ENSURING A STRONG U.S. SCIENTIFIC, TECHNICAL, AND ENGINEERING WORKFORCE IN THE 21st CENTURY

APRIL 2000

National Science and Technology Council

About the National Science and Technology Council

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space and technology policies across the Federal Government. NSTC acts as a "virtual" agency for science and technology (S&T). The President chairs the NSTC. Membership consists of the Vice President, Assistant to the President for Science and Technology, Cabinet Secretaries and Agency Heads with significant S&T responsibilities, and other White House officials.

Through the NSTC, Federal departments and agencies work cooperatively to ensure that Federal science and technology investments support national goals. NSTC Committees prepare R&D strategies that are coordinated across the Federal government to form a comprehensive investment package.

Call 202-456-6100 to obtain additional information regarding the NSTC.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on all questions in which S&T are important elements; articulating the President's S&T policies and programs; and fostering strong partnerships among Federal, state and local governments, and the scientific communities in industry and academe. The Director of OSTP also serves as Assistant to the President for Science and Technology and manages the NSTC for the President.

Call 202-456-7116 to obtain additional information regarding the OSTP, or see our web site at: http://www.whitehouse.gov/WH/EOP/OSTP/html/OSTP_Home.html

THE WHITE HOUSE

WASHINGTON

Dear Colleague:

I am pleased to transmit the National Science and Technology Council (NSTC) report, *Ensuring a Strong U.S. Scientific, Technical, and Engineering Workforce in the 21st Century*. A multi-agency working group developed the report under the auspices of the NSTC Committee on Science. This NSTC review arises from the Administration's recognition that the nation's economy, knowledge base, and ability to address pressing public health, environmental and national security challenges in the 21st century will depend greatly on the strength of its scientific, technical, and engineering (ST&E) workforce. It is a national imperative to determine, to the extent possible, whether or not the nation is on a path that will ensure the vitality and strength of the talent pool for that workforce.

In April 1998, the NSTC Committee on Science formed an Interagency Working Group (IWG) to conduct an assessment of the ST&E workforce. Members of the IWG came from among those NSTC agencies that fund research in science, technology and engineering. Further impetus for this assessment came on September 10, 1998, when President Clinton directed the NSTC to develop recommendations on how to achieve greater diversity throughout the scientific and technological workforce.

Responding to those directions, the IWG analyzed the impact that demographic and socio-economic changes could have on the future ST&E workforce in the United States. It also initiated an analysis of IWG member agency programs that are designed to increase the participation in the ST&E workforce of women, minorities and persons with disabilities. As part of its activities, the IWG, in conjunction with the National Science Foundation, organized a major workshop in July 1998 that helped establish the basis for this report.

This report makes recommendations, primarily aimed at post-secondary school efforts, that fulfill the President's request. The principal conclusion is that it is imperative that members of all ethnic and gender groups participate at increasing rates if a strong ST&E workforce is to be ensured. By implementing the IWG's recommendations, the nation will demonstrate its commitment to enhancing the number and qualifications of the ST&E workers who will contribute greatly to our nation's future success, developing the full talent pool, and addressing the ST&E needs of our diverse society.

The working group chairs are commended for their efforts in the development of this report.

Sincerely,

Neal Lane
Assistant to the President
for Science and Technology

Executive Summary

We look to science, technology, and engineering to increase the nation's productivity and economic well-being, advance healthcare, improve the environment, help ensure national security, and help educate our youth. The increasing economic role of science, technology, and engineering has, in turn, increased demand for all types of scientific, technical and engineering (ST&E) workers, from technicians to Ph.D. research scientists and engineers.

ST&E workers are essential contributors to both the private and public sectors. In the private sector, they help propel the economy and provide valuable services, such as healthcare. In the public sector, ST&E workers support important federal missions, such as maintaining a strong U.S. science and engineering enterprise and advancing biomedical research, national defense, environmental protection, energy conversion efficiency, food supply safety, and space exploration. For all these reasons, it is prudent to examine, to the extent possible, what actions will ensure that the nation has an adequate ST&E workforce in the 21st century.

Many types of ST&E jobs are among the fastest growing in the U.S. workforce, to the point that demand for workers has outstripped supply. Unemployment in science and engineering occupations is quite low: about one-half the rate for the entire U.S. workforce, a rate which itself is at historic low levels. If current trends persist, our nation may not have all of the talent it will need to enable the innovation process that has given America a strong economy and high quality of life. There is already evidence that worker shortages are limiting economic growth, and industry has repeatedly called for increases in the visa quotas that allow technically skilled non-immigrants to work in the United States.

Increasingly, worldwide socioeconomic trends and educational developments will challenge the preeminence of the United States in science, technology and engineering—and challenge its economic strength. Because other nations also recognize the importance to sustained economic growth of a highly skilled workforce, there is fierce international competition for workers in high-technology growth areas, such as electronics and information technology, and in other industrial sectors that increasingly depend on advances in these areas.

Demographic trends inspire concern about the nation's ability to meet its future ST&E workforce needs. Historically, non-Hispanic white males have made up a large fraction of U.S. scientists and engineers. However, in the 21st century this portion of the U.S. population is projected to decrease significantly. Other U.S. population groups, such as Hispanics and African-Americans, form a much smaller part of the ST&E workforce, but their populations are expected to increase markedly in the next 50 years. This implies that the ST&E fraction of the total workforce may decline if the relative participation rates of these different groups remain at their present values. If a strong ST&E workforce

is to be ensured, it is imperative that members of all groups, including non-Hispanic white males, participate at increasing rates.

The nation already depends on the increasing participation of women and minorities in the ST&E workforce. Over the past two decades there has been a substantial increase in the number of science and engineering (S&E) degrees awarded to women and under-represented minorities. If this had not occurred we would be facing even greater shortages of ST&E workers. We also would be less prepared to address the ST&E needs of our diverse society with all its unique needs, concerns, and expectations. Yet, further increases necessary to ensure a strong ST&E workforce may be at risk due to recent court and electoral actions.

The potential shortage of skilled workers could have devastating consequences for the future. Since it takes many years to train a scientist or engineer, we must invest now to guarantee the availability of a skilled and competent workforce for the 21st century. We must not only educate future ST&E workers but also provide continuing education and retraining opportunities, because many individuals in today's ST&E workforce will probably change the type of work they do several times over the course of their careers.

The federal government has an enduring interest in ensuring that the nation has an adequate reservoir of ST&E resources—including human resources—to achieve important national goals, such as a growing economy, strong defense, healthy population, safe environment, and high quality of life for its citizens. Federal science and technology agencies employ scientists, technicians, and engineers to carry out their missions, and also rely critically on the ST&E workforces of contractors and grantees to achieve their goals. Therefore, federal agencies support a variety of programs aimed at securing a healthy national talent pool of highly trained scientists, technicians and engineers. These include programs to increase the participation of groups that have been under-represented in the ST&E workforce.

Conclusion

- ST&E workers are essential to both the private and public sectors. In the private sector, they help propel the economy and provide valuable services. In the public sector, ST&E workers support important federal missions.

- Based on a tight global ST&E workforce, changing demographics, and projected growth in ST&E-based jobs, it is in the national interest to vigorously pursue the development of domestic ST&E workers from all ethnic and gender groups. We should pay special attention to groups that are currently under-represented in the ST&E workforce, because it is with these groups that much of our nation's growing talent pool resides.

Recommendations

- Federal agencies should critically evaluate how the wide range of programs they support (examples can be found in appendix B) can enlarge the ST&E talent pool by encouraging greater participation of all ethnic and gender groups. Particular emphasis should be given to women, minorities, and persons with disabilities who are under-represented in the ST&E workforce. Consistent with the Government Performance and Results Act, an important criterion for support of these programs should be their effectiveness in promoting a strong 21st century ST&E workforce. Agencies should expand or add programs that effectively overcome barriers such as the transition from one educational level to the next and that address student requirements for financial resources. Where appropriate they should work in concert with the private sector. Federal agencies should commit themselves to incorporating objectives consistent with the language in *Science in the National Interest*: "Every Federal agency's educational programs in science, mathematics, and engineering will have, as one measure of success, its impact on increased participation by underrepresented groups."[1]

- Federal agencies should continue to support research on barriers to full participation of under-represented ethnic and gender groups. The federal government should take the lead in fully understanding the dimensions of the ST&E human resources challenge and in raising the results of research to the attention of all stakeholders to promote future action.

- Federal agencies should emphasize recruitment and retention of qualified individuals from ethnic and gender groups that are currently under-represented in the ST&E workforce and vigorously pursue professional development opportunities for those already in the federal workforce.

- The Federal Government should establish and oversee the maintenance of an Internet site that provides information on ST&E workforce-related programs.

Ensuring the 21st Century U.S. Scientific, Technical, and Engineering Workforce

"We are living in a truly remarkable time, driven in no small measure by the revolutions in science and technology. Our economy depends on it more and more, and the maintenance of our leadership depends upon our deepening commitment to it more and more. Yet statistics show that in science, engineering, and mathematics, minorities, women, and people with disabilities are still grossly under-represented, even though we are becoming an ever more diverse society."

President William J. Clinton
September 10, 1998

In exploring the development of a more comprehensive ST&E workforce policy, this report focuses on the aggregated ST&E workforce and post-secondary school efforts. The full range of ST&E workers from highly skilled technicians with associate degrees or more limited formal education, to those scientists and engineers with bachelor's, master's, and doctoral degrees, falls into the aggregation. The report also aggregates private and public sector needs across all ST&E fields—not only high technology growth areas such as biotechnology and information technology, but also those sectors where there are continuing demands for ST&E skills such as the service, aeronautics and automotive industries.

This aggregation is purposeful. To meet national goals that depend on advances in science, technology and engineering, we must maintain strength over this entire range of skills.[2] Although demand for specific national ST&E workforce skills may change over time, the aggregated demand is less likely to do so. When appropriate, however, this report does present disaggregated statistics or considerations of individual components of the ST&E workforce.

1
The Need for a Robust, Diverse ST&E Workforce

Our nation's international competitiveness and national well-being have long depended on a highly skilled ST&E workforce. Recent studies have shown that science and technology have generated about half the productivity growth the United States has enjoyed over the past 50 years; created millions of high-skill, high-wage jobs; and improved the quality of life in America. Those productivity increases must continue in the 21st century if our high standard of living is to be maintained or improved.

