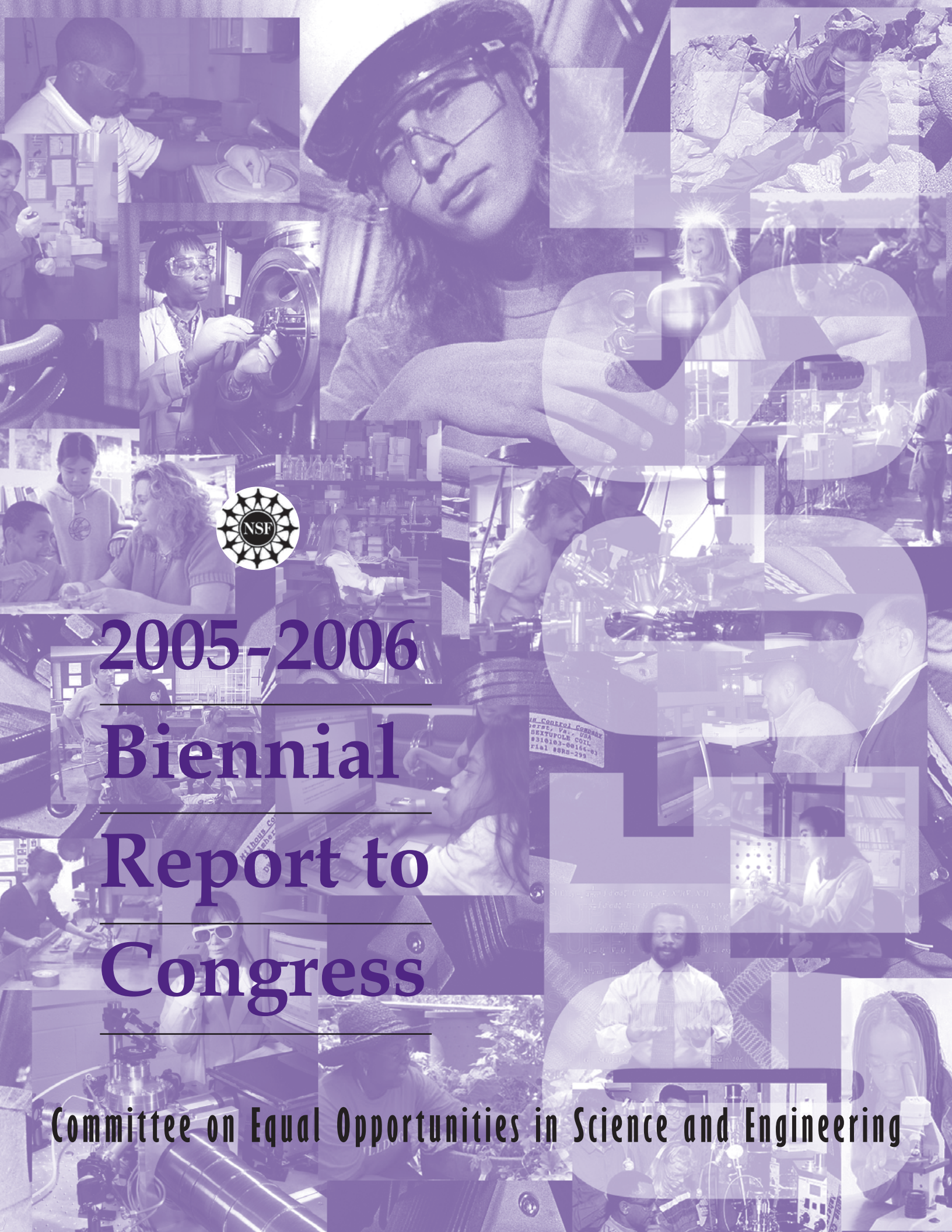

2005-2006 Biennial Report to Congress

Committee on Equal Opportunities in Science and Engineering

Mission

The Committee on Equal Opportunities in Science and Engineering (CEOSE) advises the National Science Foundation (NSF) on policies and programs to encourage full participation by women, minorities, and persons with disabilities within all levels of America's science, technology, engineering, and mathematics (STEM) enterprise.

Background

The Committee on Equal Opportunities in Science and Engineering was established by the Science and Engineering Equal Opportunities Act of 1980 to address the problems of growth and diversity in America's STEM workforce. The legislation specifically provides that:

> *There is established within the National Science Foundation a Committee on Equal Opportunities in Science and Engineering (hereinafter referred to as the "Committee"). The Committee shall provide advice to the Foundation concerning (1) the implementation of the provisions of the Science and Engineering Equal Opportunities Act and (2) other policies and activities of the Foundation to encourage full participation of women, minorities, and other groups currently underrepresented in scientific, engineering, and professional fields [42 U.S.C. §1885(c) SEC 36(a)].*
>
> *Every two years, the Committee shall prepare and transmit to the Director (of the Foundation) a report on its activities during the previous two years and proposed activities for the next two years. The Director shall transmit to Congress the report, unaltered, together with such comments as the Director deems appropriate [42 U.S.C. §1885(c) SEC. 36(f)].*

CEOSE is composed of 15 persons from diverse STEM disciplines, drawn from diverse institutions in higher education, industry, government, and the non-profit sectors. Its membership also reflects the racial/ethnic and gender diversity of the country's citizenry, including persons with disabilities. Members of the Committee typically serve a three-year term. A full committee meeting is held three times a year (usually winter, spring, and fall) to collect and review information on the state of STEM education, training, and employment of women, minorities, and persons with disabilities. Based on its findings, the Committee makes recommendations to the Foundation to improve the levels of participation of underrepresented groups within the STEM professions. Committee members also interact with other Federal agencies, such as the Department of Defense, National Institutes of Health, Department of Energy, and the National Aeronautics and Space Administration in forging trans-agency collaborations to broaden participation within the nation's STEM workforce.

2005-2006 Biennial Report to Congress

Committee on Equal Opportunities in Science and Engineering

Executive Summary

CEOSE began the 2005-2006 biennium by refocusing its priorities, which were informed by a comprehensive review and analysis of 25 years of NSF programs, CEOSE's activities and recommendations, and national trends in participation. These priorities are: (1) **assessment of impact and accountability of NSF programs**; (2) **institutional transformation**; (3) **widening creative pathways into STEM**; and (4) **improved communications about CEOSE and its mandate**. As the present report to Congress shows, CEOSE and NSF made progress in each of these key areas during 2005 and 2006.

THE STATE OF BROADENING PARTICIPATION IN STEM

K-12 students are showing some progress in improving their proficiency in mathematics and science. Women and underrepresented minorities are increasing their numbers significantly among students receiving a bachelor's degree in science and engineering. While there has been some increase in the number of female and minority graduate STEM students, the prevailing numbers of those receiving a Ph.D. are still low compared with White men. The number of American Indians among graduate students and those completing a graduate STEM program remains appallingly low. The presence of underrepresented groups within the STEM workforce is increasing, but their numbers are still disproportionately low compared with White men. Finally, there continues to be a paucity of data on the participation of persons with disabilities within the science and engineering pipeline and workforce. Since persons with disabilities are not required to disclose their disabilities or needs for accommodations, the collection of such data is extremely difficult.

NSF FUNDING FOR BROADENING PARTICIPATION

Funding of NSF's broadening participation programs for 2005-2006 was mixed. Some programs experienced increased funding and some did not. The proposed FY 2007 budget request includes $642.43 million for broadening participation programs, which is 4% more than the $618.81 million appropriated for FY 2006. Greater funding is needed to continue broadening participation in STEM, consistent with the elevated status of broadening participation in NSF's newly released Strategic Plan for 2006-2011. Making optimal use of America's pool of STEM talent would contribute significantly to sustaining America's global leadership in science and engineering. Further investments by NSF in broadening the diversity of the country's STEM workforce are critical.

HIGHLIGHTS OF CEOSE ACTIVITIES: 2005-2006

The major activities of the Committee included the following:

- On June 15, 2005, members of CEOSE met with Congressional staff in the House and Senate to discuss the findings and recommendations of the CEOSE 1994-2003 Decennial & 2003-2004 Biennial Reports to Congress. The reports were also widely distributed to professional organizations, placed on the Internet at www.nsf.gov/od/oia/activities/ceose, and summarized or cited in numerous science and engineering publications.

▼On December 20, 2005, a meeting of Federal agencies was held to discuss broadening participation in STEM. The meeting was hosted by the White House Office of Science and Technology Policy (OSTP), and was co-chaired by Dr. John H. Marburger, III, Director of OSTP and Dr. Kathie Olsen, Deputy Director of NSF. More than 15 Federal agencies were represented at the meeting, which focused on various agency-based strategies and initiatives for increasing opportunities for women, underrepresented minorities, and persons with disabilities to enter into the science and engineering workforce. It was recommended that follow-up meetings take place to further understanding of individual agency efforts and to discuss what opportunities there may be for trans-agency initiatives.

▼CEOSE hosted a Mini-Symposium on Community Colleges during the May 31-June 2, 2006 CEOSE meeting. The purpose of the gathering was to discuss the role and potential impact of community colleges as a pathway to advance education in STEM fields. Invited panelists featured faculty and administrators from community colleges across the country. The discussions included a detailed presentation on the history of community colleges; an overview of current resources of and challenges facing these institutions; and a profile of students who attend community colleges, and their subsequent educational and career pathways. The panel discussions concluded that community colleges are untapped resources for future STEM professionals, and offered some useful recommendations to NSF.

▼ CEOSE hosted a Mini-Symposium on Institutional Transformation on October 16, 2006 at the National Science Foundation to gather specific ideas that could help to promote and catalyze institutional change. The event brought together NSF program managers, CEOSE members, and individuals from academia with experience in driving and implementing institutional transformation to broaden participation in STEM. Critical issues were discussed, and some potential "best practices" emerged from the presentations and discussions.

▼CEOSE convened a follow-up Federal Inter-agency meeting, as part of the CEOSE meeting held on October 17, 2006. Representatives of NASA, NOAA, DOE, DOD, and DOL spoke with CEOSE about current efforts within their agencies to broaden participation, challenges they have encountered, the possibilities for inter-agency exchange of information about their diversity programs, and future inter-agency collaborations. Overall, the discussions were informative; and the agency representatives were very receptive to further interaction with CEOSE to increase opportunities for underrepresented groups in STEM. CEOSE decided to commission a survey of Federal agencies to ascertain further information about their efforts to broaden participation in STEM.

