TABLE OF EXTERNAL EVALUATIONS

The Table on the following pages provides information on program assessments and evaluations other than Committee of Visitor and Advisory Committee assessments.

The Table lists other types of evaluations not used in GPRA performance assessment that were completed in FY 2007. These reports, studies, and evaluations are frequently used in setting new priorities in a field or in documenting progress in a particular area. The reader is encouraged to review the reports for additional information on findings and recommendations that are beyond the scope of this report.

Reports (other than COV reports) produced by NSF are available online using the NSF's online document system and the publication number indicated. Reports are available here: www.nsf.gov/pubs/start.htm.

Information on obtaining reports produced by the National Research Council or National Academy of Sciences can be found online by searching www.nap.edu or from the National Academy Press, 2101 Constitution Avenue, N.W., Lockbox 285, Washington, D.C. 20055 (1.800.642.6242).

<table>
<tr><th colspan="2">Evaluations Completed in FY 2007</th></tr>
<tr><th></th><th>Directorate for Education and Human Resources (EHR)</th></tr>
<tr><td>Alliances for Graduate Education and the Professoriate (AGEP) Program</td><td>SCOPE:

The Alliances for Graduate Education and the Professoriate (AGEP) Program focuses on forging alliances among colleges and universities to develop and implement innovative models for recruiting, mentoring, and retaining underrepresented minority students in science, technology, engineering and mathematics (STEM) doctoral programs. The program aims to increase the number of underrepresented minorities (URM) receiving PhD degrees in STEM, and to increase the number of URM pursing advanced degrees in STEM. Early analysis of data from participating institutions suggested that the AGEP program is achieving these goals.

FINDINGS:
In 2004/05, of 1428 STEM PhDs awarded, 640 (44.8%) were awarded to URM by 62 AGEP institutions from 20 Alliances.
From 1997/98 to 2004/05, the annual percent and the number of STEM PhDs awarded to URM at 62 institutions from 20 Alliances increased by 56 or 10.3%. Such increase mostly results from positive changes in the number of PhDs awarded in Biological/Agricultural Sciences, the Physical Sciences, and the Social Sciences.
From 1997/98 to 2004/05, the annual percent of STEM PhDs awarded to all other U.S. citizens and permanent residents decreased by 6.2%, with the exception of those in Biological/Agricultural Sciences that experienced a 9.2% increase. The decline in annual percent of PhDs awarded in Psychology was about the same for URM.
From 1997/98-2005/06, the annual percent and number of URM graduate student enrollees at 67 AGEP institutions from 20 Alliances increased from 8963 to 11,105, a 23.9% increase for all STEM fields. There are increases in URM graduate enrollment in every broad STEM field. URM graduate enrollment in Natural Science and Engineering (NS&E) increased by 33.0% from 5568 to 7405. In Social Sciences, URM graduate student enrollment increased by 9.3%, from 2586 to 2826, and the annual number of URM graduate school enrollees in Psychology increased by 8% from 809 to 874.
The percent change in the graduate school enrollment in STEM fields for URM is much higher than all other students with U.S. citizenship or permanent resident status from 1997/98-2005/06 (23.9% vs. 11.5%). The annual percent change for URM graduate school enrollment in NS&E, Psychology and Social Science was 33%, 8%, and 9.3% respectively, compared with 15.6%, 4.4% and 0.3% change in those fields for all other students with U.S citizenship or permanent resident status.
RECOMMENDATIONS: None provided in report</td></tr>
</table>

	REFERENCE: George, Y. S., Malcom, S. M., Campbell, P. B., & Carson, R. (2007). *Increase in the annual number and percent of PhDs awarded to underrepresented minorities in STEM at AGEP institutions*. Washington, DC: American Association for the Advancement of Science.

Advanced Technological Education (ATE) Program	**SCOPE:** The Advanced Technological Education (ATE) Program focuses on the education and training of technicians for the high-technology industries. The program provides two types of support: ATE project grants and ATE Center grants. ATE projects utilize educators from two-year colleges in leadership roles to develop and implement ideas for improving skills for technicians and the educators who teach them. ATE Centers lead regional and national efforts to improve technician education in specific fields and build collaborative relationships with industry and academic partners to launch important reforms with broader impact. **FINDINGS:** • ATE grantees engage in collaborative activities, primarily with business, industry, and other educational institutions, which results in an additional $34 million support from external collaborators in the form of monetary donations or in-kind support in 2005, and 100 on-the-job technician education programs. • ATE grantees develop educational materials that align with workforce needs and industry standards. More than 5,000 material resources were developed within six years, and more than 500 modules or other materials developed by ATE program were commercially published. • ATE support resulted in the development of more than ➢ 2,000 two-year college programs and 16,800 courses at two-year colleges; ➢ 750 secondary-school programs and 1,500 secondary-school courses; ➢ 150 baccalaureate programs and 800 courses at baccalaureate institutions; ➢ 2,000 articulation agreements • ATE-supported programs were offered at approximately 800 locations during each of the six survey years. During that period, ATE programs reached approximately 320,000 students at two-year colleges, 6,000 students at baccalaureate institutions, and 48,000 students at secondary schools. • More than 80,000 educators participated in ATE professional development activities, in which 45% were two–year college faculty, 11% were baccalaureate institution faculty, and 44% were secondary-school teachers. • ATE added value to business and industry by increasing the number of educated technicians, improving business results, enhancing the quality of technicians, and reducing business costs. Companies associated with ATE reported that ATE program educated large numbers of current employees effectively and efficiently, and ATE instruction and student experiences are tailored to industry and company requirements. **RECOMMENDATIONS:** None provided in report **Availability:** Patton, M. (Ed.). (2006). *ATE Centers Impact 2006-2007*. Tempe, AZ: Maricopa Community Colleges. http://www.atecenters.org/pdfs/ATE_Impact_brochure.pdf

NSF Math and Science Partnership Program	**SCOPE:** The NSF Math and Science Partnership (MSP) Program, launched in 2002, is a research and development effort to build capacity and integrate the work of higher education, especially its science, technology, engineering and mathematics (STEM) discipline faculty, with that of K-12 to strengthen and reform mathematics and science education. MSP seeks to improve student outcomes in mathematics and science for all students in K-12. **FINDINGS:** **Growing Impact with Education Partners Nationwide** Since 2002, the 52 partnerships funded to date unite some 150 institutions of higher education with more than 550 school districts, including more than 3,300 schools, in 30 states and Puerto Rico. The program has also created partnerships among more than 70 businesses, numerous state departments of education, informal science organization and community-based organizations. **Evidence of Improved Student Proficiency in Math and Science** The most recent analysis of 123 schools participating in the MSP program shows improvements in student proficiency in mathematics and science at the elementary, middle and high school levels over a 3-year period. The most dramatic increases were documented by elementary grade students in mathematics where 7.2 percent more students achieved or exceeded proficiency from 2002-03 to 2003-04, followed by another increase of another 6.5 percent from 2003-04 to 2004-05, with both increases statistically significant. **Commitment to Teacher Development** Partnerships in the MSP program are expected to impact more than 141,500 teachers of mathematics and science. In academic year 2004-05, more than 30,000 teachers participated in MSP professional development designed to deepen expand their expertise. The data showed significant improvements in teachers' instructional skills and pedagogical content knowledge. **RECOMMENDATIONS**: N/A **Availability:** Directorate for Education and Human Resources, National Science Foundation. *Math and Science Partnership Program National Impact Report.* http://www.nsf.gov/news/newsmedia/msp_impact/final_msp_impact_report.pdf

