the environment; multi-scale, multi-phenomena theory, modeling and simulation at the nanoscale; manufacturing processes at the nanoscale; and studies on the societal and educational implications of scientific and technological advances on the nanoscale. FY 2008 ENG support for NNI increases by $2.0 million, to a total of $139.02 million.

Networking and Information Technology R&D: ENG supports a broad array of fundamental computer and network research, including the Control, Networks and Computational Intelligence (CNCI) program, which covers creative research and education underlying the analysis and design of intelligent engineering networks for control, communications, computation, and energy.

QUALITY

ENG maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. In FY 2006, the last year for which complete data exist, 95 percent of research funds were allocated to projects that underwent external merit review.

To ensure the highest quality in processing and recommending proposals for awards, ENG convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review, and provide a retrospective assessment of the quality of results of NSF's investments.

ENG also receives advice from the Advisory Committee for Engineering (AC/ENG) on such issues as: the mission, programs, and goals that can best serve the engineering community; how ENG can promote quality graduate and undergraduate education in the engineering sciences; and priority investment areas in engineering research. The AC/ENG meets twice a year. Its members represent a cross section of engineering, with representatives from many different sub-disciplines within the field. Members also come from a variety of institutions, have broad geographic representation, and represent a balance of underrepresented groups.

PERFORMANCE

The FY 2008 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals stated in the FY 2006-2011 Strategic Plan. These goals provide an overarching framework for progress in fundamental research and education and facilitate budget and performance integration.

Engineering by Strategic Outcome Goal

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Discovery	$494.28	$538.03	$589.88	$51.85	9.6%
Learning	52.14	51.85	53.35	1.50	2.9%
Research Infrastructure	30.12	30.67	31.57	0.90	2.9%
Stewardship	8.92	8.00	8.50	0.50	6.3%
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

Totals may not add due to rounding

ENG will continue its commitment to education, training, and increasing diversity within all of its Divisions. The FY 2008 budget will increase award size and continue to focus on multidisciplinary research activities, interagency partnerships, and international activities with special attention given to broadening participation at all levels.

Recent Research Highlights

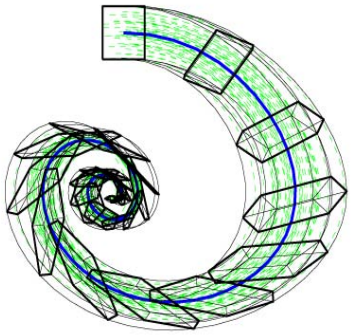
NEES investigators at UCSD's Seven Story Test Model. *Credit: Prof. Jose Restrepo, Dept. of Structural Engineering, UCSD.*

► **Cost Effective and Earthquake Resistant:** By applying innovative, intelligent design strategies, structural engineers at the University of California, San Diego, have successfully shown that new light-weight construction techniques are as earthquake-resistant as bulkier, more expensive methods.

By erecting a seven-story test building on a giant outdoor shake table – which is part of the NSF-supported Network for Earthquake Engineering Simulation (NEES) – the engineers duplicated the force of California's devastating 1994 Northridge Earthquake. Data from this test confirmed that novel designs and carefully placed reinforcements are just as effective at withstanding earthquake damage as the heavily reinforced, "hardened" buildings required by California building codes.

Full-scale tests of such large buildings have previously not been possible because of weight, space, and technical limitations of smaller indoor shake tables. The NEES shake table at UCSD can actually support a building roughly 10 times heavier than the one tested in this study. (CMMI)

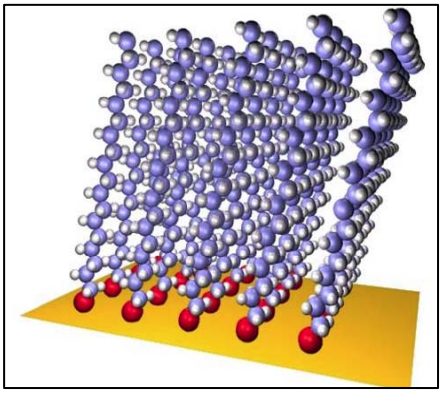
► **Modeling Uncertainty in Power Systems:** U.S. power systems are vulnerable to disruption from a variety of sources—natural events, terrorism, surges in power demand and supply, an aging power grid, and inadequate communications systems. When power systems fail, we lose electricity to operate our homes, businesses, factories, and computer networks. Realistic models of how power systems respond to disruptions are critical in protecting the nation's security and prosperity.