NSF PROGRESS IN BROADENING PARTICIPATION 2005-2006

In response to the CEOSE's 2005-2006 recommendations, NSF has made progress in supporting and expanding the Foundation's efforts to broaden participation. Included among these efforts are the following examples:

▲The Education and Human Resources (EHR) Directorate established the Education Research initiative in 2006 within the *HBCU-Undergraduate Program* to strengthen STEM education research at HBCUs and to support education research projects that advance knowledge of undergraduate STEM education.

▲NSF's *ADVANCE* program is supporting an effort led by the University of Michigan to conduct a national study that will expand the knowledge base on approaches to improve the climate for women in U.S. academic institutions and facilitate women's advancement to the highest ranks of academic leadership.

- Starting in FY 2007, eligibility of EHR's *HBCU-Undergraduate Program* will be broadened to include accredited 2-year HBCUs that do not currently have STEM degree programs. These HBCUs will be encouraged to apply for support to enhance the quality of their general STEM courses and programs and/or to establish new undergraduate STEM degree programs.
- In 2006, EHR and the *Small Business Innovative Research (SBIR)* program collaborated on a NSF-funded pilot project to support teams of faculty and students from community colleges, Tribal colleges, and Hispanic-Serving Institutions to conduct summer research projects with small businesses. Providing professional development opportunities for these faculty, whose students can benefit from their experiences, is a primary goal of this project.
- As stated in its 2006-2011 Strategic Plan, NSF will renew a focus on 2- and 4-year colleges and minority-serving institutions, and will promote faculty enrichment programs, curricular improvements and access to research instrumentation, and enhance opportunities for partnerships among community and technical colleges, 4-year colleges, and research-intensive universities.
- NSF has initiated cross-directorate efforts to broaden participation. These efforts include continued enforcement of its merit review policy, efforts to increase the diversity of reviewers, and increased efforts to identify and disseminate best program management practices.

CEOSE RECOMMENDATIONS & FUTURE PLANS: 2007-2008

The top priority recommendation for NSF is to build upon the four recommendations featured in CEOSE's last report: accountability, research, policy levers, and Tribal colleges. Specific suggestions in these areas are found in the subcommittee reports in Chapter 3.

1. CEOSE recommends that over the next two years NSF assess the outcomes of its programs, investments, and activities with respect to their impact on broadening participation and transforming institutions, and use the results to optimize policies and programs.
2. To ensure that broadening participation is not lost among the many possible broader impacts encouraged by the Foundation, NSF should provide explicit guidance to grantees that annual and final reports identify the specific impact, if any, of each award on broadening participation.
3. NSF should survey and report annually on the participation of women, underrepresented minorities, and persons with disabilities in each review panel, advisory committee, and committee of visitors (COV).
4. NSF should ensure that major new initiatives and programs, such as the Foundation-wide investments in cyberinfrastructure, are created to be fully inclusive, enabling participation in their development, implementation, and funding of persons traditionally underrepresented in STEM, persons with disabilities, and institutions that serve these populations.

CEOSE PLANS FOR 2007-2008

In preparation for 2007-2008, CEOSE merged two of the *ad hoc* subcommittees formed in 2005 to create the CEOSE *Ad Hoc* Subcommittee on Accountability, Evaluation, and Communications. The *Ad Hoc* Subcommittees on Institutional Transformation and Widening Creative Pathways are continuing. In addition, a new *Ad Hoc* Subcommittee on Strategic Planning was formed, charged to take the lead in prioritizing CEOSE's efforts. Through its meetings and *ad hoc* subcommittees, CEOSE plans to focus on the following areas:

- Continued interactions with selected Federal agencies to promote inter-agency sharing of information and best practices, along with the coordination of efforts with the goal of enhancing the overall Federal effort to increase access of women, underrepresented minorities, and persons with disabilities to STEM education, research, and employment opportunities.
- Continued review and advice to NSF on policies, programs, and initiatives that have the potential for broadening participation of women, underrepresented minorities and persons with disabilities in STEM.
- Continued consideration and analysis of research findings and metrics addressing aspects of the challenge of broadening participation in STEM.
- An expansion of interactions with NSF's research directorates and with scientific and engineering organizations to understand the challenges, commonalities, and differences *vis á vis* broadening participation faced by the diverse science and engineering fields funded by the Foundation.
- Budget permitting, CEOSE is considering a site visit to one or more community colleges, for the purpose of gaining a deeper insight that will help guide future recommendations, aimed at widening non-traditional pathways into STEM.

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Introduction

Maintaining global leadership in science and technology continues to be a top priority for America. This priority is underscored by the President's recent American Competitiveness Initiative (ACI), which aims to advance the growth of the country's economy and national security through investments and policies that increase our capacity for scientific, engineering, and technological innovation.[1] To achieve the immediate and long-term goals of the ACI, education and training of all Americans is a must—especially untapped potential STEM talent.[2] Women, underrepresented minorities, and persons with disabilities constitute the largest untapped pool of potential American scientists, engineers, technologists, mathematicians, and technicians.

The National Science Foundation (NSF), among other key Federal agencies that fund STEM research and development, will play a major role in facilitating the specific aims of the ACI, in areas such as education and training of new scientists and engineers, and discovery of new knowledge and cutting-edge technologies. Through the advice and recommendations of the Committee on Equal Opportunities in Science and Engineering, the NSF has made significant strides in broadening participation of underrepresented groups in STEM fields. Given the emphasis that ACI places on the STEM workforce, CEOSE is in a unique position to help, through the Committee's Congressional mandate to identify and recommend strategies to NSF to increase the numbers of persons entering STEM fields and to widen access to education and employment for currently underrepresented Americans in these professions.

CEOSE began the 2005-2006 biennium by refocusing its priorities, which were informed by a comprehensive review and analysis of 25 years of NSF programs, CEOSE's activities and recommendations, and national trends in participation. These priorities are:

(1) assessment of impact and accountability of NSF programs designed to broaden participation of underrepresented groups in science and engineering;

(2) institutional transformation of colleges, universities, and other organizations to facilitate increased recruitment and retention of underrepresented individuals among STEM faculty and students;

(3) widening creative pathways to STEM education and careers through linkages between 2-year and 4- year colleges, and pathways to graduate schools; and

(4) improved communications about CEOSE and its mandate to other government agencies, professional organizations, and the public.[3]

As the present report to Congress shows, CEOSE and NSF made some progress in each of these key areas during 2005 and 2006, but there remains a long way to go before the science and engineering enterprise is fully inclusive.

[1] *American Competitiveness Initiative. Leading The World In Innovation*. Washington, DC: Domestic Policy Council of the Office of Science and Technology Policy, February 2006.
[2] STEM is an acronym for Science, Technology, Engineering and Mathematics.
[3] *Broadening Participation in America's Science and Engineering Workforce*. The 1994-2203 Decennial & 2004 Biennial Reports to Congress. CEOSE, December 2004, pages 103-104.

1 STATE of BROADENING PARTICIPATION in STEM

The presence of underrepresented groups within the S&E workforce is increasing, but their numbers are still disproportionately low compared with White men. While there has been some increase in the number of women and minority-group graduate STEM students, the numbers of those receiving a Ph.D. are still very low compared with White men. The number of American Indians among graduate students and those completing a graduate STEM program remains appallingly low. Women and underrepresented minorities are increasing their numbers significantly among students receiving a bachelor's degree in science and engineering. K-12 students are showing some progress in improving their proficiency in mathematics and science. The gap between racial/ethnic minorities and White Americans is narrowing, but more remains to be done. Finally, there continues to be a paucity of data on the participation of persons with disabilities within the science and engineering pipeline and workforce. Since persons with disabilities do not have to disclose their disabilities or needs for accommodations, the collection of such data is extremely difficult.

WORKFORCE

The total S&E workforce increased by 43% between 1997 and 2003.[4] Within this context, significant progress was made in the participation of underrepresented groups in America's S&E workforce (Table 1-1). Between 1997 and 2003, the number of American Indians/Alaska Natives employed within the science and engineering fields increased by approximately +72%, African Americans, by +84%, and Hispanics, by +95%.[5] Women increased 63% within the makeup of the country's scientists and engineers. The percentage change in persons with disabilities within the S&E workforce was +30% between 1997 and 2003. It is noteworthy that most of these increases are significantly larger than the 43% growth in the size of the total S&E workforce.

Despite the advances made in the number of underrepresented minorities in the S&E workforce since 1997, American Indian/Alaska Native, African American, and Hispanic American groups collectively make up only 9% of the country's S&E workforce (Figure 1-1) which is a disproportionately low portion.

A limitation associated with the available data on S&E employment is that there is no breakdown of the types of jobs held by the underrepresented groups in S&E. This leaves open questions, such as: To what extent is there equity in the types of jobs held by those underrepresented in S&E, when compared with White or Asian Americans? Are minorities concentrated in lower-level positions? Unfortunately, CEOSE was not able to obtain direct answers to these questions. However, faculty positions held at the nation's universities provided, at least, some indication of the representation of underutilized groups in the higher professional levels of S&E.

[4]The year 2003 was the most recent period for which S&E employment data were available.

[5]National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System, 2006.

Table 1-1
Percent Change in Demographics of Individuals Working In S&E Occupations in 1997 versus 2003*

	Number		Total Percent Change	Gender Percent Change	
	1997	2003		Men	Women
Amer. Indian/ Alaska Native	9,877	17,092	+73	+71	+79
Asian Amer./ Native Pacific Islander	265,055	428,564	+62	+52	+93
African Amer.	110,503	199,851	+81	+67	+104
Hispanic Amer.	95,433	179,979	+89	+79	+117
White Amer.	2,726,336	3,522,266	+29	+23	+50
Persons with Disabilities**	185,960	242,655	+30	+26	+46
Total	3,869,422	4,816,770	+43% Overall Percent change***		

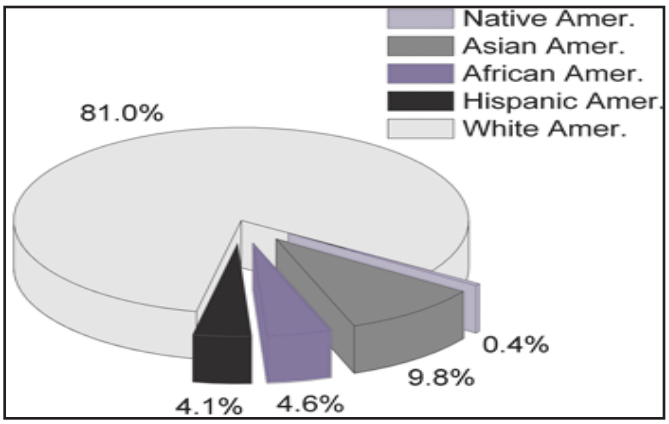
**Data obtained from National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (1997 and 2003), special unpublished tabulations. Total STEM Workforce figures for 1997 = 12,531,000 and 2003 = 21,647,000 . Total number working in science and engineering occupations in 1997 = 3,369,000 and 2003 = 4,817,000, which includes 162,000 and 469,000 persons in 1997 and 2003 respectively, not included in these tabulations to exclude temporary residents and individuals with no post-secondary education in the United States. The "White and Other" group includes individuals who either did not indicate a racial/ethnic group in 1997, or who indicated multiple groups in 2003.*

***NSF Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (1997 and 2003).*

****Figure includes persons designated as "other."*

Figure 1-1

Percentage of Racial/Ethnic Groups Employed in S&E Professions as of 2003*



Source: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System.