	Directorate for Engineering (ENG)
WTEC Study on International Assessment of Research And Development of Carbon Nanotube Manufacturing ***a***nd Applications	**Findings:** This WTEC study focuses on the manufacturing and applications of carbon nanotubes (CNTs) to identify recent progress in understanding the commercial potential of CNTs as viewed by academic, industrial, and government research facilities around the world. CNT manufacturing methods and equipment, processing and separation techniques, characterization procedures, and opportunities for international collaboration are highlighted in this study. These issues are also discussed in the context of leading electronic, optical, and mechanical applications of CNTs ranging from transistors to structural composites. CNTs can be produced by many methods, and depending on the diameter, one can obtain either single-walled CNTs (SWCNTs) or multi-walled CNTs (MWCNTs). The current capacity for the production of MWCNTs far exceeds that of SWCNTs. SWCNTs are much more expensive and difficult to manufacture than MWCNTs, and there is not yet a distinct large-scale market for SWCNTs, which is needed to drive down the production cost. For both types of CNTs, Asia's production capacity is two to three times higher than that estimated for North America and Europe combined; Japan is the prominent leader in the production of MWCNTs. Use of CNTs in lithium-ion battery electrodes is the current driving force of ton-scale MWCNT production in Japan. CNT-replacement products for indium tin oxide (ITO) and field emission devices (FEDs) are driving increased production of SWCNTs, whereas applications using transistors require precise control over CNT diameter and conductivity, which is farther from commercial realization. When the cost of bulk SWCNTs decreases significantly, applications in electromagnetic shielding (EMI) and electrostatic discharge (ESD) protection can be expected, and SWCNTs will replace MWCNTs in conductive plastics. Currently, owing to challenges in CNT functionalization and dispersion, CNTs can only achieve modest enhancements in mechanical properties of materials. While sporting goods with CNT reinforcement are beginning to appear on the market, improved processing techniques along with manufacturing techniques for long and aligned CNTs (e.g., yarns and aligned arrays) are needed to realize CNT-based materials that provide compelling advantages over existing fiber composites in lightweight structures. **Recommendations:** WTEC panels do not make explicit recommendations. However, their findings may suggest recommendations, based on analysis of the findings by the sponsors. In this case, the panel's findings suggest that there may be opportunities for enhanced R&D related to applications of CNTs in energy storage applications, in FEDs and novel switch designs for electronic systems, and in EMI and ESD applications in structural composites. For enhancements in mechanical properties of materials, the study suggests the need for more basic research on improved processing techniques, long and aligned CNTs, and in registration between the CNT fibers and the resins used to make CNT-based nanocomposites. The report specifically highlights the need for more work on dispersion, functionalization, and blending of SWCNTs to capitalize on the full potential of this unique carbon nanomaterial. For all applications categories there is a need for increased emphasis on large-scale manufacturing and purification techniques as well as reliable characterization methods. However, the volume and purity of CNTs needed for various applications vary widely and continued advancements to address this variability are needed to enable effective production. **Availability: http://wtec.org/cnm/CNM_final_report.pdf**

***WTEC Study on* International Assessment of Research and Development in Brain-Computer Interfaces**	**Findings:** Brain-computer interface (BCI) research deals with establishing communication pathways between the brain and external devices. BCI systems can be broadly classified depending on the placement of the electrodes used to detect and measure neurons firing in the brain: in invasive systems, electrodes are inserted directly into the cortex; in noninvasive systems, they are placed on the scalp and use electroencephalography or electrocorticography to detect neuron activity. This WTEC study was designed to gather information on worldwide status and trends in BCI research and to disseminate it to government decisionmakers and the research community. The WTEC panel identified several major trends in current and evolving BCI research in North America, Europe, and Asia. First, BCI research throughout the world is extensive, with the magnitude of that research clearly on the rise. Second, BCI research is rapidly approaching a level of first-generation medical practice; moreover, BCI research is expected to rapidly accelerate in nonmedical arenas of commerce as well, particularly in the gaming, automotive, and robotics industries. Third, the focus of BCI research throughout the world is decidedly uneven, with invasive BCIs almost exclusively centered in North America, noninvasive BCI systems evolving primarily from European and Asian efforts, and the integration of BCIs and robotics systems championed by Asian research programs. In terms of funding, BCI and brain-controlled robotics programs have been a hallmark of recent European research and technological development. The range and investment levels of multidisciplinary, multinational, multilaboratory programs in Europe appear to far exceed that of most university and government-funded BCI programs in the United States and Canada. In Asia, China is investing heavily in biological sciences and engineering in general, and the extent of investment in BCI and BCI-related research has grown particularly rapidly. Japan is especially vigorous in pursuing nonmedical applications and exploiting its expertise in BCI-controlled robotics. Although several U.S. government programs are advancing neural prostheses and BCIs, private sources have yet to make a major impact on BCI research in North America generally. However, the U.S. SBIRs and STTRs funding has been effective in promoting transition from basic research to precommercialized prototypes. **Recommendations:** WTEC panels do not make explicit recommendations. However, their findings may suggest recommendations, based on analysis of the findings by the sponsors. In this case, the panel concluded that there are abundant and fertile opportunities for worldwide international collaborations in BCI research and allied fields. The panel identified opportunities for non-medical applications of BCI research and applications at the interface between BCI and robotics research. There may also be opportunities for enhanced U.S. research in non-invasive approaches to BCI, based on the emphasis on, and successes with, those approaches in other countries. **Availability: http://wtec.org/bci/**

NSF Workshop on Building Electronic Function into Molecular Scale Architectures ***[jointly sponsored by MPS and ENG]***	**Findings:** The use of molecules—either singly or in small ensembles—as the elements in electronic circuits offers the opportunity to enhance and transform electronic systems. Healthcare and environmental sensors, energy harvesting and transformation technologies, and information processing and storage systems were some of the many potential applications of such systems identified during this workshop. Realizing this vision poses significant challenges to our understanding of the electronic behavior of nanoscale molecular architectures. Current capabilities include the ability to prepare nanostructured materials and to fabricate surfaces with atomic-level smoothness. Molecules and biological species can be attached to these structures and surfaces. The physical structure and the way electrons are organized in these chemically modified structures can be characterized with current measurement tools. These nanostructures and surfaces can be connected into device prototypes. However, the local molecular environment in those devices cannot be adequately characterized with existing metrology systems. Only a crude understanding of the electronic behavior of nanoscale molecular architectures exists. The report assesses which advances would accelerate the discovery and development process, and concludes that new approaches to attaching molecules to surfaces are required to make stable chemical systems. A wide range of molecules needs to be studied. Strategies must be developed to synthesize complex assemblies before integration into systems. Linking the function of molecules within electronic junctions and devices to the structure of the molecules in those junctions is perhaps the most important challenge. The participants felt that advances in the measurement sciences are key to realizing this structurefunction relationship. Electrical and physical metrology tools that report the geometric and electronic structure of molecules must be developed. These tools must report in real time and while the device is subject to multiple stimuli. A standard measurement platform that can easily be transported would allow researchers to compare results in a meaningful manner. A more complete understanding of these systems must be developed. Better descriptions are needed of the process by which electrical charge flows through molecules. New insights into how molecules interact with each other are needed, especially under conditions where the local environment is changing. **Recommendations:** Use-inspired basic research will lead to further discovery and innovation. New strategies for self-assembly of nanoscale molecular architectures are needed. Instruments to measure electronic function and molecular structure in devices must be developed. Refined and expanded models for describing the electronic behavior of molecules are needed. This discovery and development process will require, and will help to train, a new generation of scientists and engineers with the skills to translate ideas into discovery and discovery into product. Research questions that should be pursued include the following: How can we control defects in molecular assemblies? What are the practical limitations to characterizing molecules buried in a working device? How will predictive theories be reduced to tractable algorithms? How do we formulate the response of a nonequilibrium transport process involving the discrete states of molecules with continua of the electrodes? Realizing the full potential of molecular electronics requires the joint efforts of multidisciplinary teams. Strategic partnering must be encouraged. For solutions to emerge, research and development activities must be sustained. Many efforts will benefit from working with existing nanotechnology centers and networks. High-level science and technology workshops, summer schools, and coordination activities must be supported. Industry representatives must be part of the process. **Availability: http://wtec.org/MolecularElectronics/**