A. PROJECTED GROWTH IN THE U.S. WORKFORCE

In 1995, U.S. high-tech industries accounted for the largest share of the world's production of high-tech goods—nearly a third. The United States is also a major exporter of high-technology services, another growing market sector.[3] The growth of U.S. high-tech industries has, in turn, created growth in demand for ST&E workers. Escalating global economic competition means the future of U.S. industries increasingly depends on the quality of available human resources.[4]

Given this dependence, it is not surprising that many ST&E job types are among the fastest growing in the U.S. workforce. According to the Bureau of Labor Statistics (BLS), the category of "professional specialty occupations," which includes most scientists, engineers, and medical personnel, grew by 32 percent from 1988 to 1998, largely driven by demand in the computer, health, and education sectors.

BLS employment projections indicate that this category will continue its impressive growth with a 27-percent increase in the number of jobs from 1998 to 2008. This is the greatest expected increase among the major occupational categories, representing more than 5 million new jobs and 26 percent of total projected job growth. The category with the second fastest estimated growth rate is "technicians and related support occupations."[5] Of the ten specific occupations projected to have the fastest employment growth for 1998-2008, four are computer-related and five health-related. The estimated growth in these nine occupations ranges from a high of 108 percent to a low of 48 percent—quite dramatic compared to 27 percent for the professional specialty category overall and 14 percent for all occupational groups.

These recent trends are consistent with longer-term historical U.S. employment trends. For example, our analysis of BLS data indicates that the fraction of the total U.S. workforce employed in ST&E positions increased from about 11 percent in 1962 to 15 percent in 1995. It seems likely, therefore, that there will be a continuing long-term need to increase the fraction of the workforce with essential science, technology and engineering skills if the United States is to maintain its leadership position in these areas. At the very least, conservative estimates indicate that the nation will need to maintain the current fraction of its workforce devoted to science, technology and engineering.

B. DEMOGRAPHICS OF THE FUTURE WORKFORCE – RETIREMENTS

Demographic trends indicate that the ratio of workers to retired people will decline markedly in the coming century. According to Bureau of Census projections,[6] the ratio of those in the 18-64 age group to those 65 and older will decline from 4.8 in 1995 to 2.8 in 2050. This reinforces the likelihood that demand will increase over time for a workforce with essential science, technology and engineering competencies.

Given this trend, the productivity per worker must increase to maintain or increase the average standard of living. Without productivity increases, some economic changes (e.g., inflation or a declining stock market) could lead to a decline in living standards for almost all Americans, including those who have put aside what should have been adequate retirement funds. Over the last half century, science, technology and engineering have accounted for over half the productivity increases. Hence, it is likely that, to maintain a high standard of living, the nation will want to emphasize investments in science, technology and engineering in the next half-century. It also follows that the nation will probably need to maintain or increase the fraction of its workforce that has essential science, technology and engineering skills.

C. FEDERAL GOVERNMENT INTEREST IN A ROBUST ST&E WORKFORCE

In addition to stimulating economic productivity and growth in the private sector, the federal government has other compelling reasons to help build a diverse, highly educated and trained national ST&E workforce. Many federal agencies have substantial R&D programs, needed to carry out such missions as maintaining a strong U.S. science and engineering enterprise, improving healthcare and quality of life, national defense, environmental protection, improving the efficiency of energy conversion, improving food supplies, and space exploration. These agencies need a high-quality pool of scientists, technicians and engineers from which to recruit staff. This talent pool must have the ST&E competencies required for the work of the future.

In 1995, the federal government employed eight percent of all employed scientists and engineers having at least a bachelor's degree .[7] These more than 252,000 scientists and engineers included 53,000 computer scientists and mathematicians, 38,000 life scientists, 28,000 physical scientists, 17,000 social and behavioral scientists, and 117,000 engineers. They work in every department and agency, although most are in NASA, EPA, and the Departments of Defense, Agriculture, Interior, Health and Human Services, Commerce, Transportation, Veterans Affairs, and Energy.[8]

Although 92 percent of employed scientists and engineers work in the non-federal sector, federal agencies have a direct stake there as well. Federal agencies depend on non-federal scientists, technicians, and engineers in the private sector, universities, and in state and local governments to achieve progress in their respective mission areas.

These non-federal scientists and engineers also add continually to the knowledge base available for innovation. For example, improvements in healthcare depend on

pharmaceutical and biotechnology firms that transform research advances into more effective drugs, vaccines, and other treatments, and on breakthroughs in diagnostic techniques, such as CT-scans and Magnetic Resonance Imaging, by chemists, physicists and engineers. The Department of Transportation's mission to improve transportation relies on the competency of thousands of state, local and private sector highway engineers. To build the International Space Station, NASA depends on thousands of scientists, engineers and technologists in contractor organizations and on the many researchers in academe and industry who will use the station to conduct scientific experiments. NSF's mission of promoting research and education across all fields of science and engineering relies on scientists, technologists and engineers. And the Department of Defense roots U.S. superior national security and defense capabilities in advanced science and technology.

2
The Current ST&E Workforce

It is easy to wonder why there is concern about the future ST&E workforce when we seem to be doing so well at present. A look at the character of the current workforce helps identify areas of concern.

Historically, non-Hispanic white males have formed the bulk of the U.S. ST&E workforce. In 1997, non-Hispanic white men comprised 36 percent of the population but accounted for 65 percent of the ST&E labor force, 41 percent of the S&E bachelor's degrees awarded (1996) and 43 percent of enrollment in S&E graduate studies (Figure 2-1).

Figure 2-1. Percentage of Population, S&E Bachelor's Degrees Awarded, S&E Graduate School Enrollment and S&E Labor Force

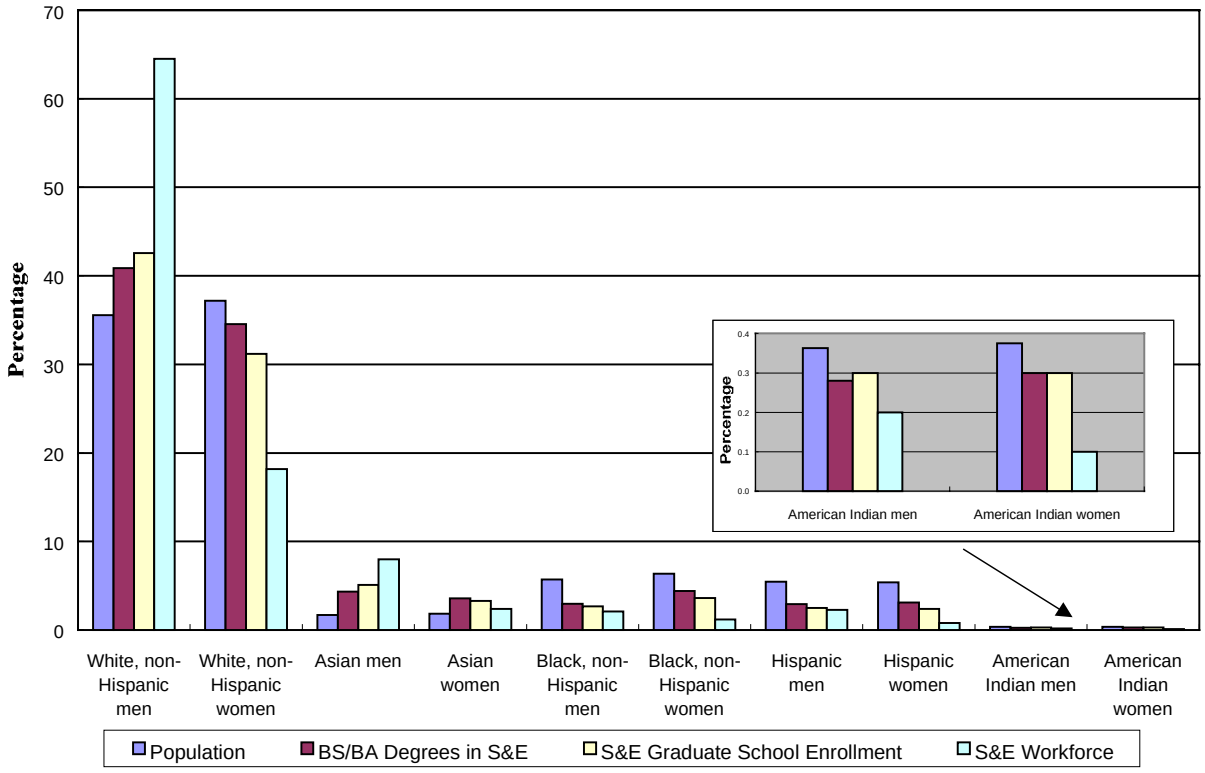

Figure 2-1. Percentage of Population (1997), S&E Bachelor's Degrees Awarded (1996), S&E Graduate School Enrollment (1997), and S&E Labor Force (1997). See figure references.

In 1996, women earned almost half (47 percent) of the S&E bachelor's degrees but only 38 percent of the master's degrees and 32 percent of the doctorates.[9] The latter statistic is

particularly significant, because it is the Ph.D. degree that enables women to join university faculties and serve as role models for female students who will become part of the future ST&E workforce. While participation of women has increased significantly over the past two decades, further improvement is needed.

The percentage of women in science, technology and engineering varies greatly from field to field. Women earned 38 percent of all science and engineering master's degrees awarded in 1996. This included 53 percent of those in biological science, but only 17 percent of those in engineering. In 1996, women earned 51 percent of the doctorates in the social and behavioral sciences and 42 percent in biology, but only 12 percent in engineering, 15 percent in computer sciences, and 21 percent in mathematics.[9] Thus, women's relative percentages are low in some fields that have rapidly increasing demands for highly skilled workers and are important for economic growth.

With the exception of Asian men, the percentages of minorities in science and engineering fall off at successive levels of advancement, from undergraduate to graduate work and into the workforce. In Figure 2-1, the leftmost vertical bar in each ethnic/gender grouping gives the group's percentage of the U.S. population. The bars to the right indicate, successively, the percentage of S&E bachelor's degrees awarded, S&E graduate school enrollment and S&E labor force represented by that group. For example, non-Hispanic Black men were 5.7 percent of the population (1997), 3.0 percent of those receiving S&E bachelor's degrees (1996), 2.7 percent of graduate enrollment in S&E (1997), and 2.1 percent of the S&E labor force (1997).

The data used to prepare Figure 2-1 can also be used to calculate relative participation rates for the ethnic/gender groups. For example, non-Hispanic Black males were a little less than one-half as likely to earn an S&E bachelor's degree in 1996 as non-Hispanic white males. They were also less likely than their non-Hispanic white male counterparts to enroll for S&E graduate studies. As with women, if only a small fraction of under-represented minorities pursues advanced degrees, the pool of role models and mentors who are available at universities to encourage minorities to pursue ST&E careers is reduced.