ACADEMIA

Underrepresented minorities and women increased significantly among the S&E professoriate between 1997 and 2003. During this period, the rates of increase for these groups exceeded the 6% rate of overall growth in science and engineering faculty at the Nation's institutions of higher education. The increase in White American faculty was marginal, with the number of White male faculty declining slightly (Table 1-2). No data were available for persons with disabilities. Moreover, there were no data available regarding the tenure status of the S&E faculty.

Table 1-2
Percent Change in S&E Faculty Among Racial/Ethnic Groups in 1997 versus 2003*

	Number		Total Percent Change	Gender Percent Change	
	1997	2003		Men	Women
Amer. Indian/ Alaska Native	500	1,300	+160	+100	+200
Asian Amer./ Native Pacific Islander	14,200	18,100	+27	+22	+50
African Amer.	4,100	5,400	+32	+29	+50
Hispanic Amer.	4,000	5,200	+30	+17	+70
White Amer.	127,700	129,300	+1	-5	+28
Total	150,700	159,600	+6% Overall Percent change**		

** Data obtained from National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (1997 and 2003), special unpublished tabulations.*

*** Figure includes U.S. citizen and permanent resident S&E faculty as defined above.*

HIGHER EDUCATION

Graduate

Overall, there was a 9.5% decline between 2000 and 2004 in the number of STEM Ph.D.s granted to U.S. citizens and permanent residents whose race/ethnicity was known (Table 1-3). The reason for this downward trend was not clear. African American men and women, and Hispanic women were the only underrepresented demographic groups that showed an increase in earned doctorates in STEM, albeit a modest increase.

Table 1-3
Percent Change in Recipients of STEM Doctorates
Among Demographic Groups in 2000 versus 2004*

	Number		Total Percent Change	Gender Percent Change	
	2000	2004		Men	Women
Amer. Indian/ Alaska Native	88	60	-32	-23	-40
Asian Amer. Native Pacific Islander	1,707	1,538	-10	-18	+2
African Amer.	710	751	+6	+3	+8
Hispanic Amer.	730	718	-2	-6	+4
White Amer.	13,443	12,031	-10	-13	-7
Persons with Disabilities	328	284	-13	n/a	n/a
Total	17,116		-9% Overall Percent change**		

** Data obtained from NSF Division of Science Resources Statistics, Survey of Earned Doctorates, 1997-2004. Total STEM doctorates for U.S. citizens and permanent residents: 2000 = 17,114 and 2004 = 15,744, which includes 438 and 646 persons designated as "other" for 2000 and 2004, respectively. Other refers to multi-racial and unknown.*

*** Total percent change in STEM doctorates between 2000 and 2004, including group of persons designated as "other."*

Also of particular note, was the rather small number of American Indians/Alaska Natives who received a doctorate in science or engineering, as compared with the other demographic groups. Women accounted for 44% of U.S. citizen and permanent residents who received a STEM doctorate in 2004; they represented 37% of all STEM doctorate recipients. American Indians/Alaska Natives accounted for 0.4%, African Americans 5%, Hispanics 5%, compared with 76% for White Americans.

Underrepresented STEM groups showed significant increases in completing a master's degree in a STEM area during the period from 2000 to 2004. There was a greater increase among African American, Hispanic, and American Indian/Alaska Native women who completed a master's degree in science and engineering compared with their male counterparts (Table 1-4). Proportionately, American Indians/Alaska Natives accounted for 0.7% of recipients of a master's degree in science and engineering among U.S. citizens and permanent residents whose race/ethnicity is known, African Americans 10%, and Hispanics 7%, compared with 72% of White Americans in 2004. Women represented 49% of U.S. citizen and permanent resident recipients of a STEM master's degree. They represented 44% of all STEM master's degree recipients. There was a 17% increase in U.S. citizens and permanent residents who received a master's degree in STEM between 2000 and 2004. The percentage changes for each of the underrepresented groups exceeded this 17% increase.

The U.S. Department of Education's NCES does not provide data about the disability status of master's degree recipients, but NCES does provide disability status data about the number of students enrolled in STEM graduate fields. NCES data suggest a decline in the percentage of students with disabilities enrolled in graduate STEM fields and NSF's *Research and Disabilities and Education* program considers this decrease to reflect success, because more campuses have made STEM education more accessible and fewer graduate students with disabilities need to report their disabilities.[6]

Table 1-4
Percent Change in Recipients of STEM Master's Degree Among Demographic Groups in 2000 versus 2004*

	Number		Total Percent Change	Gender Percent Change	
	2000	2004		Men	Women
Amer. Indian/ Alaska Native	383	535	+40	+17	+63
Asian Amer. Native Pacific Islander	6,990	8,560	+22	+22	+23
African Amer.	5,492	7,455	+36	+20	+46
Hispanic Amer.	3,746	5,073	+35	+27	+45
White Amer.	49,850	54,280	+9	+6	+12
Total	70,933	83,043	+17% Overall Percent change**		

**Data obtained from NSF Division of Science Resources Statistics, based on U.S. citizens and permanent residents. Total STEM master's degree for 2000 = 70,933 and 2004 = 83,043, which includes 4,472 and 7,140 persons designated as "other" for 2000 and 2004, respectively. Other refers to multi-racial and unknown.*
*** Total percent change in STEM master's degrees between 2000 and 2004, including group of persons designated as "other."*

Undergraduate

The number of women and underrepresented minorities (i.e., American Indians/AlaskaNatives, African Americans, and Hispanics), who received a bachelor's degree in a STEM area, increased significantly between the years 2000 and 2004 (Table 1-5). Minority women showed a greater percent change than White women for the five-year period. Unfortunately, data on the number of persons with disabilities who received a bachelor's degree in a STEM major were not available. STEM data presented here include the social, biological, and physical sciences, and engineering. Between 2000 and 2004, there was a 14% increase for all U.S. citizens and permanent residents who received a bachelor's degree in a STEM area. Percent changes for each of the underrepresented groups exceeded this aggregate 14% increase.

[6]U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2000-2004; and Sheryl Burghstahler, Seattle, WA, *AccessSTEM*: Northwest Alliance in Science, Technology, Engineering, and Mathematics, 2006.

Table 1-5

Percent Change in Recipients of STEM Bachelor's Degree Among Demographic Groups in 2000 versus 2004*

	Number		Total Percent Change	Gender Percent Change	
	2000	2004		Men	Women
Amer.Indian/ Alaska Native	2,611	3,216	+23	+25	+21
Asian Amer./ Native Pacific Islander	35,553	41,090	+16	+14	+18
African Amer.	32,924	38,328	+16	+15	+17
Hispanic Amer.	27,984	33,290	+19	+17	+21
White Amer.	270,416	295,026	+ 9	+10	+ 9
Total	383,438	436,372	+14% Overall Percent change**		

** Data obtained from NSF Division of Science Resources Statistics, Science and Engineering Degrees, by Race/ Ethnicity of Recipients (1995-2004). The data reported here are only for U.S. citizens and permanent residents . Total STEM bachelor's degrees for 2000 = 383,438 and 2004 = 436,372, which includes 13,950 and 24,422 U.S. citizens and permanent residents whose race/ethnicity was unknown for 2000 and 2004, respectively.*
*** Total percent change in STEM bachelor's degrees between 2000 and 2004, including group of persons designated as "other" or of unknown race/ethnicity.*

Although the data in Table 1-5 support an increase in the number of underrepresented STEM majors who receive a baccalaureate, the proportion of underrepresented groups among college STEM graduates still remains low in comparison with non-Hispanic White Americans. For instance, among U.S. citizens and permanent residents whose race/ethnicity was known in 2004, American Indians/Alaska Natives made up 0.8% of those awarded a bachelor's degree in science and engineering, African Americans 9%, and Hispanics 8%, compared with 72% for White Americans. Women accounted for 51% of U.S. citizens and permanent residents awarded a STEM bachelor's degree. They accounted for 50% of all STEM bachelor's degrees.

Community-college student using assistive technology to create a web page in the NSF-sponsored AccessSTEM program at University of WA.

While it is true that the U.S. Department of Education's National Center for Education Statistics (NCES) does not provide data about the disability status of bachelor's degree recipients, NCES does provide disability status data about the number of students enrolled in STEM undergraduate fields. NCES data demonstrate that there has been a 28% increase in the number of students with disabilities enrolled in undergraduate STEM fields from 2000 to 2004; this figure is comparable to the 31% increase in the number of students without disabilities.[7]

[7] U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2000-2004.

From Bachelor's Degree to Ph.D.

The positive trends reported in the previous paragraphs in the production of racial and ethnic minority group recipients of STEM undergraduate and graduate degrees must be tempered by the recognition that individuals from underrepresented groups are not progressing from the baccalaureate to the Ph.D. at the same rate as other individuals. Table 1-6 computes the share of degree recipients by race from the information provided in Tables 1-3 to 1-5.

Table 1-6
Percent Distribution of STEM Degree Recipients by Race/Ethnicity

	Bachelor's		Master's		Ph.D	
	2000	2004	2000	2004	2000	2004
Amer. Indian/ Alaska Native	0.6	0.7	0.5	0.6	0.5	0.4
Asian Amer.	9.3	9.4	9.8	10.3	9.9	9.8
African Amer.	8.6	8.8	7.7	9.0	4.1	4.8
Hispanic Amer.	7.3	7.6	5.3	6.1	4.3	4.5
White Amer.	70.5	67.6	70.3	65.3	78.5	76.4

Source: Tables 1-3 to 1-5. Percents in columns do not add to 100%, due to persons not reporting.