NSF/NIH Workshop on **Stem Cell Research for Regenerative Medicine and Tissue Engineering** ***[jointly sponsored by ENG and NIH/NIBIB]***	**Findings:** The goals of the workshop were to bring together the thought leaders in these fields to access the state-of-the-art, to define the opportunities and challenges that are being faced, and to discern how the two communities in stem cells and tissue engineering can collaborate to accelerate and advance the scientific process with emphasis on clinical development. An important objective of this workshop was to bring together stem cell and tissue engineering/regenerative medicine researchers to help build better connections between these two communities. The results of the workshop may also be useful to the Multi-Agency Tissue Engineering Science (MATES) Interagency Working Group (IWG) of the National Science and Technology Council, in which NIH, NSF and other Federal agencies participate. Workshop participants provided their insights into the key achievements and challenges in using stem cells for purposes of regenerative medicine in the areas of heart, vascularization, bone, cartilage, neural, liver, and skin. Participants also identified opportunities and underlying challenges within their respective specialties. Areas of research identified as needing increased attention in the future include vacularization of the scaffolds, controlling the inflammatory/immune response, biomimetic scaffold design (including both chemical and mechanical properties) and cell guidance and anchorage strategies in the context of stem cell delivery. Participants with translation expertise addressed the challenges faced in translating scientific discoveries and technology within their specialty to clinical products, market sector analysis, clinical trials development, host tissue integration, surgery, efficacy, and cost reimbursement. **Recommendations:** There is a need for increased efforts along the lines of this workshop, to build better communications and collaboration between the many diverse fields of science and engineering needed to translate advances in basic developmental biology and stem cell research into practical applications, both medical and non-medical. The section of the report reviewing relevant Federal activities highlights a number of issues that will require attention by the Government in order to promote advances in this field, including appropriate levels and types of research funding, coordination between the many agencies and institutes with relevant interests and activities, international cooperation, regulatory issues, and reimbursement policies (e.g., at the Centers for Medicare and Medicaid Services, CMS). **Availability:** **http://wtec.org/stem_cell_workshop/**

University of Washington's Compendium of Technology Breakthroughs at NSF Industry/University Cooperative Research Centers	The Industry/University Cooperative Research Centers (I/UCRCs) develop long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from the National Science Foundation (NSF) and are primarily supported by industry center members, with NSF taking a supporting role in their development and evolution. Each center is established to conduct research that is of interest to both the industry and the center. **Findings:** In order to evaluate the Industry/University Cooperative Research Centers' (I/UCRCs) ability to spawn technically relative research that is of value to industry; a survey was conducted by the University of Washington of industrial researchers that serve as Industrial Advisor Board (IAB) members. These industrial researchers are in the best position to objectively evaluate the accomplishments related to their center's research. Up to six IAB members/scientists from each center were invited to participate in structured interviews or online surveys by the University of Washington. They were asked to nominate technological breakthroughs that emanated from the I/UCRC research. A technological breakthrough was defined as follows: … research that led to significant process improvements, new processes or techniques, and new or improved products or services that either resulted directly from or were indirectly stimulated by the center's research program. A total of 144 breakthroughs were documented by IAB members. **Recommendations:** None **Availability: http://faculty.washington.edu/scottcs/NSF/2007/**

The "5MXE" Workshop: Transforming Mechanical Engineering Education and Research in the USA	**Findings:** Mechanical engineering education as well as engineering education is in need of a fundamental and transformative change in its principles and methods. This ambitious goal was motivated by the fact that the science-based engineering education taught at our engineering schools has become a commodity, available to students all over the world, including low-wage markets. Global companies employ such world-class engineering talent, often at 20% of the cost in the USA, and are moving manufacturing, design and even research activities to such locations. The challenge for engineering schools in the USA is how to educate a mechanical engineer that provides five times the value added when compared to the global competition, i.e., the "5XME." The transformation needed in mechanical engineering education must embrace societal priorities, and become an exciting and attractive leadership opportunity for a diverse pool of talent from all segments of our society. Such a transformation will require a new infrastructure, and new methods of educational delivery that develop the specific abilities of diverse students. Such methods should emphasize such focuses as broad grounding in fundamentals, flexibility and agility, and excellent communication, leadership and teamwork skills. In today's global knowledge economy, mechanical engineers educated in the U.S. must be able to add significantly more value than their counterparts abroad, through the breadth of their intellectual capacity, their ability to innovate, and their leadership in addressing major societal challenges. **Recommendations:** • Transformative changes are needed at each of the five major stages of the education of an engineer. These stages include: (1) primary and secondary education, (2) bachelors, (3) masters, (4) doctoral, and (5) lifelong learning. • The bachelors degree should introduce engineering as a *discipline*, and should be viewed as an extension of the traditional liberal arts degree where education in natural sciences, social sciences and humanities is supplemented by education in the discipline of engineering for an increasingly technological world. • This bachelors degree in the *discipline* of engineering can be viewed as the foundational stem upon which several extensions can be grafted: (1) continued professional depth through a professional masters degree in engineering, and (2) transition to non-engineering career paths such as medicine, law, and business administration. • The masters degree should introduce engineering as a *profession*, and become the requirement for professional practice. This is where educational institutions and professional societies can build an awareness of the profession, as opposed to producing graduates who view themselves merely as employees.