One characteristic of the ST&E workforce not apparent in the Figure 2-1 is the extent to which the nation depended on immigration to buttress the U.S.-born component of the workforce throughout the 20th century. This is apparent in the composition of the nearly nine million people in the United States holding S&E bachelor's and higher degrees: In 1995, approximately 12.4 percent were either naturalized U.S. citizens or non-U.S. citizens.[10] The world has sent many of its most promising young scientists and engineers to pursue advanced degrees or postdoctoral research opportunities at excellent U.S. research and academic institutions. Approximately half remained in the United States and contribute to the current U.S. science and technology enterprise in myriad ways.

3
The Future ST&E Workforce

Much of the concern about the future ST&E workforce arises from demographic trends that, given the structure of the current workforce, could have significant detrimental consequences.

A. DEMOGRAPHIC TRENDS

Figure 3-1. Bureau of the Census population projections for the ethnic and gender groups, ages 18 – 64 years

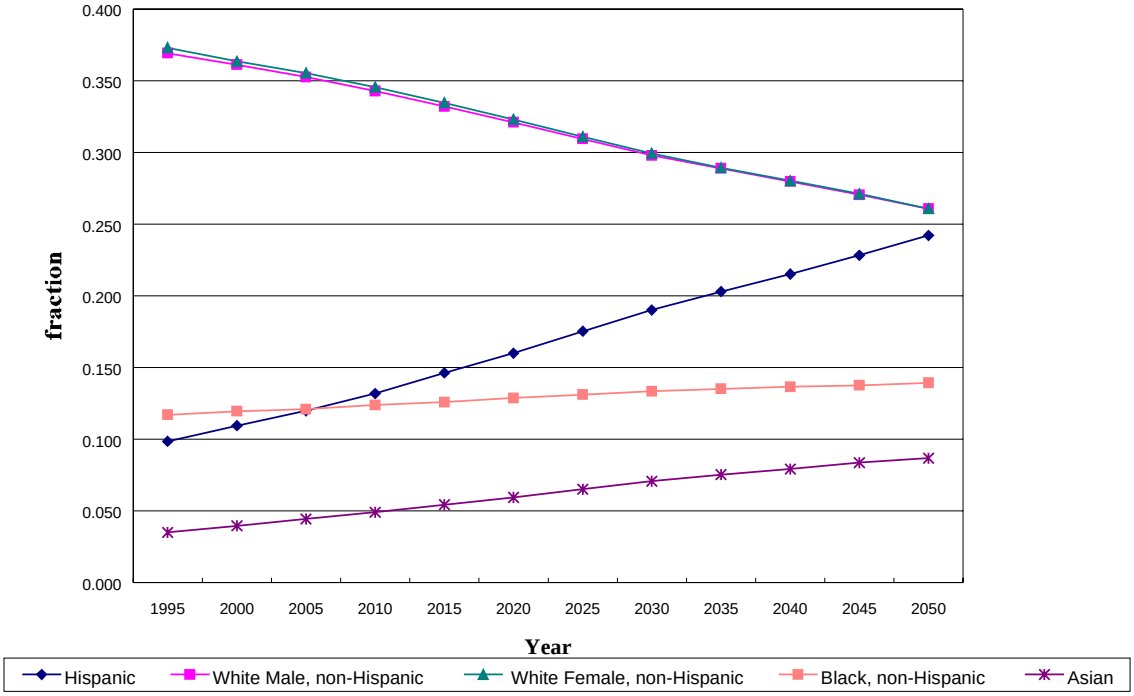

Figure 3-1. Bureau of the Census projections for the ethnic and gender groups, ages 18 – 64 years, listed in the figure legend. See figure references.

According to the Bureau of the Census projections in Figure 3-1, non-Hispanic white males, the present majority of the U.S. ST&E workforce, will decline as a fraction of the population 18 to 64 years of age (the workforce) from 37 percent in 1995 to 26 percent in 2050. After 2010, the non-Hispanic white male segment is projected to shrink in absolute as well as relative size. These projections imply that this group is not likely to provide the needed ST&E workers unless its members' participation rate increases considerably.

Over the same period (1995-2050), the workforce is expected to change from 12 to 14 percent African-American, 10 to 24 percent Hispanic, 4 to 9 percent Asian, and from 74

to 52 percent non-Hispanic white (the Native American population would stay at less than 1 percent). As a result, minorities are expected to increase from a quarter of the workforce to nearly half (48 percent).

The current under-representation of the larger minority population groups, African-Americans and Hispanics, in the ST&E workforce leads to the question of what likely impacts the projected demographic changes will have on the ST&E workforce. The ST&E workforce is largely maintained by a flow into the workforce of young people, approximately 22 years old, with science and engineering bachelor's degrees. What fraction of young people is likely to graduate with S&E degrees during the next half-century?

Unfortunately, because of current inadequacies in the way labor and population data are collected and limitations on our ability to model workforce flows, it is only possible to estimate this number. One possible scenario would assume that the same fraction of graduation-age people (22-year-olds) in each of the groups considered here (non-Hispanic white males, non-Hispanic white females, African-Americans, Hispanics and Asians) would graduate with S&E degrees as did in 1995.[9]

Figure 3-2. Calculated percentage of 22-year-olds that would earn S&E bachelor's degrees by year

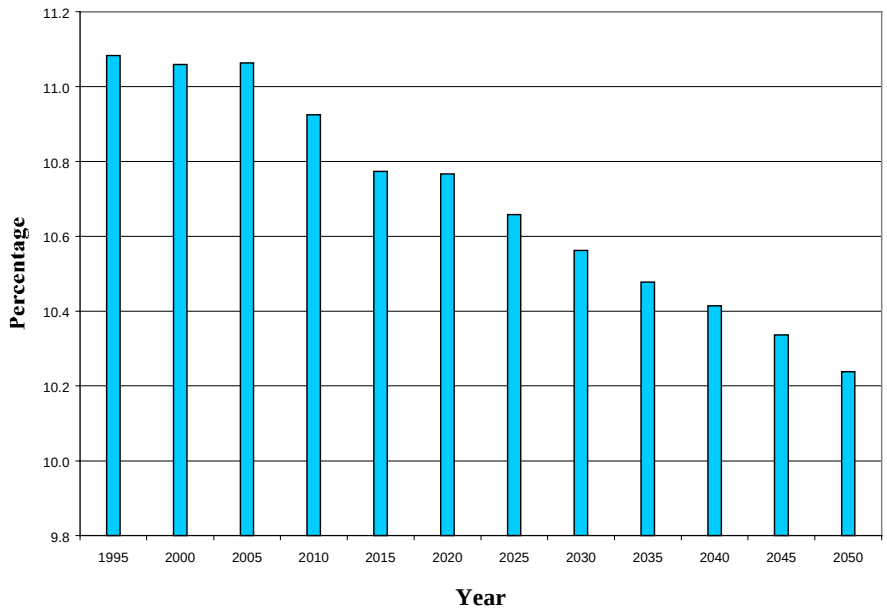

Figure 3-2. Calculated percentage of 22-year-olds earning S&E bachelor's degrees. The percentages were calculated using the U.S. Census population projections by race and gender and the assumption that the same fraction of graduation-age people (taken as 22-year-olds) in each ethnic or gender group—non-Hispanic white males, non-Hispanic white females, African-Americans, Hispanics and Asians—will graduate with S&E bachelor's degrees as did in 1995. See figure references.

Figure 3-2 gives the results. This calculation—not a prediction, but an estimate of the situation under modest assumptions—shows the consequences of failing to take action to increase the participation rate of graduation-age people who earn S&E bachelor's degrees. Without compensating influences, the calculated fraction of 22-year-olds that would earn S&E bachelor's degrees and could enter the U.S. ST&E workforce would decline from 0.11 in 1995 to 0.10 in 2050, a decline of 9 percent. If such a situation did arise, either the United States would need to increase its reliance on immigration of ST&E workers from other countries, or ST&E jobs would be sent off shore.

Factors influencing the calculation from both directions make it inappropriate to characterize this as a prediction. For example, increasing and widespread concern about issues surrounding the ST&E workforce have resulted in commitments to increase the participation of the under-represented groups in S&E.[11] These efforts and others, such as those recommended in this report, may mitigate the situation. Also, the assessment assumes that the nation will find it sufficient to maintain the present fraction of the workforce devoted to science, technology and engineering. It is more likely, however, that the desirable fraction will increase, resulting in a greater gap than the calculation indicates. It does not seem possible to project the balances among these and other operative factors. For policy development, however, it is valuable to know the out-year consequences of the present degree award rates for the groups considered here.

B. PROGRESS OVER THE PAST TWO DECADES

It is important to note that the participation of under-represented groups in science, technology and engineering has increased markedly over the past two decades. Those increases have, in turn, played an important role in maintaining the strength of the U.S. ST&E workforce.

As shown in Figure 3-3, the number of non-Hispanic white males earning bachelor's degrees annually in ST&E fields fell by about 47,000 between 1977 and 1997, from 213,000 to 166,000, largely due to the decrease in college-age people in that category. Fortunately, the decrease was more then offset by increases in participation by women and minorities. Between 1977 and 1997 the number of bachelor's degrees earned annually by non-Hispanic white women increased by 26,000, Asians by 27,000 and under-represented minorities by 25,000.[12]

Figure 3-3. Earned BS/BA degrees in ST&E fields, by Race/Ethnicity, 1977-1997 (U.S. citizens and permanent residents)

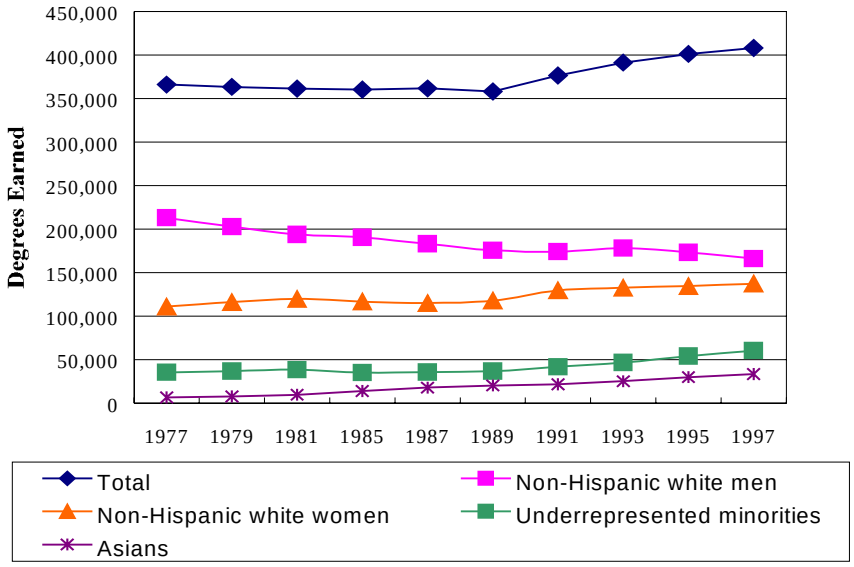

Figure 3-3. Earned BS/BA degrees in ST&E fields, by Race/Ethnicity, 1977-1997 (U.S. citizens and permanent residents). Source data are provided in the figure references.