There are modest improvements in the relative shares of STEM baccalaureate and master's degrees awarded to all racial and ethnic minority group members from 2000 to 2004. However, there are substantial drop-offs in the shares of Ph.D.s awarded to American Indians, African Americans, and Hispanics relative to their representation among bachelor's and master's degree recipients. For example, in 2004 American Indians accounted for 0.7% of all STEM bachelor's degrees awarded and 0.6% of all STEM master's degrees, but only 0.4% of all STEM doctoral degrees awarded. African Americans accounted for 8.8% and 9.0% of all STEM bachelor's and master's degrees awarded in 2004, but only 4.8% of all STEM doctorates awarded in 2004. Hispanic Americans accounted for 7.6% and 6.1% of all bachelor's and master's degrees awarded in 2004, but only 4.5% of all STEM doctoral degrees. In short, there is a narrowing of participation as educational level increases, with a significant drop in Ph.D. attainment by members of underrepresented racial and ethnic minority groups. This persistent shortage of minority doctorates is of great concern.

K-12 EDUCATION

Though lagging in performance in mathematics and science compared with students in Asian and other countries, U.S. elementary, middle school and high school students are making some gains in these academic areas. But, more needs to be done. Only about one-third of American 4th and 8th grade and less than one-fifth of 12th grade students demonstrate proficiency in mathematics and science.[8] Within the United States, some progress has been made in closing the achievement gap between males and females and between underrepresented minorities and other racial/ethnic groups. The gender gap has been narrowing to the point where there are only slight differences between females and males in mathematical skills. Females, however, still lag behind males in participating in the physical sciences.[9] The gap between African American and Hispanic 4th and 8th grade students and White students in mathematics and science has narrowed to its lowest point since 1990. However, more is still required to

[8] *National Science Board Science and Engineering Indicators 2006. Arlington, VA: National Science Foundation.*
[9] Jennifer Stepanek, *Breaking the Physics Barrier: The Classroom and Beyond.* IL: Northwest Educational Laboratory, 2005.

close the achievement gaps between White American students and their Black and Hispanic counterparts, as underscored in the box below, by Dr. Willie Pearson, Jr., former CEOSE Chair. American Indian/Alaska Native 4th- and 8th-graders are especially in need of programs to boost their achievement levels in mathematics and science. According to a recent study by the U.S. Department of Education, American Indian/Alaska Native 4th- and 8th-graders have lower average scores in mathematics and science than all other students in the Nation.[10] The achievement gap, also, between 4th- and 8th-graders with disabilities and their non-disabled peers has narrowed in both mathematics and science since 1996. Despite these gains, students with disabilities continue to have difficulty learning the required science content as quickly as their non-disabled peers, and some students with disabilities miss key academic content that limits their learning of more advanced science concepts.[11]

4th graders and NSF award-winning teacher studying microorganisms at Glenallen Elementary School in Maryland.

CLOSING THE ACHIEVEMENT GAP

Dr. Willie Pearson, Jr.*

This presentation focuses on the importance of reducing the achievement gap as one means of broadening the participation of underrepresented racial/ethnic minorities in STEM disciplines and careers. Given the importance of mathematics and science in our increasingly complex and rapidly changing world, it is urgent that NSF expand its efforts to develop home-grown STEM talent by proactively recruiting bright U.S. citizens from all backgrounds.

In my view, the challenge to the nation's continuing economic progress, security, and tradition of participatory democracy is the gap in achievement separating economically disadvantaged and some racial/ethnic minority students from other students. Admittedly, there has been some narrowing of the gap but progress remains marginal at best (Weiss, 2003). Nevertheless, regardless of grade level, White and Asian/Pacific Islander students perform better than African American, Hispanic, and American Indian/Alaska Native students in both mathematics and science.

Disadvantages, like advantages, accumulate over time. By the time many African American, American Indian/Alaska Native and Hispanic students reach grade 12, they already are about four years behind other students in both math and science achievement. The achievement of 17-year old African American and Latino students in English, mathematics and science is at the level of 13-year-old non-Hispanic White students (National Governors Association, 2006). In recent years, however, mathematics achievement has risen significantly in the earliest grades, including all-time highs for African American and Hispanic students. According to a recent Nation's Report Card, the achievement gaps in reading and math between non-Hispanic White and African American nine year-olds and between White and Latino nine year-olds are at all-time lows. Despite these improvements, however, significantly lower proportions of African American and Hispanic students are proficient at each skill level compared with their non-Hispanic White and Asian/Pacific Islander (NSB, 2006).

That too few students are prepared for college poses a significant threat to the nation's global competitiveness. Approximately 31 percent of African American and 24 percent of Hispanic high school graduates take remedial mathematics courses, compared to 15 percent of White and Asian students (Hambrick and Svedkauskaite, 2005; ACT, 2006). Although college degree

[10] *Nation's Report Card*. Washington, DC: U.S. Department of Education, 2006; and National Indian Education Study, May 2006.

[11] Gregory Stefanich, *The Status of Students with Disabilities in Science*. Las Cruces, NM: Advanced Regional Alliance for Science, Engineering and Mathematics for Students with Disabilities, 2005.

completion rates differ by racial/ethnic group, the gaps actually narrow for college entrants who have completed advanced high school courses and are well prepared. Students who take advanced math courses in high school (such as trigonometry, pre-calculus and calculus) are far more likely to earn a bachelor's degree. When African American and Hispanic students do take advanced mathematics and science courses, they are less likely than others to complete these courses (NSB, 2006).

What can be done?

Making science and engineering attractive to today's students, especially economically disadvantaged, African Americans, Hispanics, and American Indians/Alaska Natives, is a significant policy issue (Vergano, 2006). There remains a critical need for social science research to provide a better understanding of how to improve attraction, retention, persistence and achievement in STEM disciplines and careers for all citizens. This requires collecting and disaggregating data by race/ethnicity/gender/ and disability status (CEOSE, 2004; NSF, 2005). Because the factors contributing to underrepresentation differ considerably from one group to another, only by disaggregating data, can effective policy and program solutions be developed to reduce the achievement gap. Through informal and formal programs based on systematic research and rigorous evaluation, NSF can continue to play a leadership role in bridging home and school cultures of underrepresented racial/ethnic minorities and economically disadvantaged students.

Most of the challenges in reducing the achievement gap and broadening participation in STEM disciplines and careers are social and therefore amenable to corrective action based on sound social science research.

There is evidence that widening achievement gaps in science and math are due at least in part to differential learning and retention of learned material during the summer.

Research-based, rigorously evaluated programs for teachers should continue to be developed and implemented to help at-risk, underrepresented racial/ethnic minority students retain what they learn during the school year. Teachers are critical to closing the achievement gap. Holding constant the socioeconomic status levels of African American and non-Hispanic White students, roughly 50 percent of the variability in their performance can be explained by the competence of teachers, especially their ability to promote higher-order thinking (Stromquist, 2002).

NSF must continue to place a high priority on broadening the participation of underrepresented racial/ethnic minorities and not let the focus be marginalized in the broader impacts criterion. This is not to argue that the "broader impacts" criterion is unimportant, rather it is to acknowledge that many of the problems facing the U.S. in terms of a globally competitive workforce and a scientific and technically literate citizenry will be resolved by addressing the lack of full participation of a significant portion of its citizens. NSF must hold award recipients more accountable for broadening the participation of underrepresented groups (including racial/ethnic minorities) in STEM disciplines. This accountability entails providing evidence of success.

Some of these issues do not fall squarely within the mission of the NSF. Nevertheless, NSF can play a more proactive leadership role by partnering with other federal agencies, and public and private organizations (e. g., professional STEM societies, retirement organizations, and social service agencies) to reduce mathematics/science achievement gap. Finally, reducing the achievement gap should be one of the nation's top priorities. Just as health disparities have gained public attention so too must mathematics and science disparities (NSB, 2006). The U.S. has the talent to solve this challenge; it must now exercise the will to do so.

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**An earlier version of this paper was presented as testimony at the National Science Board Hearing on 21st Century Education in Science, Technology, Engineering, and Mathematics, University of Southern California, Los Angels, California. March 9, 2006. Dr. Willie Pearson, Jr. is a member and former Chair of the Committee on Equal Opportunities in Science and Engineering. He is the Professor and Chair of the School of History, Technology, and Society at the Georgia Institute of Technology.*

2 NSF FUNDING of PROGRAMS AIMED at BROADENING PARTICIPATION

Funding trends for NSF's broadening participation programs for 2005-2006 were mixed. Some programs experienced increased funding and some did not. Greater funding is needed to expand opportunities and access for underrepresented groups in STEM. Making optimal use of America's STEM talent would contribute significantly to sustaining America's global leadership in science and engineering. Further investments by NSF in broadening participation in the country's STEM workforce are critical.

Since the Biennial Report of 2003-2004, the National Science Foundation has continued to provide financial support to programs aimed at broadening participation of women, underrepresented minorities, and persons with disabilities in science and engineering. Between 2005 and 2006, NSF funding for programs dedicated to broadening participation increased from $171.42 million to $174.07 million, equalling a 2% increase. During the same period, the Foundation's total budget increased 3% from $5.481 billion to $5.646 billion, and funding for other programs that are not specifically aimed at, but are proven to benefit broadening participation, rose 24.3% (Table 2-1).[12] The total funds requested for FY 2007 for this portfolio of dedicated and other programs is $642 million, up 4% from 2006. The total NSF budget requests for FY 2007 was proposed to be higher than in 2006, as part of the ACI.[13]

Table 2-1
NSF Funding of Broadening Participation Programs (BPP)
FY 2005-2007 (In Millions)

Program Group	FY 2005 Actual Amount	FY 2006 Actual Amount	FY 2007 Requested Amount
Minority Individuals	71.29	71.46	82.80
Minority Institutions	54.56	59.93	76.85
Women	40.53	37.34	38.78
Disabled Persons	5.04	5.34	6.00
Sub-total for Dedicated-BPP	171.42	174.07	204.43
Other Programs[12]	357.72	444.74	437.91
Total for All BPP	529.14	618.81	642.34

[12]Data obtained from Broadening Participation Status Report, 2006. NSF Office of the Director. The other programs include, for example, *EPSCoR*, *Math and Science Partnership*, *Advance Technology Education*, *Noyce Scholarships*, and *CI-TEAM*.

[13]When this report went to press, NSF was operating at FY 2006 levels, under a continuing resolution, with final congressional action on the FY 2007 budget pending.

NSF LSAMP students at a Smithsonian Institution workshop.

Programs aimed at minority individuals only slightly increased between FY 2005 and FY 2006, i.e., +0.2%, while funding for programs aimed at minority-serving institutions increased by 9.8% (Table 2-1). Funding for gender-based programs, however, dropped by -5% between FY 2005 and FY 2006. Why the drop in funding for women-focused programs? The answer to this question was unclear, based on data available to CEOSE at the time this report was being prepared. Funding for programs focused on persons with disabilities increased by 2% between FY 2005 and FY 2006.