	• Doctoral education in engineering is essential to national prosperity, and global competition is rapidly increasing. The doctoral degree in engineering, while indisputably the best in the world, needs to be enhanced and strengthened with an emphasis on breadth as well as depth, linking discovery and innovation, and improved leadership and teaching skills. • Lifelong learning programs in engineering, including executive education, need to be developed and delivered to engineers at all stages in their professional development. There is a need for a national market study for engineers. What are the various career opportunities for engineering graduates, and what are the various programs that best prepare the students for different markets (e.g., corporate employment, entrepreneurial companies, academic positions). This can help shape the content for the new bachelors, masters and doctoral degrees. • In order to accomplish these transformations, several studies would be needed: A study to benchmark engineering education in the U.S. versus that in the rest of the world. A study of the doctoral engineering degree pipeline, including its economics, sources of students, and placement of students, is needed. Such a study will be important to ensure that this degree remains in a leadership position worldwide. A compilation and assessment of existing engineering programs that currently implement some aspects of the recommendations in 1 above, e.g., a liberal arts engineering bachelors degree, a 5-year professional masters degree, teaching of innovation, etc. **Availability: Draft version of the report available for comment:** http://www-personal.umich.edu/~ulsoy/pdf/5XME_Report.pdf

Structures in Fire: State-of-the-Art, Research and Training Needs	**Findings:** Structural fire safety is one of the key considerations in the design and maintenance of built infrastructure. There are serious limitations in the current approaches to fire safety as well as severe gaps in the overall understanding of fire safety. This is due to a lack of significant research activities in the field and a lack of educational and training programs related to fire hazard mitigation and research in academic institutions in the U.S. The U.S has one of the worst fire loss records in the industrialized world as demonstrated by the large number of fire-related deaths and volume of property destruction. As an illustration, recent data shows that 1,550,000 fires occurred in 2004, resulting in over 4,000 deaths, 100,000 injuries and more than $10 billion in direct property loss. Therefore, it is clear that research into the study of structural fire safety would be critical, yet it is the one of the least developed engineering fields due to a lack of research and training in the field. Current techniques in evaluating the fire behavior of a structural system were found to be lacking due to several factors. Evaluating the fire behavior of a structural system requires the use of fire resistance experiments and/or numerical models, yet at present, evaluation is undertaken only through standard fire tests on structural elements such as beams columns and slabs, or through empirically based methods. There are few validated models that can trace the realistic fire response of structural systems throughout the entire range of behavior from fire initiation to structural collapse. Fire tests are another aspect lacking in regard to fire behavior analysis. The lack of advancements in this area via numerical modeling was attributed to the non-availability of experimental data for validation under realistic fire scenarios and also the lack of established high temperature materials properties and associated constitutive relationships. Furthermore, standard fire tests do not account for real fire scenarios, structural interactions with adjacent framing, realistic load levels, and restraint conditions. Current test methods also do not give consideration to various limit states of structures and their components, such as strength, stability, deflection, and rate of defection for assembly failure. One other major hurdle in the development of state-of-the-art structural models for fire hazard mitigation is the limitation of current building code provisions in the U.S. for computationally based structural fire engineering and design. Apart from the general code allowances for alternative means and methods, building requirements clearly favor and direct users towards traditional criteria based on empirically developed fire resistance ratings from the standard fire test. This test method has it origins in the state-of-the art of the early 20th century, and has remained unchanged mostly over the past 100 years. Additionally, from a training and knowledge standpoint, most of the passive fire protection for structural framing remains within the responsibility of the project's architect without any real input from a fire protection or structural engineer. **Recommendations:** • Development of high-temperature constitutive models: As fire performance of structural members depends on the properties of constituent materials, knowledge of high-temperature materials properties are critical for advancing the state of the art. There is an urgent need to undertake materials property tests to generate reliable property data. Proper models of fire activity during an event should be identified for use in structural fire analysis as well.

	• Development of new sensor technology for fire tests: There is a serious lack of instrumentation and devices to measure the various structural response parameters during fire tests and current technologies need to be more reliable to provide meaningful data. • Collection and generation of data for model verification: The U.S. lacks laboratory infrastructure for large scale experimentation and validation of fire-related research. A large-scale testing facility, in one location, or a network of such facilities at several universities would be a great benefit for structural fire research. Such full scale tests could also be supported through the use of decommissioned buildings as a good and economical means of doing such work. Additionally, there needs to be a means to collect and store data from real life fire scenarios in a way that would be readily available to researchers for model verification. • Development of accepted tools and criteria for structural fire design: Current U.S. codes do not provide any substantial criteria for structural fire analysis and design, and relevant information needs to be developed for this purpose in a form that can be used by practitioners and incorporated into computer software for research and practice. Additionally, publications and design guides regarding practical issues are needed to complement the evolving performance-based design criteria. • Characterization of connection behavior: Connections between components play a critical role in the overall performance of a structure, especially under stress from such elements as fire. Current approaches do not account for the behavior of connections under high temperature, and therefore data and experimental and numerical studies are needed on typical connections used in buildings. • Development of university curriculum related to structures in fire at the graduate and undergraduate levels: There are relatively few university courses in the U.S dedicated fully to structural fire engineering. While the undergraduate curriculum would not accommodate such coursework, new courses, teaching aids, and model curricula are needed for use in graduate education for easy adaptation for use in interested institutions and faculty. • Modification of the E119 standard fire test: There are a number of drawbacks to the current testing provisions, and changes should be made to incorporate the recommendations above to allow for more predictable and accurate modeling of the performance of structures during fire. **Availability:** http://www.egr.msu.edu/~kodur/FireWorkshop.htm

Engineering Innovation, Strategic Planning in National Science Foundation-Funded Engineering Research Centers	The study was an examination of the use of the National Science Foundation's (NSF) Engineering Research Centers (ERC) Program's three-plane framework for developing strategic plans in 22 ongoing ERCs. The study also investigated the effect of strategic planning on two important ERC outcomes: research publication productivity and technology commercialization (i.e., research application) productivity. The aim of the ERC Program, which is the flagship scheme for federally funded support of engineering in American universities, is to foster national economic competitiveness by promoting university-industry collaboration to maintain and advance the nation's technological leadership. Since 1985, the Program has been the producer of many leading edge technologies that would not otherwise be possible in traditional academic research settings. The ERC Program has also made a significant academic contribution through knowledge generation and dissemination in the form of publications and highly trained students. **Findings:** • The three-plane strategic planning framework and a formal process of strategic planning were vital tools for organizing the research endeavor within ERCs. • Also, the three-plane framework was a useful tool for illustrating each center's strategic plan. • The method of implementing the three-plane framework critically determined whether it was beneficial to overall planning formality and quality of planning (i.e., comprehensiveness) and organizational outcomes. The most important determinant of whether planning benefited organizational outcomes was the overall comprehensiveness of the planning, rather than commitment to the planning tool or process. • Several attitudinal factors either inhibited or benefited strategic planning and, subsequently, organizational outcomes. Among the most important attitudes were psychological commitment to the ERC, acceptance of planning as a useful exercise, and knowledge of planning. • The planning process was beneficial only for organizational goals that were explicitly discussed and prioritized in planning. For example, technology commercialization productivity in ERCs was affected by strategic planning but research publication productivity was not as this is a normal outcome of academic research. • Properly set expectations for the role of planning and reasonable implementation of planning requirements impacted its effective use. • Factors relating to acceptance of, or resistance to planning, including characteristics of individual centers and their leadership. Within ERCs, overall attitudes toward planning and the three-plane framework also depended strongly on the manner in which the framework was presented and described. A one-size-fits-all approach to the planning process was not appropriate; • The leadership of the ERC Program understands that a one-size-fits-all approach is inappropriate so the ERC Program does not make strict requirements regarding the formality of the planning process. However, when requirements are set for particular components that all ERCs must include, the components should be carefully evaluated to ensure they benefit the quality of strategic planning for all types of ERCs.