C. DIVERSITY ENHANCES THE ST&E WORKFORCE

Increased diversity in the ST&E workforce would help both private and public sectors to achieve their goals. A diverse pool of scientists, engineers and technologists helps federal agencies perform their missions, for the same reasons that such a pool enables economic competitiveness: It better represents the needs of the customers it seeks to serve.

Increasing diversity in the national ST&E workforce, so that all have access to the highly skilled, high-paying jobs of the future, allows the nation to move into the 21st century with capability and confidence. Moreover, it broadens the nation's science and engineering agenda, bringing different perspectives to bear and producing a deeper analysis of alternatives.

A potential role of diversity in engineering is expressed well by William A. Wulf, president of the National Academy of Engineering: "Our profession is diminished and impoverished by a lack of diversity. It doesn't take a genius to see that in a world whose commerce is globalized, engineering designs must reflect the culture and taboos of a diverse customer base. Absent a diverse engineering team, these sensitivities may not be reflected. But it's deeper than that…. it is that the range of design options considered in a

team will be smaller. It's that the constraints on the design will not be properly interpreted…. There's a real economic cost to that."[13]

The biomedical sciences provide another example of the impact in the ST&E workforce of women, minorities, and persons with disabilities. Minority physicians are much more likely than non-minority physicians to practice in medically under-served areas.[14] And increased diversity in biomedical research also increases inclusion of these groups in existing major programs as well as the attention paid to the special health problems of under-represented groups, such as sickle cell anemia and breast cancer. Similarly, the participation of minority and female public health professionals in the formulation and implementation of public health studies of their respective groups has markedly increased the studies' effectiveness.

Recent research has documented the contributions of diversity in higher education, in the community, and in the workplace.[15,16] One classic study of innovation in organizations by Rosabeth Moss Kanter, professor of business at Harvard, found that highly innovative organizations make it a practice to use heterogeneous work teams. They were also more likely to hire women and minorities and to actively address diversity issues.[17]

We conclude, based on these considerations, that it is vital to increase the participation of all Americans in the ST&E workforce so that the nation can continue to enjoy the benefits that the ST&E workforce provides. It is particularly important to increase the participation of women, Hispanics, African-Americans and persons with disabilities. These groups have the largest untapped potential, and jobs in the ST&E workforce represent significant opportunities for career advancement. The increased participation of these groups over the past two decades implies that further efforts are likely to be fruitful, and it is a fundamental responsibility of a modern nation to develop the talent of all its citizens.

D. IMMIGRATION AND INTERNATIONAL COMPETITION

The rest of the world is not standing still. Other nations, realizing the key role that human resources play in industrial innovation and economic growth, are expanding their science and engineering education and training programs instead of sending their students to U.S. universities. They are increasing their investments in ST&E infrastructure and developing the capacity to educate, train, and employ their own human resources.[18,19,20]

These nations also continue to increase their investments in their national innovation systems. For example, six Asian countries tripled their combined investments in R&D in real terms, from $35 billion to $100 billion,[21] between 1982 and 1992. As a consequence, the United States is likely to face increased competition in extremely important portions of the economy that depend on the ST&E workforce, while facing increased competition for immigrants who currently have a significant role in the U.S. ST&E workforce.

Some nations have begun to entice their native-born ST&E professionals who immigrated to the United States to return to their country of birth. For example, in the

late 1980s, between 500 and 1,000 scientists a year returned to Taiwan, including some Nobel Prize winners. They were hired as senior faculty and as directors of laboratories, particularly at their national centers of scientific excellence.[22]

Historically, about half of all foreign graduate students have stayed in the United States for further study and employment, adding talent and skill to our ST&E workforce. In recent years, however, this has also begun to change. For example, with the increase in ST&E career opportunities in their homelands, the majority of S&E graduate students in U.S. universities from South Korea and Taiwan have been returning to their countries of birth after graduation.[23]

Clearly, the future of science and technology is global. The United States must continue to foster a healthy presence of foreign talent among students and researchers in our academic and research institutions as well as in industry, and to promote cooperative efforts in international projects.

Even as we have increased the participation of under-represented groups in the ST&E workforce, we have sought foreign technical professional workers through H-1B visas (temporary visas for skilled workers) to meet current needs. For this purpose, the number of H-1B visas was almost doubled to 115,000 for calendar year 1999, and some have proposed further increases to 200,000 per calendar year. These current and proposed increases, however, have been linked to fees to enhance education and training of U.S. citizens. This recognizes the imperative that the nation place greater emphasis on developing the talents of its citizens to ensure that all have an opportunity to participate in areas where job opportunities are growing most rapidly. It is unwise to constantly rely on increasing the nation's dependence on immigration to meet its ST&E workforce needs.

E. RECENT COURT AND ELECTORAL DECISIONS

Increased participation by women and minorities in science, technology and engineering over the past two decades gives cause for optimism that even greater increases will follow, reducing or eliminating potential shortages.

There is evidence, however, that tends to dampen that optimism. In 1995, the Supreme Court ruled in *Adarand Constructors, Inc. v. Peña* that federal race-based affirmative action programs would be subjected to "strict scrutiny," a higher standard than the "intermediate scrutiny" standard used earlier. Also in 1995, the University of California's Board of Regents banned the use of racial and gender preferences in admissions. The policy became a law in November 1996 when California voters approved Proposition 209.

That same year, the U.S. Court of Appeals for the Fifth Circuit banned the use of affirmative action to achieve diversity in university admissions in Texas, Louisiana, and Mississippi (*Hopwood v. Texas*) unless there was proof of prior racial discrimination by the university. In November 1998, voters in the state of Washington approved a measure

to ban racial preferences in university admissions, and similar efforts are continuing in a number of states.

There have been adverse effects from these recent court and electoral decisions. The fall 1998 freshmen classes at the University of California at Berkeley and Los Angeles were affected by Proposition 209. The number of African-American, Hispanic, and Native-American students admitted fell significantly, by 52 percent at Berkeley and 35 percent at UCLA. Admissions for these groups rebounded a little for the fall of 1999 but they were still down 42 and 34 percent, respectively, from 1997.[24] The very recent data for fall of 2000 show a small increase in the total number of underrepresented minority students admitted relative to 1997 for all UC campuses. This is encouraging, but the underrepresented percentage of the total admitted for fall 2000 is still below the percentage for fall 1997, and still significantly below at Berkeley (34 percent) and UCLA (28 percent.)

Applications to medical school are declining generally, by 12 percent from 1996 to 1998, but the number of applications from under-represented minorities in the states affected by *Hopwood* and Proposition 209 declined by 19 percent in the same period. In these states, the number of under-represented minorities entering medical school fell 20 percent, compared with an increase of 2 percent in other states.[25]

It should be pointed out that the extensive data reported by NSF, including the very recent data from approximately 11,700 departments at 601 institutions of higher education in the United States and outlying areas, showed that S&E graduate enrollment of minorities continued to rise in 1998, but overall enrollments fell for the fifth consecutive year from a peak enrollment in 1993. These data include non-U.S. citizens.[26]

The decline in overall enrollments is of concern. And while the increase in enrollment of minorities for the institutions included in the NSF data is encouraging, a study by the American Association for the Advancement of Science found that, in a sample of 70 graduate S&E programs at major research universities, first-year enrollments by African-American and Hispanic students dropped by almost 20 percent in 1997.[27] That study examined a number of factors driving down graduate enrollments and concluded that "policy ambivalence wrought by legal challenges (and fear of legal challenges) to programs and financial support targeted to minorities has likely had a chilling effect."

Clearly, it will be important to monitor S&E enrollments as an indicator of the future vitality of the national ST&E workforce. It will be important to determine the impact of recent efforts[28] as well as announced[29,11] or recommended programs,[2,30,31] including the actions recommended in this report.

F. TEST SCORE GAPS PERSIST

Further exacerbating the situation is the fact that the average educational test scores of African-Americans, Hispanics, and Native Americans are still relatively low, despite years of improvement. The gap between minorities and non-minorities did not change

much in 1998 or 1999, nor did the gap between men and women, while the average SAT score changed by only a point. [32,33]

Suburban students also had significantly higher scores than students from the urban areas where nearly half the Hispanic and African-American test-takers live,[32] and students whose parents earn more scored higher than those whose parents earn less.[33]

These gaps are significant because SAT scores are relied upon heavily in the admissions processes of many higher educational institutions. As a consequence, they tend to limit the enrollment of minority students at many selective institutions even though SAT scores are poor predictors of student performance. A heavy reliance on SAT scores also limits the weight that can be given to other criteria that have been shown to be valuable indicators of both student performance and future attainment.[34]

G. OTHER BARRIERS TO PARTICIPATION IN THE ST&E WORKFORCE

The barriers to the participation of women, minorities and persons with disabilities in the ST&E workforce have been the subject of many studies over the past few decades and have been shown to be complex. They vary across these groups, as well as for differing socio-economic strata within each group. Many have an impact beyond these under-represented groups. The following is a brief list of identified barriers that have stimulated intervention activities of various types, some of which are discussed in the next chapter.

- There is a shortage of mentors and role models at all levels of education for minorities and persons with disabilities. This is also the case for women at higher levels of education.

- The uncertainties associated with the duration of graduate education and the positions obtained after earning the degree discourage many from pursuing S&E Ph.D. degrees. These uncertainties are perceived to be greater than those faced by students doing post-graduate work in law, business or medicine. One consequence is that the number of mentors with a Ph.D. degree is increasing at a very slow rate.

- Too often students arrive at key transition points in their education with weak backgrounds that obscure their potential and limit their opportunities to do well in more advanced work. In general, this has to do with the level of preparation provided up to the point of departure. Sometimes, the root cause is a poor decision made at a time when the individual had no conception of the decision's implications.

- Many students' lack the financial resources needed for post-secondary education or for full-time attendance. They may have to work, sometimes attending a community college part-time. This approach falls outside the traditional pattern for S&E students.

4
The Role of the Research-Funding Agencies

This chapter discusses specific federal efforts to enhance participation in the ST&E workforce. Many of these efforts build on the K-12 and higher education programs open to all students, while others are specifically designed to address particular barriers to participation in science, technology and engineering. This chapter and the related material in Appendix B delineate many of the programs in place. It is important that the government assess these programs, maintaining and adequately funding the strongest.