A diagram of the worst-case range of responses to a power system disturbance. *Credit: I. Hiskens, University of Wisconsin, Madison.*

Models must incorporate uncertainty about power systems operations and how they respond to different disturbances. Using worst-case analysis and a probabilistic approach, a researcher at the University of Wisconsin has developed an efficient and accurate approach. He quantifies uncertainties and portrays them visually, providing a clearer view of how power systems are likely to respond to different risks. This method is particularly effective in analyzing the potential for cascading failures—such as occurred in the Northeast in 2003. This allows power system managers to anticipate potentially devastating situations and develop appropriate operations strategies. (ECCS)

► **Hydrogen Storage Pulls Itself Together:** For hydrogen to become an economical and practical fuel alternative, engineers will need to solve a number of technological hurdles, including finding a safe and effective means of hydrogen storage and transportation. Researchers at the University of Washington's Engineered Biomaterials Engineering Research Center (UWEB) – through Asemblon Inc., a spin-off company – have created a new material that can store and release hydrogen on demand. What gives this material its unique properties is the fact that its molecules self-assemble into sheets called mono-layers, which align, row upon row. This structure allows hydrogen to be chemically stored and released as needed, which is vital for energy applications. Another important quality of the material is that it can be regenerated to a hydrogen-rich form that is suitable for re-use in hydrogen production. By making hydrogen storage and transportation more practical, this innovation may play an important role in our nation's future hydrogen economy. (EEC)



Graphic demonstrating how self-assembling materials align to enable hydrogen storage. *Credit: Dan Graham, Assemblon, Inc.*

Genosensor used to detect pathogens in ocean and coastal waters. *Credit: Image Courtesy of John Paul, USF.*

► **New Sensor Detects Pathogens in Coastal Waters:** Researchers at the University of South Florida have demonstrated a rapid, highly accurate genetics-based sensor for detecting pathogens in coastal or ocean water. The system – called a genosensor – samples seawater and partially purifies the RNA found in it to assess the presence of viruses or microbes. To ensure accuracy, the system checks the genosensor results with a molecular beam probe (a secondary sensor), which causes the sample to light up if pathogens are present. The researchers are working to develop a sensor-based platform to automatically monitor ocean and coastal waters, sending information in real-time to shore-based monitoring stations.

Initial sensor research has focused on detecting *Karenia brevis*, the microbe that causes "red tides," which devastates fish and marine mammals, and also causes respiratory problems for people and animals. The researchers developed an extremely sensitive sensor that detects *K. brevis*, even if just one cell is present in the seawater sample. The probe verifies results and provides minute-by-minute readings for ongoing measurements. (CBET)

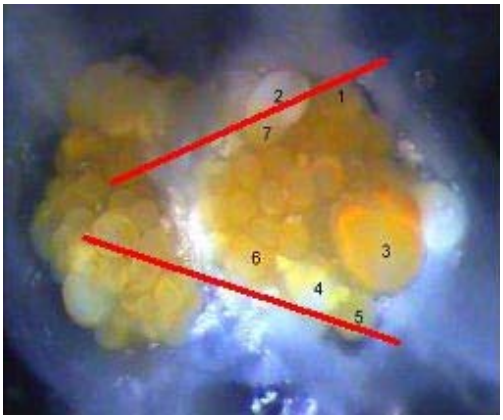
► **Partnering to Solve Real Problems:** Founders of the Learning Factory – a program that matches student teams with industrial problems – received the National Academy of Engineering's highest prize for educational innovation. "The Learning Factory is an internationally recognized leader in interdisciplinary industry-partnered, active learning." The program has been integrated into the curricula at Penn State, the University of Puerto Rico-Mayaguez, and the University of Washington. The program was designed to give students a unique experience and to attract underrepresented minorities to manufacturing engineering.

More than 10,000 students have developed designs addressing the needs of more than 200 industrial partners through the Learning Factory.

Mechanical engineering student creating a product prototype on a rapid prototyping machine in the Learning Factory. *Credit: John Lamancusa, Penn State University.*

Student teams define and characterize the problem, develop prototypes, write a business proposal to address the problem, and prepare a final report. Students face real-world pressures to develop quality products "on time" and "under budget" – critical skills in today's globally competitive world. (CMMI)

► **New Approaches to Neural Imaging:** Functional optical coherence tomography (FOCT) has the potential to be a versatile diagnostic tool – similar to ultrasound – with greater speed, flexibility, and precision. FOCT splits a light beam in two. It scans one beam across a tissue to produce a cross sectional image. It scans the other beam across a known material. The two signals are compared for differences in the intensity of the light that is scattered or reflected back. These differences provide information about tissue structure and function.



Cross sectional image of nerve fibers, abdominal ganglion, and single neurons in Aplysia californica (sea slug). *Credit: Stephen Boppart Nanoelectronics and Biophotonics Group, Beckman Institute, University of Illinois.*

To be effective, FOCT requires fast and stable optical scans. A CAREER awardee at the University of Illinois has successfully used FOCT to investigate neural activity and communication patterns at the cellular and molecular level. Using special imaging techniques and tools that he developed for rapidly processing images, the researcher captured optical changes in neural fibers of the sea slug (Aplysia californica) on a microsecond time scale with the precision of a few microns. This is an important step in developing FOCT as an effective tool for non-invasively characterizing physiological changes in single neurons, nerve fibers, and brain tissue. (CBET)

Other Performance Indicators

The tables below show the change in the number of people benefiting from ENG funding, and trends in the award size, duration, number of awards, and funding rates.