Recommendations:

Recommendations to the ERC Leadership and Best Practices Regarding Strategic Planning for Innovation

ERC Leaders. ERCs play a facilitative role in helping faculty members think about commercial applications of their research. Therefore, involvement in an ERC facilitates “role transitions” for faculty members from pure research to both research and technology commercialization. Some ERCs facilitate these transitions better than others and the following are a few best practices involving faculty member role transitions.

- Several universities have internal entrepreneurship mentoring. Often, volunteers are available in areas such as law, management, venture capital, and serial entrepreneurship. In many cases, the consultants are alumni of the ERC or the university; they can coach academics on how to participate in the commercialization of their research discoveries. These consultants also are a source of referrals for finding capital and managerial talent.
- Other universities offer support to potential faculty entrepreneurs in advancing their technology in such a way that allows the faculty researcher to remain an academic researcher instead of trying to become a start-up’s CEO.
- These models can be replicated in other places where the level of support is available from state, city, industry, and university sources. Examples of such university programs are the Stanford Technology Ventures Program (http://stvp.stanford.edu), The MIT Entrepreneurship Center (http://mitsloan.mit.edu/faculty/centrepreneurship.php), and the Rice Alliance for Technology and Entrepreneurship (http://alliance.rice.edu/alliance/Default.asp).

- Another best practice involved creating a position titled “Industry Professorship” within the ERC. The industry professorship position has been designated as a non-tenure-track faculty member who brings the industry perspective inside the ERC. This person adds industry knowledge to the planning processes and to everyday execution of research. Overall, an Industry Professor can enhance the relevance of research to industry requirements.
- Another best practice for maintaining the commercial relevance of ERC research involves communication mechanisms with the industry partners. Strong involvement from the industrial advisory board helps many ERCs become more successful. It also helps the ERC stay focused on real-world problems. This involvement provides an on-going critique of the broader “systems view” of commercialization and involves senior corporate scientists in the process. Further, it allows new perspectives and ideas to be raised as potential avenues of research in the ERC. Many ERCs have found that industry ideas contribute to plans about how new technology should be developed.

	• In addition to involvement from industry, an advisory board model that involves deans and university provosts has also proven successful. Their involvement in an advisory board can contribute to strategic planning effectiveness and funding support. Additionally, increased communication with counterparts at other ERCs, say, through advisory board membership, may be helpful in making decisions and identifying creative solutions to ERC challenges. • Many ERCs have had excellent experience with schemes to involve undergraduates in ERC research. ERCs that involve undergraduates in research have found it to be beneficial; the "naïve" questions raised by undergraduate students prove helpful in evaluating research problems and planning from different angles. Such involvement also gives undergraduate students experience in research project management. • There was positive feedback about facilitated interactions among researchers within the ERC. Some faculty members suggested that social activities were helpful to bridging boundaries among independent researchers. Many ERCs and other types of research centers hold brown bag lunches or other types of semi-informal meetings meant to communicate current happenings and facilitate networking among ERC participants. This type of interaction helps increase collaboration and communication as well as intellectual exchange. Just as strategic planning can be an integrative force by encouraging knowledge sharing and communication, informal gatherings also increase serendipitous knowledge transfer and collaboration. ***Industrial Liaison Officers (ILOs).*** The ILO is a central figure in creating an environment that fosters innovation and technology commercialization. Specifically, the more the ILO encourages technology transfer among researchers, the more successful the ERC tends to be. For example, assisting researchers in working with the technology transfer office and/or with industry can be an important role for an ILO. Further, some ILOs are effective at marketing the technologies of the ERC to potential licensees. ILOs often facilitate "coffee-break" interactions with guest speakers and volunteer consultants who present their experiences on entrepreneurial topics. Overall, ERC effectiveness was fostered when the ILO was a vital link between faculty, technology transfer professionals, and industry. **Recommendations to the ERC Program Leaders** First, the general sentiment toward the Annual ERC Conference is extremely positive. The Conference provides an invaluable vehicle for information sharing. The ERC Program leadership also may wish to consider providing other opportunities throughout the year for information sharing among ERCs (e.g., further opportunities for face-to-face or electronically-mediated communication). Even more frequent contact among current ERC leaders may help further diffuse best practices.

	Second, implementation of an elaborated training program on strategic planning and three-plane framework for all new ERC directors and administrative directors. Training already takes place at the Conference but it would be prudent to add to existing training offerings. Training sessions should involve NSF representatives along with experienced directors and administrative directors. Because the study found that knowledge of the three-plane framework was critical to both commitment to it and plan formulation, the authors believe that additional training may further enhance the effectiveness of ERCs. Third, in training ERC leaders it would be advantageous to emphasize academically-oriented language in describing and explaining the three-plane framework. It must be explained in terms that academic researchers understand and embrace. Moreover, the intended uses and limitations of the three-plane framework should be reinforced. If it is understood and effectively implemented, the three-plane framework can be an even more valuable piece of the strategic planning puzzle. **Availability:** http://www.erc-assoc.org

Designing the Third Generation of NSF Engineering Research Centers: Insights from Worldwide Practice	This study informs National Science Foundation Engineering Research Centers (ERC) management, organization, and practice regarding its program goals in light of an assessment of international center programs that were modeled after the ERC program, which started in 1985. Because the NSF ERC program is one of the preeminent university research centers programs in the United States, the focus of this study is on research centers abroad, specifically on centers in China, South Korea, Japan, England, Ireland, Germany, and Belgium. The study consisted of case studies of over thirty centers abroad based on site visits and desk studies conducted from July 2006 through March 2007. The analyses were informed by interviews with center directors and other key personnel, such as researchers and government officials, as well as by extant documentation and literature related to each center. These interviews were guided by study questions jointly established with NSF ERC program personnel at the outset of this project, focusing on five general areas of inquiry: ▪ Vision and program-level practices ▪ Center-level planning, organization, and management ▪ Industry and other external partnerships ▪ International partnerships ▪ Engineering education **Findings:** The overarching finding of this report is that the NSF ERC program, at least when compared to the centers visited abroad, which included some (but not all) progeny of the NSF ERC program, is unique in its numerous missions and in the relative “rigidity” of its approaches to these missions, including funding strategy, requirements and benchmarks, and life-span. While the centers and centers programs visited abroad focus simultaneously on, among other goals, both translational research for existing and new industries and the enhancement of engineering education, they are not beholden to address all of the missions that NSF ERCs must fulfill. While the centers and programs visited abroad are required to meet benchmarks for their scientific and technical endeavors, including for research and for interactions with industry and other partners, these requirements and timelines seem contingent on contemporaneous variables, including but not limited to the state of the science and engineering conducted therein, the economic viability of the industry or other partners served by the center, and so on. Accordingly, the centers visited abroad employ a clear vision of the relative importance of their multiple missions. With this clarity comes program-level flexibility that we recommend the NSF ERC program consider. Many of the centers visited, for example, were not subject to funding sunset clauses. Some were started with seed funds and later “promoted” to full centers. Several others pursued with substantial success each of the missions that NSF ERCs pursue, but not always at the same time.