A. FEDERAL SUPPORT OF RESEARCH AND THE TRAINING OF THE ST&E WORKFORCE

A significant barrier to ensuring a robust ST&E workforce is the students' perception that the uncertainty of obtaining an advanced degree and of the rewards upon its receipt may not justify the large amount of time required to get the degree. The federal government's long-standing support of university education (primarily graduate and post-doctoral) in science and engineering has encouraged students to pursue an advanced S&E education.

Major federal support began with land grant universities and colleges in the 1860s. Establishment of the National Science Foundation in 1950 recognized the importance of conducting the finest research while training the very best scientists and engineers. The research partnership between government and universities is instrumental in maintaining world leadership in science and technology, since a major portion of federally funded basic research is funded in this manner. The President is committed to keeping this partnership strong. At the President's request the National Science and Technology Council is studying this historic partnership and has recently issued a report aimed at strengthening it.[35]

In the fall of 1997, the federal government was the major source of support for nearly 56,000, or about 21 percent, of graduate students in science and engineering, a percentage that has held steady for nearly two decades.[36] It supports a greater percentage of graduate students in certain fields, including physical sciences (36 percent), geosciences (32 percent), and biological sciences (36 percent).

In the fall of 1997, more than 70 percent of S&E graduate students who were primarily supported by federal funds served as research assistants on federally funded research projects. Most of the rest (20 percent) had federal fellowships or traineeships. These three different modes of support for graduate education have varied features that recommend their use in particular situations.

- *Fellowships* are awarded through direct competition among students. The student may use them at the institutions they wish to attend. Usually there are eligibility

requirements for citizenship or permanent residency. Fellowships are frequently used to attract the most gifted individuals to science and engineering.

- *Traineeships* are awarded through institutional competitions for development of graduate study and research programs. The institutions select the students who will receive the funds. Usually there are citizenship or permanent residency requirements. Traineeships are frequently used to stimulate emerging areas of science and engineering and to enhance workforce capabilities.

- *Research assistantships* are awarded through standard research grants. The principal investigator selects the students. Usually there are no eligibility requirements for citizenship or permanent residency. They provide for individual selection of students in established areas of research. They are available to citizens of other countries and contain important incentives for students to remain in the U.S. following their years of study. Research assistantships are highly sensitive to levels of funding for research and development.

The appropriate relative roles of research assistantships, fellowships and traineeships is an important question well worth additional research and analysis.

B. FEDERAL PROGRAMS THAT PROMOTE INCREASED PARTICIPATION OF UNDERREPRESENTED GROUPS IN THE ST&E WORKFORCE

Federal agencies have an interest in ensuring a satisfactory supply of ST&E personnel to meet national goals. This interest has led to the development of a wide range of programs aimed at enlarging the talent pool by encouraging greater participation of women, minorities, and persons with disabilities. Examples of such programs are presented in Appendix B.

These federal programs are designed to overcome barriers that differentially affect under-represented groups. Given the demographic trends and impact of global economic forces outlined in this report, such efforts are needed today more than ever. An analysis of the best features of existing programs has identified characteristics they should all strive to achieve, as follows:

- They address a compelling interest of the agency or the nation.
- They have well-defined goals relevant to:
  - ✓ Building a strong, well-qualified ST&E workforce.
  - ✓ Overcoming barriers to full participation of all groups, by using techniques such as early intervention, mentoring, and financial support.
- They include appropriate evaluations using program metrics that indicate program effectiveness.

While each program has unique features, most are based on one or more of the following approaches:

- **Educational support of individuals:** As previously discussed, the federal government supports, through grants, scholarships and other financial vehicles, the education of a substantial portion of those who enter the nation's ST&E workforce. Some programs have specific goals associated with increasing the participation of women, minorities and persons with disabilities in fields where participation rates are low.

- **Focusing on key transitions in the education continuum:** Community colleges play a major role in the higher education of minority students. Both the transition from high school to community college and the transition from community college to a four-year college or university are important points in the education of these students. A number of federal agencies offer programs designed to ease the transition from two- to four-year colleges. Other programs address the transition from secondary to higher education. Another important transition is from four-year college to graduate school. The wide variety in available resources and degree programs at undergraduate institutions can create disparities in student background that make this transition difficult.

- **Enhancing institutions:** The federal government has long supported education and research programs at colleges and universities that improve the institutions' ability to conduct research that will realize national goals. Examples include microwave research for national defense, crop protection to improve farm production, and creation of the Internet to expand the ability of researchers to communicate with one another. Historically Black Colleges and Universities, Hispanic Serving Universities and Colleges, Tribal Colleges and Universities and other institutions also benefit from this federal support.

- **Fostering cooperation among institutions, such as partnerships and networks:** Programs that increase the collaboration between two-year and four-year colleges, and between four-year colleges and research universities, to foster attainment of higher degrees are important links in addressing transitions. Examples include partnerships between minority-serving institutions and research universities to enrich the research experiences of staff and students; public-private partnerships of various kinds; and networks or partnerships in a state or region.

- **Rewarding exemplary efforts to increase inclusiveness:** The federal government has a wide variety of programs that recognize and reward efforts to improve diversity. These programs demonstrate the federal government's commitment to ensuring that the nation's talents and resources are fully utilized.

- **Providing workforce opportunities:** Many agencies support co-op programs, summer internships, and summer jobs in their own laboratories and in universities and industrial laboratories. Some agencies sponsor retraining or re-entry programs to "retool" those who have dropped out of research owing to family or other obligations.

- **Increasing diversity within an agency's own scientific and technical workforce:** All agencies have programs designed to ensure equal opportunity for all employees. Most have active diversity initiatives involving greater outreach, networking, and other efforts to increase the pool of qualified candidates from under-represented groups.

- **Encouraging grantees and contractors to promote diversity:** Federal agencies that support R&D at universities, in national laboratories and with industry conduct most of their work through competitive grants and contracts that could include diversity efforts as a criterion. Several agencies have included such provisions in their grant and contract programs.

5
Conclusion and Recommendations for Next Steps

The foregoing analysis describes the importance of the ST&E workforce to the future of the nation and notes some troubling signs that an adequate future ST&E workforce may not be assured. The world is changing, in large part because of rapid advances in science and technology. The economy is shifting from an industrial base to knowledge-based enterprises. Highly educated and skilled workers are increasingly important in this new economy. Other nations are improving their education and training systems, particularly for scientists and engineers. Our nation must take steps to ensure that it is developing the human resources it will need, paying particular attention to seeking out talent in groups currently under-represented in the ST&E workforce.

As a result of past efforts, including those of the research-funding agencies discussed in this report, participation of historically under-represented groups in ST&E education and employment has been increasing. However, progress is slow and gradual. The analysis presented here indicates that it is vital to take more aggressive steps now to tap the full range of talent in our citizenry, thereby reducing future risk stemming from the nation's changing demographics.

The conclusion and recommendations of this report focus on post-secondary education. The nation has taken many steps toward the goal of giving all Americans appropriate backgrounds in science and mathematics by the time they have completed their elementary and secondary schooling—key to enhancing the workforce. Tax credits and education loans greatly increase opportunities for participation in higher education. However, the federal government and private sector must ensure more effective and cooperative use of resources at the post-secondary level to promote the full participation in the ST&E workforce of women, minorities, and persons with disabilities.

Conclusion

- ST&E workers are essential to both the private and public sectors. In the private sector, they help propel the economy and provide valuable services. In the public sector, ST&E workers support important federal missions.

- Based on a tight global ST&E workforce, changing demographics, and projected growth in ST&E-based jobs, it is in the national interest to vigorously pursue the development of domestic ST&E workers from all ethnic and gender groups. We should pay special attention to groups that are currently under-represented in the ST&E workforce, because it is with these groups that much of our nation's growing talent pool resides.

Recommendations

1. **Federal agencies should critically evaluate how the wide range of programs they support (examples can be found in appendix B) can enlarge the ST&E talent pool by encouraging greater participation of all ethnic and gender groups. Particular emphasis should be given to women, minorities, and persons with disabilities who are underrepresented in the ST&E workforce. Consistent with the Government Performance and Results Act, an important criterion for support of these programs should be their effectiveness in promoting a strong 21st century ST&E workforce. Agencies should expand or add programs that effectively overcome barriers such as the transition from one educational level to the next and that address student requirements for financial resources. Where appropriate they should work in concert with the private sector. Federal agencies should commit themselves to incorporating objectives consistent with the language in *Science in the National Interest*: "Every Federal agency's educational programs in science, mathematics, and engineering will have, as one measure of success, its impact on increased participation by underrepresented groups."**[1]

Facilitate Key Transitions in Student Education.

Outreach and recruitment, mentoring programs, counseling and academic support, internships and other practical training, and research experiences are all examples of actions that can ease transitions and facilitate retention. Direct support of students may also be a component of transition-related programming. Many of the current federal programs at the post-secondary level aim at facilitating such transitions. The following range of actions can enhance the effectiveness of these programs:

- Focus attention on enhancing the capabilities of the "point of departure" institutions where size and resources may influence the breadth and depth of programs and, thus, the credentials of students applying for opportunities at higher levels of education.

- Stimulate partnerships among institutions at varying educational levels. Encourage the "receiving" institutions to develop an eye for those with potential, recruiting and nurturing them with appropriate experiences.

- Allocate additional resources to develop an interagency program aimed at facilitating transitions from high school to two- and four-year colleges, from two-year colleges to the workforce and to four-year colleges, from the undergraduate level to the graduate, and from the master's level to the doctoral level. The program should be open to academic institutions or organizations within them, consortia of such institutions, professional organizations, partnerships including K-12 schools, the private sector, federally funded research and development centers (FFRDCs), etc. Rather than constrain the submitting institutions to specific formats, the program should encourage proposers to explore new modes of activity, building, where appropriate, on past successes.

Expand Support for Undergraduate and Graduate S&E Students.

There are many students for whom the greatest hurdle in their effort to obtain a science or engineering education is financial. The federal government, then, should, in cooperation with the private sector, expand the financial resources available to S&E students. Options such as scholarships, fellowships, traineeships, research assistantships, support for research experiences and internships have proven effective in providing incentives to students who pursue a career in S&E disciplines, while also providing them with a good grounding in what it is like to work in these fields. Choices among them should be made on the basis of effectiveness in addressing the needs of the agencies and the segment of the ST&E workforce targeted for enhancement.

2. **Federal agencies should continue to support research on barriers to full participation of under-represented ethnic and gender groups. The federal government should take the lead in fully understanding the dimensions of the ST&E human resources challenge and in raising the results of research to the attention of all stakeholders to promote future action.**

Research areas might include:

- Demographics of the ST&E workforce,
- Differences in training experiences among students from diverse backgrounds,
- Value of diversity in theoretical and applied research as well as in applications of technology,
- Impact of socio-economic and medical/nutritional factors, and
- Identification of barriers to participation specific to various under-represented groups.