Major Broadening Participation Programs

Major programs dedicated to broadening participation that were funded by NSF during 2005-2006 included the following:

ADVANCE—*Increasing the Participation and Advancement of Women In Academic Science and Engineering Centers*: facilitates advancement of women into faculty positions at Research I institutions.

BPC—*Broadening Participation in Computing*: aims to increase the number of Americans who receive post-secondary degrees in the computing disciplines, with a special focus on individuals from underrepresented STEM groups.

AGEP—*Alliances for Graduate Education and the Professoriate*: increases the number of American students receiving doctoral degrees in STEM and those who will become STEM faculty, with a special emphasis on underrepresented groups.

CREST—*Centers for Research Excellence in Science and Technology*: invests in upgrading the research capabilities and infrastructure of research-productive, minority-serving institutions.

GRF—*Graduate Research Fellowships*: provides fellowships for all demographic groups, including women, underrepresented minorities, and persons with disabilities.

HBCU-UP—*Historically Black Colleges and Universities Undergraduate Program*: provides awards to enhance the quality of undergraduate STEM education and research at HBCUs.

LSAMP—*Louis Stokes Alliances for Minority Participation*: provides funding to increase the number of minorities who receive bachelor's degrees in science and engineering fields, through alliances among 2-year, 4- year, and graduate schools.

RDE—*Research in Disabilities Education*: supports projects that increase the participation and advancement of persons with disabilities in STEM.

GSE—*Research on Gender in Science*: supports research, dissemination, and application of research that results in increased numbers of girls and women entering the STEM fields.

TCUP—Tribal Colleges and Universities Program: provides support to American Indian, Native Hawaiian, and Alaska Native-serving institutions to enhance the quality of their STEM instructional and outreach programs.

Between FY 2004 and FY 2006, total funding for NSF declined from $5.652 billion to $5.646 billion. Within this context, however, the percent changes in funding increased for six of the nine major broadening participation programs (Table 2-2).

Crow middle school students who won a NSF award for an affordable housing idea. Housing built by the Red Feather Development Group.

Table 2-2
Funding of Major NSF Broadening Participation Programs (BPP)
(In Millions)

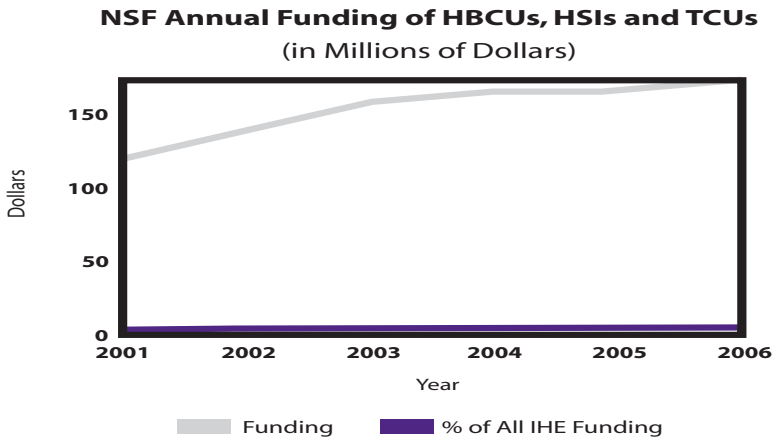
BPP	FY 2004	FY 2005	FY 2006	% Change: 2004-2006	Inflation-adj. % Change*
ADVANCE	17.1	20.5	19.0	+11	+8
AGEP	15.1	15.0	14.5	-4	-7
BPC	n/a	n/a	1.26	n/a	n/a
CREST	19.7	15.1	17.6	-11	-13
GRF	87.1	88.8	92.5	+6	+3
HBCU-UP	23.8	24.8	25.5	+7	+4
LSAMP	32.7	34.4	35.6	+9	+6
RDE	4.5	5.1	5.2	+16	+12
GSE	9.9	9.6	9.5	-4	-7
TCUP	9.9	9.4	10.5	+6	+3
Total NSF (In Billions)	5.652	5.481	5.646	-0.1	-3

Data Source: NSF Division of Budget, December 2006.
**Three percent inflation figure obtained from the U.S. Bureau of Labor Statistics.*

FUNDING OF MINORITY-SERVING INSTITUTIONS

NSF provides financial support to Historically Black Colleges and Universities (HBCU), Hispanic-Serving Institutions (HSI), and Tribal Colleges and Universities (TCU) to enhance the instructional and research infrastructure of these minority-serving institutions (MSI), and to offer educational opportunities in STEM for underrepresented minorities who attend these institutions of higher education (IHE). The level of dedicated NSF funding has grown over the last six years by 58%, from $119 million in FY 2001 to $188 million in FY 2006.

Figure 2-1



Source: NSF Broadening Participation Status Report, December 2006

As a percentage of NSF funding to all IHEs, however, funding for these minority-serving institutions has been relatively low and has increased only marginally. In FY 2001, funding for minority-serving institutions equaled 3.6% of total NSF funding for all IHEs and an estimated 4.6% in FY 2006. Minority-serving institutions enroll an estimated 6% of all students in U.S. higher education.[14] Student enrollment at MSIs has grown significantly. The most recently available data show, for example, that enrollment in HSIs increased by 14% between 1990 and 1999—exceeding the 7% growth from 1990 to 1999 for all institutions; and HBCU enrollment grew by 7% during this same period.[15]

FUNDING INDIVIDUAL INVESTIGATORS

The total number of NSF grants awarded to individual principal investigators (PIs) increased by only 1% from 10,367 to 10,450 between FY 2004 and FY 2006. Women, Hispanics, and Native Hawaiians/Native Pacific Islanders were the only underrepresented groups that showed an increase in the number of PI awards during this period. The actual number of grants awarded to Native Hawaiians/Native Pacific Islanders was, however, extremely small (Table 2-3). The award rate for all PI grants was 24% in FY 2004, 23% in FY 2005, and 25% in FY 2006 for a three-year mean of 24%. By comparison, the three-year mean rates were higher for women (26%) and American Indians/Alaska Natives (27%), slightly lower for African Americans (23%), and for Hispanics, it equaled the 3-year mean of 24%. As with the award rates for all PI grants, there was little variation among the annual award rates for these individual underrepresented groups. Award data for PIs who have disabilities were not available and are difficult to verify, because many investigators do not disclose their disabilities to their institutions or NSF. This 3-year mean award rate has dropped significantly from the average of 31% between 1994 and 2003, as reported in CEOSE's Decennial Report.[16]

[14]*There were 1,039,016 students enrolled in HBCUs, HSIs and TCUs in 2002 (National Center for Educational Statistics: Context of Postsecondary Education, Minority Student Enrollments, Table 31-2; and there were 16,611,711 students enrolled in all degree-granting institutions of higher education in 2002 (National Center for Educational Statistics: Digest of Education Statistics Tables and Figures, 2005).*

[15]*HSI data from NCES Education Statistics Quarterly, 2002; HBCU data from NCES, 1986-2001 PSEDS Fall Enrollment Survey.*

[16]*Broadening Participation in America's Science and Engineering Workforce.* The 1994-2003 Decennial & 2004 Biennial Reports to Congress. CEOSE, December 2004, page 37.

Table 2-3

Number of NSF Awards Made to Principal Investigators by Demographic Group: 2004 - 2006

Group	2004	2005	2006	Percent Change 2004 - 2006
Women	2,147	2,127	2,241	+4
Men	7,925	7,327	7,787	-2
American Indian/ Alaska Native	31	25	24	-23
Native Hawaiian/ Native Pacific Islander	4	5	7	+75
African American	207	193	198	-4
Hispanic	355	328	372	+5
Asian American	1,388	1,260	1,483	+7
White American	7,657	7,238	7,546	-1
Multi-Racial	60	86	77	+28
Total*	10,367	9,772	10,450	+1

Data obtained from NSF Budget and Finance Administration.
**Total includes persons of unknown race/ethnicity: 2004 = 672, 2005 = 637, and 2006 = 736.*

3 HIGHLIGHTS of CEOSE ACTIVITIES: 2005-2006

Energized by the challenge that more needs to be done to diversify the STEM workforce, which was the conclusion of the Committee's 1994-2003 Decennial Report, the activities of CEOSE during 2005-2006 focused on four strategic areas for broadening participation. These areas included (1) promoting institutional transformation in higher education; (2) widening creative pathways into STEM education; (3) forming Federal agency collaborations to expand the impact of broadening participation efforts; and (4) assessing NSF programs designed to broaden participation. The decision to concentrate on these particular areas was informed by the analysis of past and current participation-related policies and programs of NSF as well as the Committee in reviewing its actions, accomplishments, and insights over the last 25 years.

Institutional transformation of colleges and universities refers to proactive and intentional reform of the organizational culture of these institutions that leads to sustained efforts to recruit, retain, educate, and graduate underrepresented Americans, who are interested in pursuing a career in STEM. The transformation process occurs over time, and inevitably meets with some resistance to change in institutional assumptions, behaviors, and procedures. Nevertheless and based on information amassed by CEOSE over the years, institutions of higher education must undergo a change in their culture and operational routines that are responsive to the needs of women, underrepresented minorities, and persons with disabilities, if they are to satisfy the demands of the STEM workforce and the Nation's need to stay competitive in the global STEM marketplace.[17]

Widening creative pathways for STEM education emerged from CEOSE's discussions as a strategy to expand opportunities for underrepresented groups to advance their education in science and engineering. The strategy specifically aims to establish and/or improve linkages between 2-year and 4-year colleges and between Tribal and 4-year colleges. CEOSE recognizes that community colleges represent a rich source of potential STEM talent, as large and increasing numbers of underserved populations enroll in them. According to a recent study by the National Center for Education Statistics, 40% of the country's undergraduates attend a community college, amounting to approximately 7.6 million students. Compared with 4-year college students, those enrolled in a community college are more likely to be female, Black, Hispanic, American Indian, or disabled.[18]*About 19% of community college students major in a STEM area.*[19]

[17]Kemp, Jennifer, et al., *Organizational Culture and Institutional Transformation*. ERIC Digest, 2003: www.ericdigests.org\2003-1\culture.htm.
[18]National Postsecondary Student Aid Study. National Center for Education Statistics, 2004.
[19]Profile of Undergraduates in U.S. Postsecondary Education Institutions: 2003-2004. With a Special Analysis of Community College Students. National Center for Education Statistics, June 2006.

INSTITUTIONAL TRANSFORMATION

CEOSE's 2004 report, Broadening Participation in America's Science and Engineering Workforce, concludes that progress since 1980 in broadening participation in STEM has been measurable, but disappointingly modest. This situation impoverishes America's STEM enterprise, which cannot benefit from the ideas and energy bright people from different backgrounds can bring. Spurred by a fervent desire to achieve full participation in STEM long before 2030, CEOSE in its 2004 report identifies institutional transformation as an essential strategy deserving priority CEOSE action.