This program-level flexibility does not appear to have come at the cost of mission fulfillment. The case analyses do not suggest a necessary substitution of program level flexibility for success in numerous areas, including research, education, industry involvement, and international partnerships. In fact, some of the least successful centers visited were also the least flexible, most notably the Korean Science and Engineering Foundation ERCs, which are based on NSF ERCs.

Recommendations:

The recommendations this report makes for the NSF ERC program stem from this "meta recommendation" that the NSF ERC program achieve program level mission clarity and flexibility regarding the numerous missions NSF ERCs pursue, including:

- In addition to the current open solicitation for NSF ERC proposals, solicit a limited number of proposals that are directed towards salient, problem-focused areas of research deemed important by the scientific and engineering community, industry, policy makers, or ideally all three.
- In addition to traditional academic faculty, employ center-dedicated researchers who are not beholden to academic appointments.
- In addition to awarding centers to university-based researchers and engineers, allow researchers working at institutions that are university-affiliated and co-located but not necessarily university-based to compete for NSF ERC funds.
- Instruct existing and new NSF ERCs to revisit their intellectual property rights (IPR) agreements with university technology licensing offices to make license royalty payments by firms contingent on the success firms have marketing ERC based products and processes and consider alternative IPR sharing arrangements.
- Encourage NSF ERCs to collaborate internationally, but require that they demonstrate *ex ante* the "value" of the collaboration and also its necessity (e.g., the existence of resources abroad that are not available in U.S. institutions).
- Ensure that international collaborations in practice go beyond faculty exchanges and joint workshops to facilitate collaborative research projects.

It is important to note that these recommendations are not based on general findings. The centers that were visited and studied were not randomly selected but rather were chosen in consultation with NSF ERC personnel, ERC directors, and centers experts who were contracted to conduct the study. As such, the selection of centers for this study was biased deliberately to focus on centers with reputations for scientific excellence and proficiency in the above identified areas of activity deemed pertinent to the ERC program's current mission.

Availability: http://www.erc-assoc.org

Assessment of the Small Business Innovation Research Program at the National Science Foundation	**Findings:** In the 2000 reauthorization of the SBIR program, Congress tasked the National Research Council of the National Academies to conduct a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet Federal research and development needs. The study covered the five largest SBIR programs (DOD, HHS, NASA, DOE, and NSF) accounting for 96% of SBIR awards made by the Federal government. The NRC Study found that the NSF SBIR program is adding to the public scientific and technological knowledge by contributing in many important ways, for example by: generating knowledge; creating and disseminating intellectual capital; building networks with universities; moving technology from universities toward the market; broadening the scope and speed of research; testing ideas and building capacity; and conducting high-risk research. The report was supportive of NSF's centralized management, the flexibility in the program and the strong commercialization focus. The study notes that NSF SBIR is well-managed and endorses the use of an Advisory Committee and Committee of Visitors. The NSF SBIR Phase IIB program was detailed and highlighted as a noteworthy model for all agencies. **Recommendations:** The NRC study findings recognized the accomplishments of the NSF SBIR program and recommended that in order to maintain the program's excellence that NSF consider the following: 1. Continue to reinforce its efforts to improve commercialization 2. Greater efforts for outreach 3. Better data collection 4. Increase participation by women and minorities 5. Better documentation and evaluation in order to improve program output and facilitate program management 6. Preserve program flexibility **Availability:** The complete study (440 pages) can be found at: http://books.nap.edu/openbook.php?record_id=11929&page=R1

International Benchmarking of U.S. Chemical Engineering Research Competitiveness, National Research Council	**Findings:** Over a quarter of the jobs in the United States depend on chemistry in one way or another, and over $400 billion worth of products rely on innovations from this field. Chemical engineering, as an academic discipline and profession, has enabled the science of chemistry to achieve this level of significance. However, over the last 10-15 years, concerns have been raised about the identity and future of the U.S. chemical engineering enterprise, stemming from the globalization of the chemical industry; expansion of the field's research scope as it interfaces with other disciplines; and narrowing of the field's ability to address important scientific and technological questions covering the entire spectrum of products and processes—from the macroscopic to molecular level. At the request of the National Science Foundation, the National Research Council conducted an in-depth benchmarking analysis to gauge the current standing of the U.S. chemical engineering field in the world. The benchmark measures included: 1) the development of a Virtual World Congress comprised of the "best of the best" as identified by leading international experts in each sub area, 2) analysis of journals to uncover directions of research and relative levels of research activities, 3) analysis of citations to measure the quality of research and its impact, and 4) the quantitative analysis of trends in degrees conferred to and employment of chemical engineers, and some other measures including patent productivity and awards. **The United States is presently, and is expected to remain, among the world's leaders in all sub areas of chemical engineering research, with clear leadership in several sub areas. U.S. leadership in some classical and emerging sub areas will be strongly challenged.** The United States is currently among world leaders in all of the sub areas of chemical engineering research identified in the report, and leads in both classical sub areas such as transport processes as well as emerging areas such as cellular and metabolic engineering. Although the comparative percentage of U.S. publications has decreased substantially, the quality and impact still remain very high and clearly in a leading position. For example, 73 of the 100 most cited papers in chemical engineering literature during the period 2000-2006 came from the United States. As a result, the United States is expected to maintain its current position at the "Forefront" or "Among World Leaders" in all sub areas of chemical engineering research, and to expand and extend its current position into sub areas such as biocatalysis and protein engineering; cellular and metabolic engineering; systems, computational, and synthetic biology; nanostructured materials; fossil energy and extraction and processing; non-fossil energy; and green engineering. **Availability: http://books.nap.edu/catalog.php?record_id=11867**

The Future of US Chemistry Research, National Research Council	**Findings:** Chemistry plays a key role in conquering diseases, solving energy problems, addressing environmental problems, providing the discoveries that lead to new industries, and developing new materials and technologies for national defense and homeland security. However, the field is currently facing a crucial time of change and is struggling to position itself to meet the needs of the future as it expands beyond its traditional core toward areas related to biology, materials science, and nanotechnology. Additionally, there has been growing concern by the President, Congress, and American public about U.S. competitiveness and the ability to lead the world in innovation and job creation. At the request of the National Science Foundation and the U.S. Department of Energy, the National Research Council conducted an in-depth benchmarking analysis to gauge the current standing of the U.S. chemistry field in the world. This report highlights the main findings of the benchmarking exercise. Today, chemistry research in the United States is stronger than in any other single country, but competition from Europe and Asia is rapidly increasing. In 2003, the United States published about 19 percent of the world's chemistry papers, down from 23 percent in 1988. Although the United States published a larger percentage of any single nation, it is about four percent less than all of Western Europe. Although U.S. chemists have been publishing at a steady rate of about 15,000 chemistry papers per year, chemists from other nations are increasing their rate of publication. More importantly, U.S. chemists lead in the quality of their publications, with about 50% of total citations in 30 prominent chemistry journals over the last 16 years. When all of the journals indexed in the ISI Essential Science Indicators between January 1996 and November 2006 are considered, U.S. chemistry citations account for 28 percent of total citations compared to the next two ranked countries of Japan and Germany, both with 9 percent. The United States also leads in the number of citations per paper. In addition, U.S. chemists are the most prolific authors in high-profile journals such as Science and Nature. U.S. chemists contributed to 50 percent of the 100 most frequently cited chemistry papers, while Western Europe contributed 41 percent. Finally, 50 percent of the world's most frequently cited chemists are from the United States. In a further effort to characterize chemistry leadership, experts from the United States and abroad were asked to identify the "best of the best" in chemistry who they would invite to an international conference. The national makeup of these "virtual congresses" provides another indicator of U.S. leadership in chemistry by the strong predominance of U.S. speakers (ranging from about 40 to 70 percent for the different areas of chemistry) selected for virtual world congresses. U.S. chemistry is particularly strong in emerging cross-disciplinary areas such as nanochemistry, biological chemistry, and materials chemistry.