Action to overcome barriers might include:

- Enhancing the dialogue on integration of research and education now underway in conjunction with the principles identified in *Renewing the Federal Government-University Research Partnership for the 21st Century*.[35] (It should include dialogue on how the partnership might help to meet ST&E workforce objectives identified in this report.)

- Developing a national dialogue on barriers to participation with private industry, academe, local government, and community leaders, as well as women, minorities, and persons with disabilities. (Information on barriers and on effective practices in addressing such barriers, resulting from these dialogues, should be widely disseminated to the ST&E community and the public and their implementation in suitable situations encouraged.)

3. **Federal agencies should emphasize the recruitment of qualified individuals from ethnic and gender groups who are currently under-represented in the ST&E**

workforce and vigorously pursue professional development opportunities for those already in the federal workforce.

The federal ST&E workforce must serve as a model for the nation by:

- Assessing the effectiveness of the programs already underway, continuing and expanding those that are successful, and phasing out those that are not.

- Emphasizing diversity in recruiting the federal ST&E workforce; and

- Offering robust ST&E professional development opportunities to those already in the federal workforce.

4. **The Federal Government should establish and oversee the maintenance of an Internet site that provides information on ST&E workforce related programs. This should include creating and maintaining a Web-based resource of extant programs, their aims, and their eligibility requirements that is broadly accessible to students and their counselors and mentors.**

Appendix A:
Members of the NSTC Interagency Working Group
On the U.S. Science & Technology Workforce of the Future

DOC
Gordon Fields
Deputy AGC for Administration
U.S. Department of Commerce
14th & Constitution, NW, Room # 5898
Washington, D.C. 20230

DOD
Lance Davis
Deputy Director, Defense Research and Engineering (Laboratory Management)
U.S. Department of Defense
3080 Defense Pentagon, Room 3D129
Washington, D.C. 20301-3080

DOE
Martha Krebs
Director, Office of Science
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

DOE
Bill Valdez
Office of Science
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

DOI/USGS
Marguerite (Margo) Kingston
Special Assistant to Chief Geologist
U.S. Geological Survey, DOI
Mail Stop 954, National Center
Reston, VA 20192

DOJ
Mark Gross
Deputy Chief, Appellate Division
U.S. Department of Justice
P.O. Box 66078
Washington, D.C. 66078

NASA
Jim Gorman
NASA Headquarters
Washington, D.C. 20546

NASA
Doris Wojnarowski
Associate General Counsel for General Law
NASA Headquarters

Washington, D.C. 20546-0001

NIH
Patricia Kvochak
Deputy NIH Legal Advisor
National Institutes of Health
Public Health Division/HHS OGC
Room 2B-50, NIH Building 31
31 Center Drive, MSC 2111
Bethesda, MD 20892-2111

NIH
Harold Slavkin
Director, National Institute of Dental Research
National Institutes of Health
31 Center Drive, MSE-2290
Building 31, Room 2C-39
Bethesda, MD 20892-2290

NSF
Wanda E. Ward
Assistant to the Deputy Director for Human Resource Development
National Science Foundation
4201 Wilson Boulevard, Ste. 1205
Arlington, VA 22230

NSF
Christopher Ashley
Assistant General Counsel
National Science Foundation
4201 Wilson Boulevard, Ste. 1265
Arlington, VA 22230

NSF
Nirmala Kannankutty
Science Resources Analyst
National Science Foundation
4201 Wilson Boulevard, Suite 965
Arlington, VA 22230

USDA
Albert T. Berry
Office of General Counsel
U.S. Department of Agriculture
Room 2321 South Building
Washington, D.C. 20250

USDA
Lois A. Davis
U.S. Department of Agriculture
1400 Independence Avenue, SW
Washington, D.C. 20250-2251

WHCO
Edward Correia
White House Counsel's Office

Room 126, OEOB
The White House
Washington, D.C. 20512

OSTP
Arthur Bienenstock
Associate Director for Science
Office of Science and Technology Policy
Executive Office of the President
Washington, D.C. 20502

OSTP
Bob Marianelli
Science Division
Office of Science and Technology Policy
Executive Office of the President
Washington, D.C. 20502

The members of the IWG would like to particularly thank Mike McGeary, a writing consultant on this project, for all of his hard work.

Note: A number of other individuals also contributed to this report, including: Dr. Jong-On Hahm, Dr. Marilyn Baker, and Dr. Charlotte Kuh, Office of Scientific and Engineering Personnel, National Research Council; Dr. Miriam Foreman with the Department of Physics and Astronomy, State University of New York at Stony Brook; Ronni Denes of the National Action Council for Minorities in Engineering, Inc. (NACME); the entire SRS Division of the National Science Foundation as well as other NSF staff; Dr. Catherine Gaddy, Commission on Professionals in Science and Technology; Doug Braddock and Howard Fullerton of the Bureau of Labor Statistics and too many to mention in OSTP. Bob Marianelli extends his apologies to any that were omitted.

Appendix B:
Examples of Agency Programs that Support the Development of Diversity in the ST&E Workforce

Educational Support of Individuals:

AGENCY-SUPPORTED EXTERNAL PROGRAMS

- NASA WISE program

NASA's WISE (Women in Science and Engineering) program is an undergraduate academic and research program with the goal of increasing the number of highly qualified minority and disadvantaged women in scientific and technical careers. It is an academic program with strong mentoring and research components designed to encourage students to pursue graduate studies and/or advanced degrees. Participants are provided opportunities for research experiences at all NASA Centers, the Jet Propulsion Laboratory, universities, and other federal laboratories.

The effectiveness of this program is evaluated through an annual reporting of outcomes data. Performance measures include student support activities such as: structured early admission program; mentoring; personal and career counseling; discipline-related summer research experiences; and supervised undergraduate research experience. The success of the WISE Scholars Program is evidenced by the 10-year achievements of students in the program.

- EPA WISE program

The goals of EPA's WISE (Women in Science and Engineering) council are: to increase the number of female scientists and engineers at EPA through recruitment and community outreach, to update and expand their skills, to enhance their careers and work environment, and identify barriers to professional advancement and take action to correct inequities that may exist.

WISE, which represents the concerns of all of EPA's women scientists and engineers, and estimates it's constituency to be 36 percent of EPA's scientific and technical workforce, is affiliated with the Interagency Committee for Women In Science and Engineering, that is comprised of representatives of Federal agencies employing scientists and engineers.

- NIH National Research Service Award (NRSA) Program and the Minority Supplements Program

The National Research Service Award (NRSA) Predoctoral Fellowships for Minority Students program supports minority graduate students in doctoral level study. A separate program, the Minority Supplements Program, permits the NIH to make supplemental awards to nearly all its 26,000 research grants for the support of research experience for

minorities at all educational levels (high school through graduate and medical school, as well as faculty).

NIH has administered the NRSA program since 1974 to ensure that the nation has an adequate supply of biomedical and behavioral scientists. Assessments of personnel needs are based on a formal planning process involving analysis and recommendations by a committee of the National Research Council, which reports every few years. [37]

In FY 1996, NIH supported 15,381 NRSA positions. Most were provided through institutional training grants, although some are individual fellowships. Most predoctoral positions were traineeships. The few fellowships were in areas of special need, primarily in the behavioral sciences and health services research. There were more postdoctoral fellowships, but postdoctoral positions were also mostly traineeships (see table).

	Total		Fellows		Trainees	
	Number	%	Number	%	Number	%
Predoctoral NRSA positions	8,520	100%	677	8%	7,843	92%
Postdoctoral NRSA positions	6,861	100%	1,978	29%	4,883	71%

Source: National Institutes of Health.

- USDA Higher Education Multicultural Scholars Program

The Office of Higher Education Programs in the Cooperative State Research, Education, and Extension Service administers the Multicultural Program, begun in 1994. The program is intended to achieve greater diversity in the food and agriculture scientific and professional workforce by improving postsecondary participation and graduation rates of historically under-represented groups.

The program awards competitive grants to colleges and universities that (1) offer bachelor's degree programs in the food and agricultural sciences and (2) have significant minority enrollments or other capacities to increase the diversity of students earning baccalaureates in the food and agricultural sciences. A secondary purpose of the program is to increase workforce diversity within the federal government, especially USDA, and USDA staff endeavor to offer special mentoring opportunities to students in the program.

- NASA Space Grant Program

One objective of NASA's National Space Grant College and Fellowship Program is to recruit and train professionals, including women, disadvantaged minorities and persons with disabilities, for careers in aerospace science and technology. Space Grant was established by Congress to ensure continued U.S. strength in space-related research and education and to capitalize on multiple opportunities afforded by the space environment.

For the period 1991-1996, 9,900 fellowships were awarded, of which 21 percent were to under-represented groups and 38 percent were to women.

- EPA Tribal Lands Environmental Science Scholarship Program

The purpose of the EPA Office of Water, American Indian Environmental Office, Tribal Lands Environmental Science Scholarship Program is to enable Native Americans to work for the environmental protection of tribal lands by assisting students in their pursuit of Environmental Science degrees. Full-time junior, senior, and graduate students with a minimum GPA of 2.5 are eligible to compete for the scholarships. Students must be majoring in an environmental discipline such as chemistry, environmental science, biology, toxicology, environmental economics, chemical engineering, hydrology, biochemistry, or entomology. Students compete based on grade-point average, knowledge of Indian culture, commitment to environmental protection, character and leadership ability, level of study and work experience. EPA works with the American Indian Science and Engineering Society (AISES) to select the scholarship winners.

- DOE Institutes of Biotechnology, Environmental Science and Computing for Community Colleges

This program was created in 1999 by the Office of Science in collaboration with the American Association of Community Colleges to provide special technical research experiences for students traditionally under represented in mathematics, science and other technical fields. Participants spend 10 weeks during the summer in special laboratory-based institutes in professional settings working with scientists who serve as mentors. In its first summer, the program supported 107 students from 48 community colleges in 18 states. Seventy percent of the participants represented demographic groups traditionally under represented in mathematics, science and other technical fields.

- EPA Culturally Diverse Undergraduate Fellowship Program

The purpose of this EPA Office of Research and Development program is to identify promising undergraduate students with an interest in environmental science or engineering and support their last two years of undergraduate study. As part of the two-year program, students must complete an internship at an EPA research facility during the summer between their junior and senior years. Undergraduate students who are enrolled full-time in minority institutions and with two years remaining from the start of the fall term are eligible. Students must have a "B" average overall and major in environmental science, physical sciences, biological sciences, computer sciences, environmental health, mathematics, or engineering. They must be U.S. citizens or lawfully admitted permanent residents. Each award pays the student's full tuition and fees, plus an amount for books and a monthly stipend for each of the two years. In addition, the student receives travel and living expense money for the summer spent on their internship.