Number of People Involved in ENG Activities

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Senior Researchers	5,648	5,930	6,226
Other Professionals	1,278	1,344	1,475
Postdoctorates	396	426	470
Graduate Students	5,025	5,276	5,540
Undergraduate Students	2,186	2,427	2,650
Total Number of People	14,533	15,403	16,361

ENG Funding Profile

	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate
Statistics for Competitive Awards:			
Number	1,737	1,750	1,855
Funding Rate	18%	20%	24%
Statistics for Research Grants:			
Number of Research Grants	956	1,050	1,265
Funding Rate	14%	15%	18%
Median Annualized Award Size	$90,000	$93,000	$93,500
Average Annualized Award Size	$110,032	$115,000	$118,000
Average Award Duration, in years	3.0	3.0	3.0

CHEMICAL, BIOENGINEERING, ENVIRONMENTAL AND TRANSPORT SYSTEMS $144,970,000

The FY 2008 Budget Request for the Chemical, Bioengineering, Environmental and Transport Systems Division (CBET) is $144.97 million, an increase of $20.53 million, or 16.5 percent, above the FY 2007 Request of $124.44 million.

Chemical, Bioengineering, Environmental and Transport Systems Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Chemical, Bioengineering, Environmental, and Transport Systems	**$125.09**	**$124.44**	**$144.97**	**20.53**	**16.5%**
Major Components:					
Research and Education Grants	113.83	111.95	131.86	19.91	17.8%
Science and Technology Center (STC)	4.08	4.00	4.00	-	-
National Nanoscale Infrastructure Network (NNIN)	3.17	3.20	3.20	-	-
Nanoscale Science and Engineering Centers (NSEC)	4.01	5.29	5.91	0.62	11.7%

About CBET:

The Chemical, Bioengineering, Environmental and Transport (CBET) Division supports research to enhance and protect US national health, energy, environment, security, and wealth. Through CBET, the physical, life and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics. CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines.

To achieve synergy across disciplinary boundaries, CBET is organized in four program clusters: Chemical, Biochemical, and Biotechnology Systems; Transport and Thermal Fluids Phenomena; Biomedical Engineering and Engineering Healthcare; and Environmental Engineering and Sustainability

In general, 61 percent of the CBET portfolio is available for new research grants. The remaining 39 percent funds continuing grants made in previous years.

CBET Priorities for FY 2008:

The Division will continue to support research in key applications of the physical sciences, such as catalysis, chemical process design, environmental engineering, advanced materials, fuel cells, fluid flow, combustion, heat transfer, and particulate processes. These investments contribute to advances that are important for energy, the environment, transportation, information technologies, health-related products, and other areas to sustain and enhance US competitiveness and impact our daily lives.

Current high-emphasis applications of the life sciences include post-genomic engineering, tissue engineering, biophotonics, nano-biosystems, and biotechnology. This research leads to improved biosensors, biomaterials, controlled drug release, bioimaging, medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, bioremediation, water and waste treatment, and food engineering.

While sustaining the vitality of these core research areas, CBET actively supports the following theme areas:

Energy, Environment, and Sustainability: CBET will continue to support research on environmentally benign processes. Energy conversion areas include cleaner combustion processes, the fabrication of new materials for solar cells, novel electrode materials for fuel cells, microbial fuel cells, liquid biofuels, and biohydrogen. The management of greenhouse gases with their links to climate change will be supported. CBET leads the Water and Environmental Research Systems (WATERS) Network project, which has, as its objective, the transformation of water resource engineering research at a national scale. Resilient, sustainable infrastructure is a new area of support for several programs within the division.

Nanoscale Science and Engineering: CBET will continue its leadership role in designing, synthesizing, and analyzing nanoscale systems. Current emphasis is on active nanoscale systems leading to improved devices and manufacturing techniques. CBET also plays a key role in funding exploratory research on biosystems at the nanoscale. For example, chips and sensors, combined with microfluidics, are integrated intimately with nanobiotechnology. Many of these systems are for medical, environmental, and other sensing applications.

Cyber-enabled Discovery and Innovation (CDI): CDI efforts are pervasive throughout CBET's programs. Projects involving CDI are funded throughout CBET, and draw increasingly on High Performance Computing (HPC) capabilities that will be enhanced by NSF-level CDI initiatives. Multi-scale modeling (MSM) is growing rapidly in the academic communities funded by CBET. CBET hosts the interagency solicitation on MSM in Biomedical, Biological, and Behavioral (BBB) systems. CBET is also part of an interagency working group on multi-scale chemical sciences and process informatics kinetics.

Complex Engineered and Natural Systems: CBET invests heavily in complex natural systems through the environmental programs, including the plan for the WATERS Network, and through projects awarded in the Biomedical Engineering and Engineering Healthcare cluster. Examples of these types of awards include the development of artificial retinal implants for sight restoration and neurotechnology-based computer interfaces to allow brain-injured people use of their limbs.

CBET continues to participate in major NSF wide initiatives and supports large scale facilities through Science and Technology Centers, Nanoscale Engineering Centers and the National Nanotechnology Infrastructure Network.