	Chemistry research in the United States is projected to remain stronger in the next decade than in any other single country, but competition is increasing. In the near future, U.S. chemistry is projected to be the leader or among world leaders in all areas, but not in all sub areas. For example, virtual congress data showed that the United States has a very strong, perhaps even dominant, position in nanocrystal and cluster science, but revealed strong competition in self-assembly science from Europe, Israel, and Japan. Because of the advance of chemistry in other nations, competition is increasing and the lead of U.S. chemistry will shrink. There will be increasing competition from European competitors such as the European Union, Japan, and other Asian countries, particularly China and India. Also, U.S. leadership in chemistry publications will continue to diminish. As U.S. publication rates remain steady, the number and quality of papers from other countries are increasing. **Availability: http://books.nap.edu/catalog.php?record_id=11866**

	Directorate for Mathematical and Physical Sciences (MPS)
Astronomy and Astrophysics Advisory Committee (AAAC)	**Scope:** The AAAC advises the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE) on selected issues within the fields of astronomy and astrophysics that are of mutual interest and concern to the agencies. Astronomy and astrophysics are understood to encompass observations and theoretical investigations of astronomical objects and phenomena, including the sun and solar-system bodies. Specifically, the AAAC is charged to: Assess and make recommendations regarding the coordination of astronomy and astrophysics programs of the NSF, NASA and DOE. This includes the identification of gaps and duplications among the agencies in areas such as research, analysis programs, missions, observatories, facilities and archives. Assess and make recommendations on the status of NSF, NASA and DOE activities as they relate to the recommendations contained in National Research Council reports, especially the 2001 report "Astronomy and Astrophysics in the New Millennium." Advise on the development of the agencies' strategic plan for astronomy and astrophysics. Advise on areas that may benefit from interagency coordination, including formulation of activities, financial support, and solicitation of proposals for research and/or hardware development. Not later than March 15 of each year, transmit a report to NSF, NASA, DOE, the Committee on Science of the U.S. House of Representatives, the Committee on Commerce, Science and Transportation of the U.S. Senate, and the Committee on Health, Education, Labor, and Pensions of the Senate. The report will contain the findings and recommendations of the committee on the first two items above. In addition, the AAAC will conduct specialized studies when requested by the agencies. These studies will be published as reports if appropriate. Findings and Recommendations: The AAAC's findings and recommendations for the agencies from the March 2007 are summarized below and discussed in detail in the report. **NSF** A). The AAAC strongly supports the effort to further strengthen R&D through ACI increases at NSF. Significant innovation and competitiveness gains will accrue. B). The MRFEC process is of great interest to the astronomy community since major facility projects are essential for progress in astronomy and astrophysics. The AAAC fully supports efforts to improve the MREFC process and to refine the Facility Plan. C). The multi-stage process for major, high technology projects recommended by the AAAC will make the MREFC program more robust, lessen cost growth and risk during construction and enhance science return during operations. D). The AAAC commends AST for initiating and supporting the Senior Review and for fully involving the astronomy community through its solicitations of input and its "Townhall" meetings.

	E). The AAAC recommends consideration of the operations funding needs of major projects as an integral part of a thorough "lifecycle" cost assessment, and planning for the likely required additional funding. F). The AAAC appreciated the NSF support for the revised ALMA budget, and hopes that ATST can be moved forward as a New Start. The AAAC welcomes the continuing development of LSST and GSMT, and recommends that the next Decadal Survey be used to assess the ranking of these facilities for Federal support, without impacting their near-term efforts. G). The AAAC recommends that NSF, MPS and AST respond to the need for mid-scale instrumentation funding. H). The AAAC recommends that NSF, AST and MPS, along with the projects, explore mutually-beneficial (and likely innovative approaches) for funding the Federal component of GSMT, with OSTP help if need be. I). The AAAC recommends that further consideration be given to any efficiencies that could accrue in the longer-term by improved linkages between the major national optical-IR facilities, NOAO and Gemini. **NASA** Recommendations for NASA centered on issues of budgetary projections, programmatic balance in the Astrophysics Division, plans for support for development of future missions, and the re-establishment of the advisory structure for NASA. **DOE** Comments on DOE programs included observations on budget trends and programmatic issues such as support of dark energy and dark matter research. The AAAC also identified and commented on a number of programs that present particular opportunities and/or raise issues for the vitality of the nation's astronomy and astrophysics enterprise as carried out by NSF, NASA and DOE within the framework of the astronomy and astrophysics 2000 Decadal Survey and similar NRC reports and discussed specific programs and activities that involve interagency coordination. **Availability:** http://www.nsf.gov/mps/ast/aaac/reports/annual/aaac_2007_report.pdf

Division of Astronomical Sciences Senior Review	**Scope:** Astronomy – the scientific study of the universe and its contents – has furnished some remarkable discoveries in recent years, from new planets around nearby stars to black holes at the far reaches of the universe, to the tiny gravitational ripples that grew to form the structure that we see around us today. The science is driven by observations made using new telescopes, especially those located at ground-based observatories. However, this confluence of revolutionary scientific opportunities and new technology has led to an historically unprecedented demand on the development and operation of astronomical facilities. The National Science Foundation's Astronomy Senior Review Committee was charged with examining the Division of Astronomical Sciences portfolio of facilities and other selected, discretionary activities with the goal of redistributing roughly $30M of annual spending, roughly 15 percent of the total budget and 25 percent of the budget currently spent on facilities. The committee considered the balance of investment between the support of current research activities and the development of necessary future facilities as specified in National Research Council studies over the past five years. This process of renewal within strict budgetary limits is essential for maintaining the remarkable rate of scientific discovery in astronomy, although it comes with great cost. **Findings:** 1. **The Scientific Challenge.** Proper maintenance of current facilities while simultaneously developing and beginning operation of the proposed new facilities is infeasible under any reasonable expectations for federal budget support based on past funding levels. The cuts that are recommended here are as deep as they can be without causing irreparable damage and will only allow a start to be made on the new initiatives. The scientific promise of the proposed new facilities is so compelling and of such broad interest and importance that there is a strong case for increasing the overall AST budget to execute as much of the science as possible. 2. **The Operations Challenge.** Major astronomical observatories typically take at least a decade to plan, construct and commission. They are usually operated for several decades. The full costs of operating, maintaining, upgrading, exploiting, and decommissioning them are many times the costs of construction. Realistic life cycle costing for the observatories that are under construction or consideration is an essential part of planning. 3. **The Strategic Challenge.** Construction on the Advanced Technology Solar Telescope may begin as early as 2009 (so as to be operational in 2014) and there is a strong scientific case for proceeding with the Giant Segmented Mirror Telescope, the Large Survey Telescope and the Square Kilometer Array projects as soon as feasible thereafter. A realistic implementation plan for these projects involves other agencies and independent and international partners. Some choices need to be made soon; others can await the conclusions of the next decadal survey. Much work is needed, scientifically, technically and diplomatically, to inform this plan. 4. **Towards a Coherent National Astronomy Enterprise**. In order to meet the challenge of (multi-)billion dollar, ground-based optical-infrared and radio observatories, there will have to be strong collaboration between the federal and independent components of the US astronomical enterprise and firm leadership by AST. A high-level commission addressing optical-infrared facilities provides one way to start to bring together the diverse components of the national program to realize the full potential of the US system.