AGENCY-SUPPORTED INTERNAL PROGRAMS

- DOI Diversity Intern Program

The Department of the Interior (DOI) strives to increase diversity in its workforce by providing internship opportunities to qualified ethnically diverse and disabled students. Through its Diversity Intern Program, interns work during the fall and spring semesters and summer months for bureaus and offices nationwide.

The Office of Educational Partnerships in Washington, DC, provides project coordination and oversight of the program. Administration of internships is provided by five nonprofit organizations: Haskell Indian Nations University, Hispanic Association of Colleges and Universities, Minority Access, Inc., National Association for Equal Opportunity, and the Student Conservation Association. The nonprofit organizations recruit, screen, and pay a stipend to students from their Native American, Hispanic-Serving, Historically Black, and natural resources/conservation higher education institutions, respectively, to serve internships at DOI sites in the Washington, DC, area and field locations.

The objective of the Diversity Intern Program is to provide professional experience for ethnically diverse students and students with disabilities that will enable them to make educated career choices. A result is the creation of a pipeline of future employees who have had positive, meaningful work experience with the federal government, and who might consider federal service as a serious career choice. Through exposure to research and development, technology, and the government environment, a pool of talented students can explore and understand professional practices.

Since its inception in 1994, the program has been highly successful. The number of students receiving training and work experience has grown, from 16 in 1994 to 146 in 1998. All students have continued their educational programs and earned their degrees. Individual bureaus within DOI track those students who go on to the Student Career Experience Program and are eventually hired.

- DOI: Education's C²OOL website and web database system

Education's C²OOL (Educational, Conservation and Cultural Opportunity Outreach Locator System) is a user-friendly Internet website and web database whose mission is to automate the connection of Department of the Interior (DOI) employees, partners, internship and career candidates throughout the workforce/succession planning systems of DOI its Bureaus and Offices.

A key feature is Education's C^2OOL Register of Diverse Job Seekers/Job Candidates: This feature provides a diverse source of intern and career candidates to augment the hiring needs of DOI Bureaus/Offices. The subsystem includes: an Internet-based resume form for use by job seekers, especially students and graduates interested in Interior internships and career opportunities; and a Register of Diverse Job Seekers/ Job Candidates - Locator Screen, which can query resumes based on various criteria

including academic information such as: major, educational levels achieved through post-graduate school, and state/geographic region of the job seeker/ job candidate. This locator screen is available for use by specialists, supervisors, and managers in the DOI Personnel and Equal Employment Opportunity communities. These DOI Personnel may access this locator screen by requesting a user ID and password from the DOI Office of Educational Partnerships. Education's C^2OOL Register of Diverse Job Seekers/Job Candidates applicant tool satisfies U.S. Office of Personnel Management (OPM) requirements for resume data. The dual-use resume form is appropriate for the job seeker to indicate interest in employment and for the job candidate to be hired.

Focusing on Key Transitions in the Education Continuum:

- NSF Advanced Technology Education Program (ATE)

As work becomes more interdisciplinary and team-oriented, technical education must find a way to educate students more broadly in S&E and in general workplace competencies. One important goal of ATE is to improve curricula and classroom experiences in advanced technological education in secondary schools and two-year institutions, thereby easing the transition from high school to college and from two-year to four-year colleges and universities.

ATE projects also seek to enhance career opportunities for graduates of two-year science and engineering technician programs, and to maintain currency of teachers and faculty in fields that are undergoing rapid technological transformation.

The ATE program, begun in 1994, supports more than 100 projects in 36 states that strengthen science and mathematics preparation at the secondary school and undergraduate levels, especially of technicians being educated for the high-performance workplace of advanced technologies. ATE supports projects in instructional materials and curriculum development; laboratory development and enhancement; faculty and teacher enhancement and preparation; and technical experience for students.

For example, the Maricopa Advanced Technology Education Center focuses on semiconductor manufacturing and related supporting industries. Primary objectives include creating new curricular systems and materials, providing technical support for faculty who prepare students for these technical careers, and increasing the number of students who prepare for and become employed by the semiconductor manufacturing industries.

- Department of Education Tech Prep Program

The Tech Prep Program, created in 1990, supports more than 1,000 consortia that link secondary and postsecondary education programs to promote continued education and acquisition of advanced technical skills. It is designed to help American youth make the transition from school to work, particularly young people who do not attend four-year

colleges. It is funded by a formula grant to the states, which fund consortia of secondary schools and institutions of higher education in a locality.

Tech Prep programs are a formal sequence of study starting in high school and extending through two years of postsecondary occupational education or apprenticeship programs. They culminate in an associate degree or certificate. One of the legislative requirements of a Tech Prep program is equal access for special populations. States are required to give priority consideration to Tech Prep programs that offer effective employment placement; transfer to four-year baccalaureate programs; that are developed in consultation with business, industry, labor, and baccalaureate-granting institutions; and that use outreach and intensive counseling and assessment to address dropout prevention, re-entry, and the needs of special populations.

- NIH Bridges Program

The Bridges Program was created in 1992 to address racial and ethnic under-representation in the biomedical research workforce. It helps students at two-year community colleges make the transition to four-year colleges and students in master's degree programs to make the transition to doctoral programs. The program was initiated after an NIH fact-finding team identified two barriers to increased minority participation in biomedical research careers: the transition from two-year to four-year institutions and from master's to doctoral degree programs.

Bridges has been very successful. For example, 65 percent of the community college students enrolled in the Bridges Program in 1993-1995 have transferred to four-year institutions and 20 percent have graduated from those institutions. Although it does not target minorities, the Bridges program is also successful in assisting under-represented groups achieve bachelor's degrees in S&T higher education, because a large proportion of minority students attend community colleges for financial reasons. The program also supports students making the transition from master's-degree-awarding institutions that have substantial minority enrollment to university doctoral degree programs in science and engineering.

Enhancing Institutions:

- NSF Centers of Research Excellence in Science and Technology (CREST)

NSF's Centers of Research Excellence (CREST) program supports activities in approximately 10 centers. Each center, which may receive up to 10 years of support, serves as a hub for conducting competitive research at the most productive minority institutions of higher education, including those that produce well-trained doctoral students in S&E fields. CREST centers also serve as models for the integration of education and research and engage in interdisciplinary activities.

An example of the program's impact is the establishment of a doctoral program in high-energy physics by Hampton University, a CREST center since 1991, which has now graduated its first three Ph.D.'s.

- NOAA Education Partnership Program with Minority Serving Institutions

NOAA began collaborating with minority serving institutions 25 years ago when NOAA partnered with Jackson State University in Mississippi to create a school of meteorology. It is the only Historically Black College and University with such a school. NOAA also has a 25-year relationship with Savannah State University in Georgia in marine biology and, since 1993, has been helping to develop an earth systems sciences program at Clark Atlanta University, which offers a master's degree in meteorology and earth sciences. The agency has also partnered with the University of Oklahoma where it maintains the National Severe Storms Laboratory, and has ongoing programs with Florida A&M University and the University of Puerto Rico.

NOAA recognizes the fact that minorities are still underrepresented in the atmospheric, environmental and ocean sciences, and that this is reflected in NOAA's scientific personnel. It also recognizes that this deficiency can be redressed most effectively through direct active engagement with educational institutions to train and retrain minorities in these scientific disciplines. Since approximately 40 percent of minorities receive their degrees at minority serving institutions, the agency has focused a $17 million, FY 2001 initiative on working with minority serving institutions to build the necessary capacity and increase the number of graduates in atmospheric, earth and oceanic sciences at these institutions.

- EPA Research Apprenticeship Program for Culturally Diverse High School Students

The EPA Office of Research and Development in Research Triangle Park has negotiated a Cooperative Training Agreement with Shaw University, an HBCU in Raleigh, NC to jointly develop a research apprenticeship program. The purpose of the program is to interest students to seek college and post graduate degrees in the fields of science or engineering. Students are accepted into the program in the summer following the eighth grade and attend classes in science, math, and related subjects at Shaw University on Saturdays during the school year and for six weeks during the summer. During the summers following the 11th and 12th grades, students are apprenticed to EPA scientists and work in EPA's laboratories at Research Triangle Park, NC. The students are paid for their participation in this highly competitive program.

- Interagency Program with Haskell Indian Nations University (USGS, Bureau of Indian Affairs, and EPA)

Haskell Indian Nations University—in partnership with the U.S. Geological Survey, the Bureau of Indian Affairs, and the U.S. Environmental Protection Agency—has developed a Geographic Information Systems (GIS) program on the Haskell campus in Lawrence, Kansas.

The program provides GIS educational opportunities and work experience to Native American/Alaska Native students at Haskell and also provides educational outreach and GIS application support to tribes. The GIS laboratory is an integral component of the natural science program of Haskell's Environmental Research Studies Center. The GIS program increases employment opportunities and provides students with valuable skills that they can take back to their tribes or villages.

USGS is currently also assisting Haskell in developing earth science courses at the University. The primary sources for the concepts and principles conveyed in the course will be a combination of existing earth sciences texts and traditional North American indigenous sources: stories, symbols, ceremonies, and social institutions. Place-based teaching modules in environmental science for tribal homelands are now also being developed in the Great Plains and Northern Rocky Mountains regions as well as in Alaska.

- DOE Minority Technical Education Program

The Minority Technical Education Program (MTEP) supports 8 community colleges, focusing on academically talented students and their pursuit of technical energy-related degrees and careers. The MTEP provides institutional infrastructure support, and community/private sector linkages to ensure successful career placements.

- EPA College Relations Program

The EPA Office of Solid Waste and Emergency Response College Relations Program is a long-term recruitment and educational partnership with the University of Arizona. The program strives to bring qualified and culturally diverse employees into EPA's workforce, particularly into science and engineering positions, cooperative education and other hiring authorities, and a summer internship program supported through training grants. The Cooperative Education agreement enables EPA to recruit students from all ethnic backgrounds to fill positions within the hazardous waste management programs, both in EPA headquarters and the Regions.

The summer internship program, which emphasizes minority students of culturally diverse backgrounds, provides the University of Arizona undergraduate and graduate students with an opportunity to apply their academic training to solving actual hazardous waste management problems. An online link also has been established with the University of Arizona to facilitate the transfer of EPA documents and resource materials to key university faculty to assist in curriculum development and foster the exchange of ideas.

- EPA Culturally Diverse Academic Institutions Traineeship Program

This EPA Office of Research and Development traineeship program supports graduate academic programs in minority institutions and provides educational opportunities for

deserving students who are pursuing graduate degrees in environmental science fields. EPA awards funds competitively to Historically Black Colleges and Universities (HBCUs) and to the American Indian Consortium of Higher Education Institutions.