Changes from FY 2007:

- Support of $3.75 million for the new Cyber-enabled Discovery and Innovation (CDI) key investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by $620,000 in core research areas and NSEC support to a total of $43.44 million.
- An increase of $16.16 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.

CIVIL, MECHANICAL AND MANUFACTURING INNOVATION $174,080,000

The FY 2008 Budget Request for the Civil, Mechanical and Manufacturing Innovation Division (CMMI) is $174.08 million, an increase of $21.92 million, or 14.4 percent, above the FY 2007 Request of $152.16 million.

Civil, Mechanical and Manufacturing Innovation Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Civil, Mechanical and Manufacturing Innovation	**$148.82**	**$152.16**	**$174.08**	**$21.92**	**14.4%**
Major Components:					
Research and Education Grants	121.76	124.31	144.81	20.50	16.5%
Network for Earthquake Enginnering and Simulation (NEES)	20.55	21.27	22.17	0.90	4.2%
National Nanoscale Infrastructure Network (NNIN)	1.63	1.65	1.65	-	-
Nanoscale Science and Engineering Centers (NSEC)	4.88	4.93	5.45	0.52	10.5%

About CMMI:

The Civil, Mechanical and Manufacturing Innovation (CMMI) Division enables a globally competitive and sustainable future for the nation by supporting fundamental research to advance the frontiers of knowledge. CMMI supports areas related to analyzing, modeling, designing, building, and securing the nation's critical infrastructure, and manufacturing and service enterprise. CMMI also invests in engineering education to foster a world-class engineering workforce. CMMI programs are organized into three areas: engineering infrastructure systems, innovation science and decision engineering, and materials transformation and mechanics. These areas will provide funds for the creation of necessary knowledge to design and secure the nation's infrastructure, and to grow our nation's wealth-producing enterprises.

A major portion of CMMI's portfolio supports the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) and hazard-related research. NEES is a system of 15 experimental facilities located at universities across the United States, which work together via cyberinfrastructure. This research facility addresses important challenges in earthquake and tsunami engineering research that previously could not be addressed, such as testing structures at near to full scale. Investments in fundamental earthquake engineering and other hazard-related research enables NSF's Engineering Directorate to quickly send research teams to gather ephemeral data immediately following natural as well as man-made disasters. The fundamental knowledge gained from these investments is being used to design predictive systems for the nation's infrastructure to mitigate damage, down time, and loss of life from a wide range of hazards.

CMMI's design, manufacture, and service portfolio is the largest of the federal agencies that support fundamental research and discovery that is driven by innovative research ideas from the community rather than narrowly defined specifications. This has led to early investments in solid-modeling systems, optimization and network methods, and processes that provide solid representations directly from digital data and enable engineered processes for growing tissue.

In general, 63 percent of the CMMI portfolio is available for new research grants. The remaining 37 percent funds continuing projects made in previous years and operation of facilities and centers.

CMMI priorities for FY 2008:

CMMI's priorities for FY 2008 align with ENG's priorities in:

- *Manufacturing Frontiers* by supporting research in the enabling processes, systems and enterprises to advance nanomanufacturing and the technology for healthcare delivery.
- *Complex Engineered and Natural Systems* by supporting research that leads to fundamental knowledge of complex systems and their modeling and by supporting research that leads to technologies for the protection, maintenance, or modification of the nation's critical civil and cyber infrastructure.
- In addition, CMMI will collaborate in advancing ENG's theme areas of: *Innovation* and *Nanotechnology*.

A major priority for the CMMI division is support for NEES research, operations, and grand challenge research. To date, 33 research projects have now been funded to utilize the NEES facilities. Current grand challenge research projects address the seismic vulnerability of nonductile concrete buildings in urban areas and port structures. In FY 2008, research will continue to involve experimental and theoretical simulations as the NEES facilities as well as expand educational outreach.

CMMI is engaged with its research community to focus its investment priorities. This includes several workshops on fundamental research needs in the area of jointed structures, cosponsored with Department of Defense agencies, workshops for the Mechanical Engineering and Civil and Environmental Engineering communities for their future research directions.

CMMI supports nanoscale science and engineering, with programs in the Materials Transformation and Mechanics cluster, including Nanomanufacturing and Nano/Bio-Mechanics. These programs have a critical role in converting discoveries into innovations, and are a key component of the Directorate's *Nanotechnology* theme and the grand challenges for the National Nanotechnology Initiative. A range of manufacturing discoveries and innovations are needed to design the systems and processes to deliver products, devices and components that take advantage of the unique properties of the nanoscale. Simultaneously, an entirely new manufacturing workforce needs to be educated and trained in nanotechnology to bring to fruition the many exciting opportunities that nanotechnology has opened up. CMMI's Nanomanufacturing program will continue to support research on improving human physical and mental abilities through the integration of nanotechnology, biotechnology, information technology, and cognitive science, as well as a new generation of tools and processes to achieve this goal. CMMI's Summer Institute on Nano Mechanics and Materials continues to train 150 current and prospective faculty members per year in these areas.