> "CEOSE should seek to understand the elements necessary to transform institutions into entities that are supportive of a diverse population of students and faculty, engage leaders of NSF grantee institutions in the goal of broadening STEM participation, and thereby recommend to NSF means by which it can propel institutional transformation through its policies and programs."[20]

CEOSE hosted a Mini-Symposium on Institutional Transformation to gather specific ideas and direction that could help to promote and catalyze institutional change. Because diversifying the population of STEM students and broadening the demographics of STEM faculty are two different challenges, they are likely to require and respond to different policy levers and institutional change strategies. The Mini-Symposium explored both. The stated goals of the Mini-Symposium were:

- To identify best practices in and persistent barriers to institutional transformation that broaden participation in STEM—both among students and among faculty.
- To share the ideas and experiences of leaders in the STEM academic community.
- To make recommendations to CEOSE on what actions it could take that would best propel the institutional-transformation agenda forward.
- To make recommendations to CEOSE and to funding agencies (including NSF) on ideas for policies and programs that will cause institutions to choose to make changes, which taken together will transform the STEM enterprise to become much more welcoming, supportive, inclusive, enabling, and advancing of persons from groups traditionally underrepresented in STEM (and obtain the data to demonstrate this progress).

Held at the National Science Foundation on October 16, 2006, the Mini-Symposium on Institutional Transformation brought together NSF program managers, CEOSE members, and individuals with experience in driving and implementing institutional transformation to broaden participation in STEM. Three roundtable-style, moderated panels, featured respectively: specific NSF programs that influence institutional transformation, challenges and strategies for broadening participation in the STEM faculty, and ways to improve the climate in STEM for our Nation's rich demographic pool of students. Seeded by brief presentations from the invited panelists, the ensuing discussions involved all attendees and were extremely helpful to CEOSE. The major insights and ideas are summarized below.

What is Institutional Transformation (IT)?

The Mini-Symposium did not attempt to reach consensus on this important question, but found a few perspectives to be useful:

- From the American Council on Education: IT alters the culture of the institution by changing underlying assumptions and overt institutional behaviors, processes and structures; is deep and pervasive, affecting the whole institution; is intentional; and occurs over time.[21]

[20] *CEOSE, Broadening Participation in America's Science and Engineering Workforce,* CEOSE 04-01, p. 103, 2004. Available at http://www.nsf.gov/od/oia/activities/ceose/reports/ceose2004report.pdf.

[21] ACE 2001, *"On Change V".*

- Four interacting dimensions that must transform in synchrony: students, faculty, curriculum, structure and climate.
- A lesson from engineering: conceive, design, implement, and operate.
- An analogy from chemistry and physics: IT as an institutional "phase transition" and re-crystallization into a different stable state.

Insights

Different types of institutions face different transformational challenges to broadening participation in STEM. Primarily, undergraduate institutions and traditional minority-serving institutions have inclusive and supportive STEM programs and demographically diverse faculty. Their transformational challenge is to develop and sustain sufficient research activity so that their students and faculty routinely engage in discovery science and engineering and attain STEM preparation on a par with the best in the country. On the other hand, the key transformational challenge for our leading, primarily majority institutions is to become more inviting to, supportive of, and enabling of students and faculty from underrepresented groups both academically and socially. Despite these differences, it is possible that some strategies for transforming institutions could be applicable to all institutions of higher education, from community colleges to the elite research universities.

Some potential "best practices" emerged from the panelists' presentations and the discussions. These approaches could be viewed as attributes that are helpful or desirable, and some were recognized as key to specific institutions, programs, and situations.

- Appointment of someone who is dedicated to the transformation initiative and responsible and accountable for achieving results.
- Creation of an administrative infrastructure in the form of an office or person to whom underrepresented students and faculty can go for assistance of many types.
- Clear interest and encouragement or pressure from "the top," for example, from the President or key board member(s).
- Development and execution of a strategic plan to guide the effort.
- Presence and encouragement of faculty members who are supportive and actively engaged in the effort. Without considerable faculty "buy-in," success would be very unlikely.
- Alignment of the institution's reward structures for faculty, staff, and students with the goals of broadening participation.
- External pressure from important constituencies (e.g., funding agencies, major donors, employers of many STEM graduates).
- Implementation of effective and multifaceted mentoring—both formal and informal—where the mentor is focused on helping the protégé to succeed through the next career milestone to the point of becoming established in the following career phase. For example, a faculty mentor for an undergraduate student would guide the student through graduation and into a well-matched graduate program. A Ph.D. mentor would make sure the protégé obtained the research, publication, presentation, teaching, and proposal-writing experience needed to be selected competitively for a post-doctoral, industrial, or tenure-track faculty position, and would continue to mentor the newly minted Ph.D. until well established in the next position.

- Establishment of linkages and partnerships between STEM education and research programs and diverse communities outside of academe, to engage students and faculty in actively applying their STEM expertise to issues that are important to the communities that underrepresented students come from.

Issues

Three issues emerged as being particularly important in institutional transformation to broaden participation in STEM higher education. First, the high K-12 dropout rate for underrepresented minority students, especially in poor urban and rural areas, means that less than half of this population is prepared for higher education of any type, much less in STEM fields, which require significant background in mathematics. Starting in elementary school, attention clearly must be paid to keeping these children in school, challenged, motivated, and learning; and to providing multiple pathways for them to develop and cultivate their STEM talent. Second, the STEM potential of persons with disabilities is often ignored entirely. Rarely are data disaggregated to reveal the overlap and intersections among disability, gender, race, ethnicity, and socio-economic status *vis à vis* inclusion in STEM. Moreover, given the range of types and magnitudes of disabilities, there is no simple fix that will invite and allow access for all. Transformed institutions will need fail-safe mechanisms that unobtrusively and gracefully help students and faculty members succeed in STEM, regardless of their disability. Third, since both mentors and leaders can be "made," institutional transformation initiatives should include training to help willing individuals develop the skills needed to become leaders in the effort. In addition, training can help people become effective mentors for underrepresented individuals, whose background, experiences, and perspectives are markedly different from their own and from their traditional STEM colleagues.

Recommendations from the Mini-Symposium

For CEOSE:

1. CEOSE should seek to develop an operationally useful definition of institutional transformation aimed at broadening participation. What attributes would a transformed institution have? What measures or metrics would be useful to drive and assess transformation?

2. Working with NSF, CEOSE should organize a meeting focused on institutional transformation to be attended by presidents, provosts, and board members from several of the top universities in terms of NSF funding. The meeting should challenge them to improve the overall performance of their campus with respect to inclusion and advancement of persons from underrepresented groups at the undergraduate, graduate, post-doctoral, and faculty levels. In addition, the meeting should help these leaders create and commit to strategies to do better.

3. CEOSE should invite each NSF directorate to understand and describe for CEOSE at an upcoming meeting the specific barriers its community faces to broadening participation, and then to design and implement programs that drive progress.

4. CEOSE should encourage each NSF research directorate to provide start-up research funding for new investigators who bring a commitment to broadening participation. Such programs could be modeled on the *Research Initiation Grants and Career Advancement Awards* (RIG/CAA) program in the BIO Directorate.

5. CEOSE should ask NSF to update its plan for broadening participation among its STEM staff, rotators, reviewers, review panels, advisory committees, and committees of visitors.

For NSF:

1. NSF should ensure that the Office of Cyberinfrastructure (CI) is "born" inclusive at all levels, enabling participation in its development and access to its transformational resources by persons traditionally underrepresented in STEM, institutions that serve these populations, and persons with disabilities.

2. NSF should strengthen accountability for broadening participation by requiring annual and final reports to address specifically this topic, separately from other broader impacts. The charges to panels reviewing cooperative agreements and *MREFC Projects* should include a specific question to assess progress toward broadening participation. COVs should be asked specifically to assess the extent to which the programs they are reviewing are proactive about broadening participation.

3. NSF should consider how to configure programs so that it becomes possible for undergraduate institutions, *EPSCoR* states, and minority-serving institutions to "graduate" from targeted programs (like *EPSCoR*, *CREST*, and *HBCU-UP*) to become successful in competing for grants from mainstream programs in the research directorates and from prestigious interdisciplinary programs, such as *Science and Technology Centers* (STCs).

4. NSF should target an evaluation of the *AGEP* and *ADVANCE* programs to determine the extent to which they are changing the culture of the institutions that have received grants.

5. NSF should fund research to understand institutional transformation aimed at broadening participation in STEM. Among other objectives, this research should determine if there is a common framework, set of practices, or sequence for successful transformations.

6. NSF should encourage leaders of its grantee institutions to sustain and build on the successful programs launched using NSF funds, through fundraising for "endowments," through inclusion of these programs in its basic operating budget, and through other means.

WIDENING CREATIVE PATHWAYS FROM COMMUNITY COLLEGES AND OTHER INSTITUTIONS

CEOSE established a subcommittee to focus on STEM education and opportunities in the Nation's community colleges.[22] As a part of its charge, the subcommittee identified the following objectives:

- Make recommendations to NSF for programs and activities that will result in an increase in the number of STEM students transferring from community colleges and Tribal colleges to 4-year colleges.
- Make recommendations to NSF for programs and activities that will result in greater number of community college and Tribal college students moving on to graduate education.
- Communicate to the public the value and role of community colleges and Tribal colleges in providing STEM educational opportunities to students.

Mini-Symposium

Co-chaired by Professor Ashok Agrawal and Dr. J.K. Haynes of CEOSE, a Mini-Symposium on Community Colleges was held as part of the May 31-June 2, 2006 CEOSE meeting at the National Science Foundation. The panelists included Professor Emeritus Alfredo de los Santos, Maricopa Community College; Dr. Henry D. Shannon, St. Louis Community College; Dr. Charlene Nunley, Montgomery College; and Dr. John Tsapogas, NSF.

Professor de los Santos gave a detailed presentation on the history of community colleges, stating facts and giving his assessment of the situation and the current status. Dr. Henry D. Shannon focused his presentation on community college concerns, external and internal challenges, and resources. Later, Dr. John Tsapogas provided trend data on community colleges. He noted several important observations in the data: community colleges are serving first generation college students; and minority graduates are attending community colleges in large numbers. Dr. Charlene Nunley's presentation focused on the current state of affairs at the Nation's community colleges. While there are challenges (e.g., access, affordability, faculty issues, student loan burdens, financial sup-

[22]Ibid. page 4.

port, student transfer issues), there are numerous opportunities (i.e., programs that hold the interest of students and successes). Dr. Samuel Myers, CEOSE Chair, summed up the presentations in his statement: "Community colleges play an important role in broadening the pipeline of students of various races and ethnicities through involvement with local schools and in the production of scientists and engineers."