5. **Future Reviews.** Balancing the demands of the current program against the aspirations of the future program is an ongoing obligation. The Senior Review process should be implemented as a standard practice within the Division of Astronomical Sciences and should be a consideration included in the next decadal survey.

Recommendations:
There are four Recommendations for the Base Program:
1. **Grants Program**. The Division of Astronomical Sciences should anticipate that pressure on the grants program will intensify over the next five years and should be prepared to increase its level of support to reflect the quality and quantity of proposals.

2. **Optical-Infrared Astronomy Base Program**. The Optical-Infrared Astronomy Base program should be led by the National Optical Astronomy Observatory. It should deliver community access to an optimized suite of high performance telescopes of all apertures through Gemini time allocation, management of the Telescope System Instrumentation Program and operation of existing or possibly new telescopes at Cerro Tololo Inter-American Observatory in the south and Kitt Peak National Observatory or elsewhere in the north. The balance of investment within the Base Program should be determined by the comparative quality and promise of the proposed science. In addition, there should be ongoing support of technology development at independent observatories through the Adaptive Optics Development and the Advanced Technologies and Instrumentation Programs.

3. **Radio-Millimeter-Submillimeter Astronomy Base Program**. The Radio- Millimeter-Submillimeter Base program should comprise the Atacama Large Millimeter Array, the Green Bank Telescope and the Expanded Very Large Array operations together with support for University Radio Observatories and technology research and development through the Advanced Technologies and Instrumentation program.

4. **Solar Astronomy Base Program**. The Synoptic Optical Long-term Investigations of the Sun facility is the only current solar astronomy facility that should remain in the Base Program in the Advanced Technology Solar Telescope era. In order to implement a forward-looking, large-facility program and act rapidly on new scientific opportunities, it will be necessary to develop new technology and release resources by reducing support to some existing facilities. There are three recommendations for the Transition Program:

5. **Optical-Infrared Astronomy Transition Program**. Gemini operations will continue through 2012. Decisions on new Gemini instrumentation and negotiations for operation beyond 2012 should be guided by a comparison with the cost, performance, and plans of other large optical telescopes. The National Optical Astronomy Observatory should plan to reduce its major instrumentation, data products, administrative and science research staff over the next five years and concentrate on executing its base program more efficiently. Growth in support of a Giant Segmented Mirror Telescope and a Large Survey Telescope should be paced by Federal project choices and the schedule for Major Research Equipment and Facilities Construction account funding as well as progress by the partners in these projects.

	6. **Radio-Millimeter-Submillimeter Astronomy Transition Program**. The National Astronomy and Ionosphere Center and the National Radio Astronomy Observatory, which are heavily subscribed by other communities, should seek partners who will contribute personnel or financial support to the operation of Arecibo and the Very Long Baseline Array respectively by 2011 or else these facilities should be closed. Reductions in the cost of Green Bank Telescope operations, administrative support and the scientific staff at the National Radio Astronomy Observatory should be sought. US participation in the international Square Kilometer Array program, including precursor facilities, should remain community-driven until the US is in a position to commit to a major partnership in the project. 7. **Solar Astronomy Transition Program**. The National Solar Observatory should organize an orderly withdrawal of personnel and resources, including the Synoptic Optical Long-term Investigations of the Sun telescope, from Kitt Peak/Tucson and Sacramento Peak and start to close down operations at these sites as soon as the Advanced Technology Solar Telescope funding begins. It should also consolidate its management and science into a single headquarters. Support of the Global Oscillations Network Group project should cease one year after the successful deployment of the Solar Dynamics Observatory. **Availability:** http://www.nsf.gov/attachments/107964/public/SR_Report_MPSAC(updated12-1-06).pdf

The Third Workshop on Future Directions of Solid State Chemistry: The Status of Solid State Chenistry and its Impact in the Physical Sciences	**Scope:** This NSF Workshop on the Status of Solid State Chemistry and its Impact in the Physical Sciences took a close look at the discipline of Solid State Chemistry in the beginning of the third millennium and explored its continued impact and relationship with allied disciplines in the physical sciences and also industry. The report highlights accomplishments, emerging research directions and areas requiring increased effort. An assessment of how solid state chemistry is impacting the physical sciences, through continuing advances and the many ways of interacting across disciplinary boundaries, could help the National Science Foundation and the scientific community better appreciate its value and contributions in the greater scientific and societal context. The report includes discussions of existing and new modes for educating students, and the development and use of national facilities for performing state-of-the-art research in the field of solid state and materials chemistry. A critical enabler of societal benefits has been funding from the NSF and other agencies in this area, in particular the nation's premier national user facilities. **Findings and Recommendations:** 1. There is great interest in developing methodologies for synthesis of materials with intended functionalities. To continue the pace of progress, sustained support is recommended for exploratory synthesis and directed synthesis aimed at new materials discoveries and the development of methodological and design principles. Syntheses assisted by theory and modeling are only still emerging and should be encouraged. 2. Structure-property relationships are the fundamental underpinning of solid state sciences. Be they experimental or theoretical, efforts and ideas that will make advances in this area should be supported with sustained funding from the Foundation. 3. The Foundation should encourage and support outreach ideas aimed at explaining, promoting and projecting the place and significance of solid state chemistry to society. This could be done under the umbrella of Centers or smaller special projects. 4. Fundamental research and materials discovery emanating from NSF and other agency support of solid state chemistry in academia ultimately affects the strength of industry and therefore the economy. Where appropriate, the NSF should seek the advice of industrial experts in solid state chemistry as a development tool in formulating potential research directions. In addition existing programs aimed at supporting academic-industry collaborations leveraging industry resources and providing graduate students with goal-driven perspectives are viewed favorably. 5. Solid state and materials chemistry research will extract maximum benefit from NSF funding of personnel and support activities in national facilities. These often unique facilities enable the solution of important problems in solid state chemistry. Greater utilization of these facilities is limited by lack of expertise on the use of these techniques amongst solid state chemists and limited user support from the facilities. The NSF has an important role to play as an advocate for the needs of solid state chemistry to the facilities. 6. The NSF should consider and implement mechanisms for supporting collaborative research between the solid state sciences and investigators in far-ranging fields, which may require creative funding mechanisms involving other agencies. 7. Programs within NSF that foster collaborative research with international PIs, groups or Institutes such as the Materials World Network should be supported. Also recommended is funding for short term overseas career development 'sabbaticals' for faculty and increases in the number of US postdoctoral fellowships for positions abroad with a well defined NSF affiliation. **Availability:**http://chemgroups.northwestern.edu/poeppelmeier/dmr/files/NSF_Solid_State_Chemistry_Workshop_Report_2006.pdf