Changes from FY 2007:

- Support of $3.13 million for the new Cyber-enabled Discovery and Innovation investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by $520,000 in core research areas and NSEC support to a total of $28.79 million.
- An increase of $17.37 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.
- An increase of $900,000 to a total of $22.17 million will continue to accommodate the operations phase for the Network for Earthquake Engineering Simulation.

ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS $93,960,000

The FY 2008 Budget Request for the Electrical, Communications and Cyber Systems (ECCS) Division is $93.96 million, an increase of $13.06 million, or 16.1 percent, over the FY 2007 Request of $80.90 million.

Electrical, Communications and Cyber Systems Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Electrical, Communications and Cyber Systems	**$77.91**	**$80.90**	**$93.96**	**$13.06**	**16.1%**
Major Components:					
Research and Education Grants	65.91	69.19	81.91	12.72	18.4%
Nanoscale Science and Engineering Centers (NSEC)	3.13	3.16	3.50	0.34	10.8%
National Nanoscale Infrastructure Network (NNIN)	4.77	4.55	4.55	-	-
Science and Technology Center (STC)	4.10	4.00	4.00	-	-

About ECCS:

ECCS will address fundamental research issues underlying device and component technologies, power, controls, computation, networking, communications and cyber technologies. ECCS will support the integration and networking of intelligent systems at the nano, micro and macro scales for a variety of application domains in healthcare, homeland security, disaster mitigation, energy, telecommunications, environment, transportation, manufacturing, and other systems-related areas. ECCS envisions a research community that will address major technological challenges for the next generation of devices and systems due to convergence of technologies and increased emphasis on interdisciplinary research to achieve the goals of the American Competitiveness Initiative. ECCS will integrate education into its research programs to ensure the preparation of a diverse workforce for the 21st century that can enable innovative advances in emerging technologies as drivers of the global economy.

ECCS is organized around three programs that will focus on research and educational issues of device and component technologies, network and computational technologies, and systems engineering: (1) Electronics, Photonics and Device Technologies (EPDT); (2) Power, Controls and Adaptive Networks (PCAN); and (3) Integrative, Hybrid and Complex Systems (IHCS).

In general, 69 percent of the ECCS portfolio is available for new research grants; the remaining 31 percent funds continuing grants made in prior years.

ECCS Priorities for FY 2008:

The Electronics, Photonics and Device Technologies (EPDT) program will seek to improve the fundamental understanding of devices and components based on the principles of electronics, photonics, magnetics, organics, electro-optics, electromechanics, and related physical phenomena. The program will enable discovery and innovation in advancing the frontiers of spin electronics, molecular electronics, bioelectronics, silicon nanoelectronics and beyond, nonsilicon electronics, flexible electronics, optoelectronics, microwave photonics, power electronics, and mixed signal devices. EPDT will further support related topics in quantum engineering, novel electromagnetic materials-based devices, radio frequency integrated circuits, and reconfigurable antenna for telecommunications, telemedicine and other wireless applications. EPDT will provide additional emphasis on emerging areas of diagnostic and

implantable devices and will continue its support for manipulation and measurement with nanoscale precision through new approaches for tools.

The Power, Controls and Adaptive Networks (PCAN) program will invest in the design and analysis of intelligent and adaptive engineering networks, including sensing, imaging, controls, and computational technologies for a variety of application domains. PCAN will further invest in adaptive dynamic programming, brain-like networked architectures performing real-time learning, neuromorphic engineering, telerobotics and systems theory. PCAN will place a strong emphasis on critical infrastructure aspects of electric power networks and grids, including generation and integration (InterGrid) of renewable, sustainable and distributed energy systems in large power networks, high power electronics, and understanding of associated regulatory and economic structures. PCAN will provide additional emphasis on emerging areas, such as quantum and molecular modeling and simulation of devices and systems, energy scavenging and alternative energy technologies, and interdependencies of critical infrastructure in power and communications.

The Integrative, Hybrid and Complex Systems (IHCS) program is intended to spur visionary systems-oriented activities in collaborative research and education environments for multidisciplinary integrative activities. The program will support innovative research in nano/microsystems, communication systems, and cyber systems that integrate physical devices and components with computational intelligence and networks. The goal is to design, develop, and implement, new nano/micro/macro complex and hybrid systems with engineering solutions for a variety of domain-specific applications. Some examples include: system-in-a-package; system-on-a-chip; wireless networks of handheld or wearable computing devices; integrated hybrid optical and electronic systems for high-speed computation and communications; distributed sensing and actuation in telemedicine; ambient intelligent systems for homes of the future; and self-organizing blackout-free electric power grid.

ECCS will continue to provide support for specialized resources and infrastructure that facilitate research and educational activities, including NNIN, STC, NSEC and NSEE, as well as crosscutting activities. ECCS will support the development of people through Foundation-wide programs, such as CAREER and ADVANCE, and through REU and RET supplements, and will actively participate in the development and management of cross-disciplinary programs. ECCS plans to continue to support Graduate Research Supplements (GRS) to broaden participation of underrepresented Ph.D. students majoring in electrical engineering. ECCS will hold grantees' workshops to assess the results of research and education grants and focused workshops to assess research and technology areas of current and future importance.