At the end of the question and answer period, Dr. J.K. Haynes and Professor Ashok Agrawal provided closing comments on the Mini-Symposium. Dr. Haynes spoke of community colleges as untapped resources—a group of colleges that are growing much faster than 4-year colleges.

Also, at the end of the Mini-Symposium, one member of CEOSE said that he "used to be one of those skeptics who didn't believe good students go to community college". He said that he started changing his mind years ago, and that, after Thursday's discussion, "my transformation is complete." Not only can students with community colleges in their background compete, they can excel, according to presenters at the committee meeting.

Other suggestions made by the Mini-Symposium presenters included:

- Increase financial aid for community college students—both while attending community colleges and upon successful transfer to 4-year institutions.
- Consider broadening NSF's S-STEM Program (*Scholarships for Science, Technology, Engineering and Mathematics*), and expand to target more community college students.
- Support better articulation with 4-year schools, as called for by National Academy of Engineering. Consider creation of a *Bridges to the Baccalaureate* program like the one at NIH--which provides more research/internship opportunities for 2-year students.
- Expand funding for NSF's *Course, Curriculum and Lab Instrumentation* (CCLI) grants. Allow for a program geared specifically to 2-year colleges. This will allow for curriculum and equipment changes to occur at the same time at both institutions, with no need for catch-up at 2-year colleges.

Recommendations and Action Items from the Mini-Symposium

For CEOSE:

1. Conduct site visits to one or more community colleges.
2. Request that NSF's Division of Science Resources and Statistics assemble data on STEM activities at community colleges which include:
   - Characteristics and number of students who enter community colleges intending to transfer to 4-year colleges (aggregated and disaggregated by underrepresented and total STEM groups).
   - Graduation and transfer rates (aggregated and disaggregated by underrepresented and total STEM groups).
   - Percentage of students who received master's and Ph.D. degrees (aggregated and disaggregated by underrepresented and total STEM groups).
3. Prepare a report on the degree of success of Bridge Programs in facilitating transfer of students from community colleges to baccalaureate degrees and beyond. Contact NIH for data availability immediately—to be completed by June, 2007.

4. Prepare a concept paper based on assessment of data on *Models of Research and Education Centers at Community Colleges* for a new program initiative at NSF (to be brought to the full CEOSE committee for discussions at the June 2007 meeting).

   These *Model Research and Education Centers* should be provided NSF funding so that their faculty members can engage in research and scholarly activities, including partnership with university faculty in applied and fundamental research in STEM fields and pedagogical research to enhance STEM teaching at the undergraduate level with special emphasis on teaching underrepresented minorities.

5. NSF should implement specific programs at community colleges that will result in increasing the percentage of students pursuing STEM programs; and utilize the findings and recommendations of NAE reports on Pre-Engineering Programs at community colleges to determine how the recommendations of the report can be expanded to other areas in STEM.

6. NSF should develop a program that will allow senior faculty members from universities to work as visiting faculty members at community colleges.

7. NSF should recommend that OSTP promote the value and recognition of community colleges amongst all Federal agencies, much like NSF has now done.

8. NSF should develop and implement other new initiatives and programs at community colleges that will:

   ▲ Result in increasing the percentage of students pursuing STEM programs.

   ▲ Result in increasing the percentage of American Indians pursuing STEM programs.

FEDERAL INTER-AGENCY COLLABORATION

On December 20, 2005, a meeting of Federal agencies was held to discuss broadening participation in STEM. The meeting was hosted by the White House Office of Science and Technology Policy (OSTP), and was co-chaired by Dr. John H. Marburger, III, Director of OSTP and Dr. Kathie Olsen, Deputy Director of NSF. More than 15 Federal agencies were represented at the meeting, which focused on various agency-based strategies and initiatives for increasing opportunities for women, underrepresented minorities, and persons with disabilities to enter into the science and engineering fields. It was recommended that follow-up meetings take place to further understanding of individual agency efforts and to discuss what opportunities there may be for trans-agency initiatives. This set the stage for CEOSE to assume a leadership role in this nascent effort to form inter-agency cooperation in broadening participation.[23]

The Assessment, Evaluation and Communications Subcommittee of CEOSE emphasized the need for a research study of what other Federal agencies are doing specifically to increase participation in STEM. The study would provide a basis for recommending how best to proceed with trans-agency initiatives. A white paper previously prepared by CEOSE Chair, Dr. Samuel Myers and former Chair, Dr. Willie Pearson, Jr., was discussed with NSF's Deputy Director, Dr. Kathie Olsen, during the May 31, 2006 CEOSE meeting. As one of the first steps, Dr. Luis Echegoyen suggested that members of other Federal agencies be invited to the next CEOSE meeting. Representatives from the National Aeronautics and Space Administration (NASA), National Oceanographic and Atmospheric Administration (NOAA), Department of Energy (DOE), Department of Defense (DOD), Department of Labor (DOL), National Institutes of Health (NIH), National Institute of Standards and Technology (NIST), and the United States Geological Survey (USGS) were invited.[24]

[23] *CEOSE February 2-3, 2006 Meeting Minutes, page 4.*
[24] *CEOSE May 31-June 2, 2006 Meeting Minutes, page 7.*

On October 17, 2006, Dr. Julie A. Pollitt of NASA, Dr. Jacqueline Rousseau of NOAA, Dr. Joseph V. Martinez of DOE, Ms. Evelyn Kent of DOD, and Mr. Greg Weltz and Mr. Paul Lyons of DOL attended the CEOSE meeting. Representatives from NIH, NIST, and USGS were unable to attend. The agency representatives talked about the current efforts within their agencies to broaden participation, the challenges they have encountered, the possibilities for inter-agency exchange of information about their diversity programs, and future inter-agency collaborations. Overall, the discussions were informative; and the agency representatives were very receptive to further interaction with CEOSE to increase opportunities for underrepresented groups in STEM.[25] It was evident from some of the agency presentations, however, that STEM diversity efforts were based within different divisions or offices of their agencies and that follow-up contact with the agency would be needed to get a fuller picture of how each agency as a whole is responding to broadening participation. This provided further rationale for the Federal trans-agency survey study.

ASSESSMENT OF NSF BROADENING PARTICIPATION PROGRAMS

Throughout 2005-2006, the CEOSE Subcommittee on Accountability, Evaluation and Communications continued to emphasize the need to find out what impacts NSF programs have had on broadening participation for the underrepresented groups. The need for evidence of the Foundation's diversity programs was echoed by the Advisory Committee for GPRA Performance Assessment. In its most recent report, the Committee stated that it "...would like to see data on all aspects of broadening participation. Specifically, more conclusive evidence is needed on whether NSF has indeed increased opportunities for underrepresented individuals and institutions; and that NSF should explore creative mechanisms to bring industry and academia together to achieve this goal."[26] In addition to obtaining and reviewing recent program evaluation studies from the Foundation's directorates, CEOSE invited directorate staff to provide presentations on innovations in evaluation methodology and findings from recent program assessments. Several speakers were invited to the October 2005 CEOSE meeting to update the Committee on NSF programs to increase female participation in STEM and related research. Among the speakers was Dr. Ruta Sevo of EHR, who reported on her research into the professional life of women scientists and barriers to their advancement. She identified factors that enhance the experiences of women in undergraduate and graduate STEM education, such as having mentors, women role models, and student engagement in research projects with faculty. She has also identified factors that directly or indirectly contribute to positive change for females in science and engineering, e.g., programs aimed at narrowing or eliminating the gender gap in science and mathematics, and outreach programs to attract females to the STEM fields. Dr. Sonia Esperanca reported on factors that contribute to a better climate for women in STEM academic careers, by highlighting some effective approaches used by the NSF' *ADVANCE* program (e.g., Institutional Transformation awards and fellowships).[27] Drs. Donald Thompson, Bernice Anderson and Elizabeth VanderPutten of EHR spoke to the Committee during the CEOSE February 2006 meeting on the uses of evaluation and gave examples of ongoing evaluations in the *Faculty Early Career Development*, *Math and Science Partnership*, and *Robert Noyce Scholarship* programs.[28] Several evaluation consultants to EHR recently contributed to the state of knowledge about evaluation methodology used in assessing programs to broaden participation, by conferring together and producing a monograph on the plusses and minuses of specific approaches to determining the effects of broadening participation programs. Many of the programs cited in the monograph are NSF-funded diversity programs. The monograph should prove very useful to principal investigators as well as project evaluators.[29]

[25]CEOSE October 17-18, 2006 Meeting Minutes, page 4.
[26]Report of the Advisory Committee for GPRA Performance Assessment FY 2006, July 25, 2006, page 7.
[27]CEOSE October 25-26, 2005 Meeting Minutes, page 6.
[28]CEOSE February 2-3, 2006 Meeting Minutes, pages 5-6.
[29]Douglas Hoffman and Frances Lawrenz, Editors, *Critical Issues in STEM Evaluation*. New Directions for Evaluation, Number 109, Spring 2006.