Changes from FY 2007:

- Support of $3.12 million for the new NSF-wide Cyber-enabled Discovery and Innovation (CDI) investment area.
- Support for the National Nanotechnology Initiative (NNI) increases by $340,000 in core research areas and NSEC support to a total of $39.12 million.
- An increase of $9.60 million to support leading edge, frontier research in core programs and in support of the Engineering research themes.

INDUSTRIAL INNOVATION AND PARTNERSHIPS $128,390,000

The FY 2008 Budget Request for the Industrial Innovation and Partnerships (IIP) Division is $128.39 million, an increase of $8.31 million, or 6.9 percent, over the FY 2007 Request of $120.08 million.

Industrial Innovation and Partnerships Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Industrial Innovation and Partnerships	**$109.65**	**$120.08**	**$128.39**	**$8.31**	**6.9%**
Major Components:					
Small Business Innovation Research (SBIR)	88.57	97.47	104.20	6.73	6.9%
Small Business Technology Transfer (STTR)	10.50	11.41	12.21	0.80	7.0%
Grant Opportunities for Academic Liaison with Industry (GOALI)	4.00	4.40	4.70	0.30	6.8%
Industry/University Cooperative Research Centers (I/UCRC)	6.58	6.80	7.28	0.48	7.1%

About IIP:

The Division of Industrial Innovation and Partnerships serves the entire foundation by fostering partnerships aimed at advancing technological innovation. The division is organized to respond to the American Competitiveness Initiative by catalyzing the transformation of discovery into societal benefits through stimulating partnerships for innovators. IIP is home for the two congressionally mandated small business research programs, the Small Business Innovation Research program (SBIR) and the Small Business Technology Transfer program (STTR). In addition, IIP leverages industrial support through two research programs, the Industry/University Cooperative Research Centers (I/UCRCs) and the Grants Opportunities for Academic Liaison with Industry (GOALI) program.

Twice each year, SBIR and STTR release proposal solicitations containing topics targeted to the innovative small businesses in the United States. These solicitations cover technologies that emphasize innovation with commercialization potential. From the business community perspective, SBIR/STTR investments are considered "pre-seed." That is, they support research that is considered too high-risk for even early stage corporate investment. The research topics in the SBIR/STTR solicitations are grouped into three business opportunity areas. These topics are designed to meet the needs of capital/investment markets, strategic partners, and national and societal priorities. They also have the potential to encourage business investments outside of the SBIR/STTR program.

The Industry/University Cooperative Research Centers (I/UCRC) program develops long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from NSF, and are primarily supported by industry center members, with NSF taking a supporting, guiding role in their development and evolution. Each center is established to conduct research that is of interest to both the industry and the center. An I/UCRC contributes to the nation's research infrastructure base and enhances the intellectual capacity of the engineering and science workforce through the integration of research and education.

The Grant Opportunities for Academic Liaison with Industry (GOALI) program enables partnerships between industry and academe where there is a common intellectual and educational agenda. The program supports (a) faculty, postdoctoral fellows, and students to conduct research and gain experience

in an industrial setting; (b) industry scientists and engineers to bring industrial perspective and integrative skills to academe; and (c) interdisciplinary university/industry teams to conduct long-term projects. The program targets high-risk and high-gain research, with focus on fundamental topics that would not otherwise have been undertaken by industry; the development of innovative, collaborative university/industry educational programs; and the direct exchange of new knowledge between academe and industry.

IIP Priorities for FY 2008:

Within the SBIR/STTR research topics, Biotechnology, Information Technology, and Electronics Technology are positioned as potentially attractive to the venture capital and "angel network" communities. Advanced Materials and Manufacturing and Chemical Technology research topics are of interest to the large corporations that see the potential for strategic partnerships with the small business community. Selected topics are launched in response to national priorities such as Manufacturing Innovation and Security Technology. To accelerate near term technological innovation, a special topic, Emerging Opportunities, and a supplement to qualifying Phase I grantees, were launched in 2006. Starting in FY 2006, SBIR and STTR programs reversed the downward trend in funding rate from a low of 14 percent by controlling release of solicitation topics. With increased funding in 2008, the target is to achieve 20 percent funding rate.

The 47 I/UCRCs work closely with industry to develop enabling technologies needed to manage the electrical power system, improve manufacturing and biological processes, develop new materials, information and telecommunications technologies, and innovate new products and services. The I/UCRC program provides modest seed funds and management expertise to these highly leveraged centers, with states joining in many partnerships to expand the centers' activities to have an impact on local economic development. In FY 2006, I/UCRC launched a supplemental research initiative to advance the underlying fundamental science and technology of the centers. Currently, the I/UCRC and SBIR/STTR programs are exploring synergistic academic-small business partnership opportunities as a model to accelerate the innovation process.

The strategic plan for the Directorate for Engineering calls for increasing partnerships between academic and industrial communities. GOALI is well positioned to directly impact this objective. GOALI leverages its budget with support from other academic research programs by a factor of four-to-one. In FY 2008, the GOALI program will seek opportunities to accelerate innovation, strengthening the discovery knowledge base for a quicker transformation of discovery to societal benefit.

Changes from FY 2007:

- Increase of $6.73 million, to a total of $104.20 million for the Small Business Innovation Research program.
- Increase of $800,000, to a total of $12.21 million for the Small Business Technology Transfer program.
- Funding increases $480,000, to a total of $7.28 million for the I/UCRC program.
- Increase of $300,000, to a total of $4.70 million for GOALI program.

ENGINEERING EDUCATION AND CENTERS $116,900,000

The FY 2008 Budget Request for the Engineering Education and Centers (EEC) Division is $116.90 million, a decrease of $9.07 million, or 7.2 percent, from the FY 2007 Request of $125.97 million.

Engineering Education and Centers Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Engineering Education and Centers	**$123.99**	**$125.97**	**$116.90**	**-9.07**	**-7.2%**
Major Components:					
Research and Education Grants	43.89	50.35	50.69	0.34	0.7%
Engineering Research Centers (ERC)	62.31	62.79	52.86	-9.93	-15.8%
Earthquake Engineering Research Centers (EERC)	6.00	-	-	-	N/A
Nanoscale Science and Engineering Centers (NSEC)	8.44	9.48	10.00	0.52	5.5%
Network for Computational Nanotechnology	3.35	3.35	3.35	-	-

About EEC:

The Engineering Education and Centers (EEC) Division promotes and facilitates university research and curricula by supporting innovative programs that integrate research and education, improve the quality of the engineering workforce, cut across disciplines, and whose breadth of investigation spans from idea inception to proof-of-concept. The division's programs are divided into three major categories: development of interdisciplinary research centers that foster partnerships between academe, government and industry; advancing graduate and undergraduate engineering education; and development of a diverse and capable technical workforce. EEC programs address issues that are critical to all fields of engineering and benefit from a centralized management focus, as well as complement the research and education portfolios of the other divisions of the Engineering Directorate. Included programs benefit from a scope encompassing all of engineering and a scale that both facilitates the incorporation of new scientific knowledge into engineering and requires rigorous monitoring and evaluation systems.

In general, 89 percent of the EEC portfolio is used to fund centers, graduate fellowships, and undergraduate programs. Approximately 9 percent of the EEC portfolio is available for new research grants.

EEC Priorities for FY 2008:

In FY 2008, EEC will provide support for Engineering Research Centers, Nanoscale Science and Engineering Centers, engineering education research, and engineering workforce development. Approximately 57 percent of the EEC budget supports center related activities, with the remaining 43 percent supporting engineering education and workforce development programs.

In FY 2007, fifteen Engineering Research Centers received funding. Examples of center research would include: research and development of sensory prostheses that interface to the human nervous system, systems for detection of and warning of severe storms, computer-integrated surgical systems, biomaterials for implants, reconfigurable manufacturing systems, and power electronics. In FY 2006, five new ERCs

were added to the portfolio, enabled by funds released into the ERC program through the graduation to self-sufficiency of five ERCs in FY 2005, and phasing down support to seven ERCs during FY 2005 and 2006 to prepare them for self-sufficiency.

The eight Nanoscale Science and Engineering Centers, fully or partially supported by EEC, perform research to advance the development of the ultra-small technology that will transform electronics, materials, medicine, and many other fields. They involve key partnerships with industry, national laboratories, and other sectors; and support education programs from the graduate to the pre-college level designed to develop a highly skilled workforce. Funds are also provided to smaller interdisciplinary teams and to the Network for Computational Nanotechnology, a web-accessible repository of simulations of nanoscale phenomena for research and education.

EEC programs in engineering education are aimed at transforming engineering education to produce an engineering workforce that is diverse and creative, understands the impacts of its solutions on both technical and social systems, and possesses the ability to adapt to the rapidly evolving technical environment in industry, academe, and society. In FY 2008, research will be supported to improve the development, management, and productivity of quality engineering education at both the undergraduate and graduate level. Significant breakthroughs in understanding are sought so that our undergraduate and graduate engineering education can be transformed to meet the needs of the changing economy and society. Topics of particular interest include: the aims and objectives of engineering education, the content and organization of the curriculum, how students learn problem solving, creativity and design, new methods for assessment and evaluation of how students learn engineering, and research that helps us understand how to attract a more talented and diverse student body to all levels of engineering study

Existing programs in Research Experiences for Undergraduates (REU) Sites and Research Experiences for Teachers (RET) Sites, which have been shown to be successful programs for broadening participation in engineering programs at both the undergraduate and graduate levels will continue in FY 2008 at their current levels.

Changes from FY 2007:

- Support for the Research and Education Grants increases by $340,000 to a total of $50.69 million.
- Support for Nanoscale Science & Engineering Centers increases by $520,000, to a total of $10.0 million.
- Funding for ERCs decreases by $9.93 million, to a total of $52.86 million as the total number of centers is returned to the historical level of fifteen and funding of some previously available supplemental programs is reduced. Funds are being reallocated to the three primary ENG research divisions to help further buoy the very low ENG funding rate for research grants.