Dr. A. James Hicks, along with Dr. Clemencia Cosentino de Cohen of the Urban Institute, made a presentation to CEOSE during the June 2006 CEOSE meeting on the *Louis Stokes Alliances for Minority Participation* program. Since the program's inception in 1991, more than 24,000 of its minority student-participants have obtained a bachelor's degree in a STEM field. This and other findings show that the success of LSAMP warrants the program's replication on a national scale. The presenters also provided some positive evaluation feedback on the new *Bridges to the Doctorate* program, which is currently sponsoring 546 graduate students in STEM.[30]

Finally, CEOSE continued to focus on the Foundation's overall performance in regard to broadening participation as well as on specific programs within the directorates. Towards this end, CEOSE members met in early 2005 with members of NSF's GPRA Advisory Committee, Drs. Susan Cozzens and Dawn Adams, to discuss the nature of CEOSE's deliberations in regard to NSF's Strategic Plan. CEOSE appointed one of its members, Dr. Robert Lichter, as a liaison to the GPRA Advisory Committee.[31]

OTHER KEY CEOSE ACTIVITIES

During the 2005-2006 biennium, CEOSE was also involved in a number of other key activities, which include the following:

- Finalization and distribution of the CEOSE 1994-2003 Decennial & 2003-2004 Biennial Reports to Congress. On June 15, 2005, members of CEOSE met with Congressional staff in the House and Senate to discuss the findings and recommendations of these reports.
- In the months following the June meeting with the Congressional staff, members of CEOSE made numerous presentations on the reports throughout the STEM community, including a symposium organized by Dr. Beverly Karplus Hartline and Dr. Robert Lichter at the American Association for the Advancement of Science Annual meeting on February 19, 2006, entitled "Next Generation Pathways;" and presentations by Dr. Samuel Myers and Dr. Hartline to the Minority Access, Inc. 7th National Role Models Conference on September 18, 2006 on the mandate for CEOSE and findings of the CEOSE Decennial and Biennial Reports to Congress.[32]
- The CEOSE Decennial and Biennial Reports to Congress were also widely distributed to professional organizations, placed on the Internet at www.nsf.gov/od/oia/activities/ceose, and summarized or cited in numerous science and engineering publications.
- Former CEOSE Chair, Dr. Robert Lichter, sent a letter to NSF Director, Dr. Arden Bement, in December 2005 about the need to differentiate between NSF's broader impacts criterion and broadening participation when data are presented to CEOSE and others; about ensuring that the efforts to improve the proposal submission and review process and increase success rates do not work to the disadvantage of underrepresented populations; and about ensuring that the use of the Department of Education's definition of minority-serving institutions (MSIs) does not distort data needed for assessing the effectiveness of NSF's efforts in broadening participation, because the definition includes minorities that are not underrepresented in STEM. Dr. Bement responded constructively to the letter.[33]
- On January 1, 2006, Dr. Samuel Myers became the new Chair of CEOSE and Dr. Luis Echegoyen, the new Vice Chair. Dr. Myers and other members emphasized the need for research on policies and practices for

[30]CEOSE May 31-June 2, 2006 Meeting Minutes, page 5.
[31]CEOSE June 16-17, 2005, Meeting Minutes, page 4.
[32]*CEOSE May 31-June 2, 2006 and October 17-18, 2006 Meeting Minutes.*
[33]Dr. Robert Lichter.

broadening participation across Federal agencies, especially for underrepresented minorities and persons with disabilities.[34]

- Mrs. Ruth Brannon of the National Institute on Disability and Rehabilitation Research (NIDRR) made a presentation to the Committee on the mission and activities of NIDRR. Dr. Ted Conway of NSF focused on persons with disabilities nationwide, and informed CEOSE that 20% of the U.S. population has some disability, yet they lag behind in advocacy of the need for attention to their issue.[35] Related to this topic, Dr. Joan Burrelli of NSF's Science Resources Statistics Division made a presentation to the Committee on June 1, 2006, entitled, "The Intersection of Race, Gender, and Disability in the STEM Workforce." Based on estimates, 5% of people employed in STEM have disabilities; most are White males; 0.3% are underrepresented minority males; and 0.1% are underrepresented minority females. [36]
- On September 18, 2006, Dr. Samuel Myers and Dr. Wesley Harris made a presentation to the National Academy of Sciences, entitled "Science and Engineering Workforce and U.S. Competitiveness."[37]
- During the October 17-18, 2006 CEOSE meeting, it was decided that the Committee would develop a strategic and implementation plan to guide its goals and activities over the next five years, i.e., 2007-2011. Dr. Muriel Poston was appointed Chair of the Strategic Planning Subcommittee.[38]

CEOSE RECOMMENDATIONS TO NSF: 2005-2006

Based on its information-gathering and discussions, CEOSE made a number of recommendations during 2005-2006:

1. NSF should expand its systematic and objective evaluation to assess, understand, and report the effectiveness and impact of its programs and policies on broadening participation.
2. NSF should sponsor additional social science research that will advance understanding of the causes and effects of progress in and barriers to broadening participation in STEM at all levels—from learners to leaders.
3. NSF should continue to design and employ new policy levers that focus the attention of principal investigators and their institutions on diversity aspects of the broader-impacts criterion, on embedding diversity goals in their research, and on designing and implementing sustainable institutional change that helps STEM become more inviting and supportive of women, underrepresented minorities, and persons with disabilities at all levels.
4. To engage and advance more American Indians in STEM, NSF should enhance research capacity and research opportunities at Tribal colleges, for example, by supporting more faculty exchanges and innovative distance-education and research technologies, especially collaborations with research institutions, and helping Tribal colleges and their faculty to become competitive at proposal writing and more aware of grant opportunities.
5. NSF should implement specific programs at community colleges that will result in an increase percentage of students pursuing STEM programs.

[34]CEOSE February 2-3, 2006 Meeting Minutes, page 3.
[35]CEOSE February 2-3, 2006 Meeting Minutes, pages 4-5.
[36]CEOSE May 31-June 2, 2006 Meeting Minutes, page 4.
[37]CEOSE October 17-18, 2006 Meeting Minutes, page 7.
[38]Ibid.

[39] *Investing in America's Future. NSF Strategic Plan FY 2006-2011*, page 8.
[40] Ibid. pages 9-10.

6. An evaluation should be made of NSF programs and activities designed for minority-serving institutions (MSI), in order to recommend best practices to strengthen MSI-related programs.

7. NSF should provide an across-directorate process to share best practices and drive continuous improvement within NSF to broaden participation of women, underrepresented minorities, and persons with disabilities.

NSF PROGRESS IN BROADENING PARTICIPATION 2005-2006

In response to the CEOSE's 2005-2006 recommendations, NSF has made some progress in supporting and expanding the Foundation's efforts to broaden participation. Included among these efforts are the following examples:

- The Education and Human Resources (EHR) Directorate established the Education Research initiative in 2006 within the *HBCU-Undergraduate Program* to strengthen STEM education research at HBCUs and to support education research projects that advance knowledge of undergraduate STEM education.
- NSF's *ADVANCE* program is supporting an effort led by the University of Michigan to conduct a national study that will expand the knowledge base on approaches to improve the climate for women in U.S. academic institutions and facilitate women's advancement to the highest ranks of academic leadership.
- Starting in FY 2007, eligibility of EHR's *HBCU-Undergraduate Program* will be broadened to include accredited 2-year HBCUs that do not currently have STEM degree programs. These HBCUs will be encouraged to apply for support to enhance the quality of their general STEM courses and programs and/or to establish new undergraduate STEM degree programs.
- In 2006, EHR and the *Small Business Innovative Research* (SBIR) program collaborated on a NSF-funded pilot project to support teams of faculty and students from community colleges, Tribal colleges, and Hispanic-Serving Institutions to conduct summer research projects with small businesses. Providing professional development opportunities for these faculty, whose students can benefit from their experiences, is a primary goal of this project.
- As stated in its 2006-2011 Strategic Plan, NSF will renew a focus on 2- and 4-year colleges and minority-serving institutions, and will promote faculty enrichment programs, curricular improvements and access to research instrumentation, and enhance opportunities for partnerships among community and technical colleges, 4-year colleges, and research-intensive universities.[39]
- NSF has initiated cross-directorate efforts to broaden participation. These efforts include continued enforcement of its merit review policy, efforts to increase the diversity of reviewers, and increased efforts to identify and disseminate best program management practices. For example, NSF's Teaching Academy includes content about the importance of broadening participation in the Program Management Seminar series.[40]

4 Recommendations and Future Plans: 2007-2008

In his remarks at the October 2006 CEOSE meeting, Dr. Samuel L. Myers, Jr., CEOSE's 2006 Chairperson, emphasized the need for CEOSE to continue its focus on evaluation and accountability, institutional transformation, non-traditional pathways into STEM, and overcoming the challenges of race, gender, and disability taken together. Dr. Myers posed important questions to guide CEOSE's future emphases and deliberations, which provide a springboard into the coming biennium:

- What is the science of understanding diversity and underrepresentation? Can we develop metrics useful for driving and assessing progress and accountability?
- How can we transform the culture of the STEM enterprise, so that within less than 20 years there will be sustained change for the better?
- What can be done to widen, publicize, and "break open" the non-traditional pathways into STEM currently followed by many people from underrepresented groups? Could CEOSE learn as much from visiting a community college as it did in its 2004 visit to two Tribal colleges?
- What about the intersection of race/ethnicity, gender, and disability? How can we understand and address the compounded barriers?

Recommendations for NSF:

The top priority recommendation for NSF is to build upon the four recommendations featured in CEOSE's last report: accountability, research, policy levers, and Tribal colleges. Specific suggestions in these areas are found in the subcommittee reports in Chapter 3.

1. CEOSE recommends that over the next two years NSF assess the outcomes of its programs, investments, and activities with respect to their impact on broadening participation and transforming institutions, and use the results to optimize policies and programs.
2. To ensure that broadening participation is not lost among the many possible broader impacts encouraged by the Foundation, NSF should provide explicit guidance to grantees that annual and final reports identify the specific impact, if any, of each award on broadening participation.

3. NSF should survey and report annually on the participation of women, underrepresented minorities, and persons with disabilities in each review panel, advisory committee, and committee of visitors (COV).

4. NSF should ensure that major new initiatives and programs, such as the new Office of Cyber-Infrastructure, are created to be fully inclusive, enabling participation in their development, implementation, and funding of persons traditionally underrepresented in STEM, and institutions that serve these populations.

CEOSE PLANS FOR 2007-2008

In preparation for 2007-2008, CEOSE merged two of the *ad hoc* subcommittees formed in 2005 to create the CEOSE *Ad Hoc* Subcommittee on Accountability, Evaluation, and Communications. The *Ad Hoc* Subcommittees on Institutional Transformation and Widening Creative Pathways remain active. In addition, a new *Ad Hoc* Subcommittee on Strategic Planning was formed, charged to take the lead in prioritizing CEOSE's efforts. Through its meetings and *ad hoc* subcommittees, CEOSE plans to focus on the following areas.

- Continued interactions with selected Federal agencies to promote inter-agency sharing of information and best practices, along with the coordination of efforts with the goal of enhancing the overall Federal effort to increase access of women, underrepresented minorities, and persons with disabilities to STEM education, research, and employment opportunities.
- Continued review of and advice to NSF on policies, programs, and initiatives that have the potential for broadening participation of women, underrepresented minorities and persons with disabilities in STEM.
- Continued consideration and analysis of research findings and metrics addressing aspects of the challenge of broadening participation in STEM.
- An expansion of interactions with NSF's research directorates and with scientific and engineering organizations to understand the challenges, commonalities, and differences *vis á vis* broadening participation faced by the diverse science and engineering fields funded by the Foundation.
- Budget permitting, CEOSE is considering a site visit to one or more community colleges, for the purpose of gaining deeper insight that will help guide future recommendations aimed at widening non-traditional pathways into STEM.

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* *Dr. Hartline served out the unexpired term of Dr. Echegoyen as Vice Chair of CEOSE during 2006*

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Chapter 2

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