EMERGING FRONTIERS IN RESEARCH AND INNOVATION $25,000,000

The FY 2008 Budget Request for the Office of Emerging Frontiers in Research and Innovation (EFRI) is $25.0 million, equal to the FY 2007 Request of $25.0 million.

Emerging Frontiers in Research and Innovation Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Emerging Frontiers in Research and Innovation	**-**	**$25.00**	**$25.00**	**-**	**-**

About EFRI:

The Office of Emerging Frontiers in Research and Innovation (EFRI) was established in FY 2007 as a result of strategic planning and reorganization of NSF Engineering Directorate (ENG). Motivated by the vision of ENG to be the global leader in advancing the frontiers of fundamental engineering research, EFRI serves a critical role in helping ENG focus on important emerging areas in a timely manner.

Each year EFRI recommends, prioritizes, and funds interdisciplinary initiatives at the emerging frontier of engineering research and education. These emerging frontiers research areas are frequently found in transformative interdisciplinary areas. The divisions within the NSF's Engineering Directorate are not strategically aligned to support this type of research, which often falls outside the usual classifications and research areas. EFRI enables the Engineering Directorate to pursue these interdisciplinary areas by allowing the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields. This Office will have the potential to push the frontier in new and emerging areas.

Technological innovations, particularly over the past decade, have given rise to new industries, expanded our access to quality healthcare, and fueled our nation's prosperity even in the face of growing global competition. Now that global competition is increasing, the technical underpinnings of the past may not be adequate to ensure our continued success. EFRI will provide critical, strategic support of fundamental discovery, especially in areas leading to breakthrough technologies.

EFRI investments represent transformative opportunities, potentially leading to: new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge. These challenges may include areas such as safe, clean water; sustainable energy resources; technologies to overcome physical limitations from disease or injury; and integrated systems designed to thwart attacks on U.S. infrastructures and interests throughout the world. EFRI will have the necessary flexibility to target our long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

In general, 100 percent of the EFRI portfolio is available for new research grants.

EFRI Priorities for FY 2007:

The role of the EFRI Office is to fund research opportunities that would be difficult to fund with current mechanisms, such as Small Grants for Exploratory Research, typical core awards, or large research center

solicitations. EFRI support will represent transformative opportunities with high potential payoff leading to: new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge. The successful topics would likely require small- to medium-sized interdisciplinary teams of researchers with significant funding, for a period of time needed to make substantial progress that would provide evidence for additional follow-on funding through other established funding mechanisms.

Mechanisms: Potential EFRI topics can arise from input from a number of sources – the community, ENG leadership, advisory committees, workshops, professional societies, academies, proposals and awards, and NSF committees of visitors. Yet, in the case of directed specified topics, the ENG Program Directors will play the central role within NSF.

EFRI will operate by the following process:

- At the beginning of each Fiscal year, NSF Program Directors will propose frontier research areas that show potential for significant growth or transformative results.
- Program Directors will then prioritize these topical areas, which will be reviewed by the ENG leadership. ENG leadership will evaluate the recommendations and make the final EFRI allocation decisions on list of topics.
- Based on this list of topics, working groups will generate proposed announcements.
- These lists of topics will be presented to the ENG Advisory Committee at their spring meeting.
- These decisions will be the foundation of EFRI Solicitations and/or Dear Colleague Letters, which will go through the appropriate NSF preparation and clearance processes.

Potential EFRI topics will be evaluated against criteria such as: Does the topic represent an opportunity for a significant leap or paradigm shift in a research area, or have the potential to create a new research area? Is there potential for making significant progress on a current national need or grand challenge? Is the financial and research scope beyond the capabilities of one division? Is the community able to organize and effectively respond?

Topics: EFRI research in FY 2008 will better enable the Engineering Directorate to meet its strategic goal of fostering frontier and transformative research. Topics for EFRI support will typically relate to the five key ENG Themes. These are: *Complex Engineered and Natural Systems*, which addresses unifying principles that enable modeling, prediction, and control of emergent behavior in complex systems, *Energy and the Environment*, which includes frontier research to improve the cost, sustainability, and security of our nation's energy system, *Innovation*, which enables national competitiveness and the ability to foster and catalyze innovation, and the research needed to move from fundamental knowledge to societal benefit, *Manufacturing Frontiers*, which includes research that catalyzes multiscale manufacturing, from fundamental metrology through atomic-scale control of raw materials, and *Nanotechnology*, which drives our nation's efforts to lead the world in fundamental nanotechnology research with topics that span both active and complex nanosystems that are critical for frontier technologies that harness the integration of biology, neurology, energy, and water resources.

These frontier research areas will guide the decision-making process throughout the ENG Directorate, but specifically within the Office of Emerging Frontiers in Research and Innovation. The EFRI Office resides within the Office of the Assistant Director for Engineering and considers areas of emerging frontiers of engineering research, innovation, and education. The EFRI Office identifies and prioritizes emerging frontier areas of research and education, and provides resources for pursing these priorities.

Changes from FY 2007: No change is requested over FY 2007.