Funds are awarded to the students according to the policies of the institutions that receive the awards. The largest awards are for master's and doctoral degrees. The master's award provides for tuition and fees for two academic years, plus an amount to support the fellow for a mandatory summer internship. Doctoral awards provide funds for tuition, fees, and stipend for up to three years.

Fostering Cooperation among Institutions:

- NSF Alliances for Minority Participation (AMP)

The AMP program, established in 1991, is a comprehensive multidisciplinary undergraduate program designed to increase substantially the quantity and quality of students that receive baccalaureate degrees in S&E fields, including minority students and others enrolled in science and engineering fields..

AMP encourages the formation of coalitions among leaders throughout academia, government, industry, and other organizations, especially ones that include partners from both two- and four-year higher education institutions, businesses and industries, national research laboratories, and local, state, and federal agencies. Currently, AMP supports 30 alliances of two- and four-year colleges and universities, and is increasing the number of baccalaureate degrees earned by students from under-represented groups in S&E by using the knowledge, resources, and capacities of a broad range of organizations in the higher education, private, and federal sectors. About 210,000 students currently benefit from AMP activities, and more than 18,000 students graduated in 1998 with baccalaureate S&E degrees.

The AMP program is effective. For example, the Florida/Georgia alliance of 12 institutional partners has tripled the production of S&E baccalaureate degrees earned by under-represented minorities in those states—from 416 a year to 1,380 a year. AMP projects typically employ a range of intervention strategies to enhance the academic performance of students, including summer bridge programs, peer study groups, undergraduate research projects directed by faculty, and institutes for graduate school preparation.

- NSF Program for Persons with Disabilities (PWD)

The PWD Program supports efforts to increase participation and achievement of individuals with disabilities in ST&E education and research. Emphasis is given to projects that build alliances between higher education, precollege educational systems, and business and industry to provide continuity for participants from early education through employment in ST&E occupations.

New Mexico State University, for example, has established a laboratory to develop methods for improving access of students with motor and sensory disabilities to ST&E materials and educational technologies. The laboratory supports the training of 20 mentors to assist students with disabilities who are majoring in ST&E fields. This is having a significant impact on recruitment and education of students with disabilities at that university.

- EPA Design for the Environment (DfE) Program

The EPA Office of Prevention, Pesticides, and Toxic Substances Design for the Environment (DfE) program focuses on incorporating pollution prevention and Design for the Environment considerations into the curricula of community colleges, technical schools and tribal colleges. Tribal colleges serve tribal minority groups directly. In addition, the streamlined entrance requirements and flexible scheduling offered at community and technical colleges afford more opportunities for access to higher education for minorities, persons with disabilities, and women. These colleges typically have a more diverse profile than four-year colleges.

The DfE program is entering its third year of cooperation with the Partnership for Environmental Technology (PETE) organization. PETE is a national, non-profit organization established to provide leadership in the field of environmental education and workforce development. PETE has over 650 member schools from the community colleges, technical schools, and tribal colleges across the country. It is successful because of its diverse collaborations and the partnerships it forges. The community college, technical school, and tribal college traditionally place great emphasis on meeting workforce-training needs through the development of career skills. Through its partnership with PETE, the DfE program is able to reach a new, broader audience and to incorporate Pollution Prevention and DfE principles and methodologies into the curricula and training for the future workforce. This aspect of the curriculum in turn provides graduates from these programs with some unique skills that can help them find better positions in the workforce.

Rewarding Exemplary Efforts to Increase Inclusiveness:

- Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring

In 1994, the White House, through the National Science and Technology Council and Office of Science and Technology Policy, established the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. Implemented in 1996, and administered by NSF, the program seeks to identify outstanding mentoring efforts by individuals and institutional programs that are designed to enhance the participation of groups under-represented in science, mathematics, and engineering.

Grant awards and Presidential certificates are presented to (1) individuals who demonstrate outstanding and sustained mentoring and effective guidance to a significant

number of students at the K-12, undergraduate, or graduate level and to (2) institutions with programs that enable substantial numbers of students from groups under-represented in science, mathematics, and engineering to complete ST&E degree programs. Since its establishment in 1996, 40 individuals and 28 institutions have received awards.

Providing Workforce Opportunities:

AGENCY-SUPPORTED EXTERNAL PROGRAMS

- NSF POWRE program

NSF's Professional Opportunities for Women in Research and Education (POWRE) program supports more than 200 women in science and engineering. Established in 1997, POWRE provides support for visiting researchers, research and educational enhancement, and supplements to existing NSF-funded activities that promote academic career advancement of women in ST&E fields. This program (co-sponsored by NIH) helps women who want to re-enter science careers improve their academic standing or advance to tenure track positions.

- NIH Re-entry Program

The NIH Re-entry program focuses on workers who had to withdraw from their careers because of family responsibilities such as caring for children or an ill family member. Supplements to existing research grants provide salary support and some research costs to assist the re-entering scientist in the transition back to the laboratory, under the sponsorship of a mentor. A similar program is the mentored Research Scientist Development Award for more senior re-entering scientists. Under these awards, scientists who have had a hiatus from their research career can apply for support for a period of supervised training to update their skills and knowledge.

AGENCY-SUPPORTED INTERNAL PROGRAMS

- DOI Student Educational Employment Program

The Student Educational Employment Program, an OPM program open to all federal agencies, has been successfully used by the DOI for increasing the S&T workforce. This program provides federal employment opportunities to students who are enrolled or accepted for enrollment as degree-seeking students taking at least a half-time course load in an accredited 2 or 4 year college or university, or graduate or professional school.

The program is composed of the Student Temporary Employment Program (STEP) and the Student Career Experience Program (SCEP). STEP provides maximum flexibility to both students and managers, because the nature of the work does not have to be related to the student's academic or career goals. SCEP, however, provides work experience that is directly related to the student's academic program and career goals. Students in SCEP

may be noncompetitively converted to career federal appointments following completion of their academic and work experience requirements.

At USGS, approximately 800 students have been working under this program each year, nearly all in ST&E positions. This is nearly 8 percent of the total workforce. About 50 percent of SCEP students, and about 10 percent of STEP students are hired as regular employees. Many STEP students progress to the SCEP program and are hired after completion of the program requirements.

- USGS Science Internships for Workforce Diversity

The USGS created a student internship program, Science Internships for Workforce Diversity, over 25 years ago with the objective of providing funding support for students interested in pursuing degrees in the earth sciences and biological sciences. The program has been extremely successful over the years, with almost 2,000 students gaining valuable experience in scientific research and applied investigations throughout the United States. Most of these students continue on to receive a scientific degree. Project managers obtain funding through an annual merit proposal process. Interns receive student appointments with the USGS under the Federal Government's Student Educational Employment Program.

- DOE Technical Leadership Development Program (TLDP)

Begun in 1994 as a centrally managed, three-year technical intern program, the TLDP is producing a large number of diverse candidates with technical backgrounds. The program is designed to nurture the potential of highly competent technical personnel by providing a combination of general and specific technical training activities, management and leadership development activities, and rotational work experiences in a variety of functional programs and program support areas in Headquarters, Field Offices, Laboratories and/or contractor organizations. The TLDP program is now a decentralized program, with interns hired by their employing office at the outset, with specific duties and responsibilities determined by the hiring organization. Recruitment is producing a large number of diverse candidates with technical backgrounds.

Increasing Diversity Within an Agency's Own S&T Workforce:

- Department of Defense Civilian Equal Opportunity (EEO) Programs

DoD employs a large civilian work force, including a large share of the engineers in the federal service. The Department recognizes EEO programs as essential elements of readiness that are vital to meeting the national security mission.

In 1995, the Deputy Secretary of Defense issued an "Action Plan for Civilian Equal Employment Opportunity Progress in the Department of Defense," which had a series of action steps, including incorporation of EEO programs in agency strategic plans; increases in the number and type of executive development programs and better

representation of minorities, women, and persons with disabilities in those programs; special efforts to ensure equal opportunity in filling higher level civil service and Senior Executive Service (SES) positions; and development of a comprehensive DoD-wide plan to implement executive orders regarding Historically Black Colleges and Universities, Hispanic Serving Universities and Colleges, Tribal Colleges and Universities and other minority institutions.

DoD agencies are required to establish special emphasis programs for African-Americans, Hispanics, Asian/Pacific Islanders, and Native Americans/Alaska Natives in recognition of the unique employment situations each group has experienced. For example, DoD's Hispanic employment program manager is developing a partnership agreement with the Hispanic Association of Colleges and Universities to identify student and faculty employment opportunities within DoD and to develop mutually beneficial research and grant funding possibilities.

These efforts to increase the number of minorities in the workforce have been successful, and include programs specifically designed to bring more minorities and women into engineering positions. DoD reduced its civilian workforce by 33 percent between September 1989 and December 1998. The number of engineers declined by 39 percent during that period. The minority percentage of the workforce stayed about the same, 27 percent in 1998 compared with 26 percent in 1989. The percentage of minorities in high-grade civilian positions (GS-13 through GS-15 and SES) increased. The percentage of minorities in engineering positions increased from 15.8 percent in 1989 to 19.4 percent in 1998.

- DOE Fossil Energy Hispanic Internship Program

This program is an element of the DOE Fossil Energy's Headquarters' implementation of the Department of Energy's Hispanic Outreach Initiative. Key elements of the Program include:

- candidates from colleges and universities all over the U.S. are eligible;
- minimum grade point average requirement of 2.8;
- candidates must be U.S. citizens;
- students are required to perform a specific technical assignment;
- students report on their assignment at the end of the term as part of the Fossil Energy Hispanic Internship Program Technical Forum;
- a week of Leadership Training.

Encouraging Grantees and Contractors to Promote Diversity:

- NSF Merit Review Criteria

NSF recently revised its merit review criteria, which are used to identify and fund the most meritorious research proposals. The two new criteria are:

- What is the intellectual merit of the proposed activity?
- What are the broader impacts of the proposed activity?

Under the second criterion proposers are asked to address how well the activity addresses the participation of underrepresented groups, among other issues related to broader impacts. In addition, all NSF program announcements encourage principal investigators to provide reviewers with information necessary to respond fully to both of the criteria, with specific attention to integrating diversity into NSF programs, projects, and activities.

- DOE Contractual "Diversity Clause"

DOE has implemented a Final Rule amending the Department of Energy Acquisition Regulation on November 28, 1997. This creates a corporate diversity policy that requires major contractors to develop and meet diversity performance goals as part of their normal business operations. To ensure uniform implementation of this policy in its management and operating contracts, DOE adopted a diversity contract clause to be included in major facilities management contracts awarded after December 28, 1997.

This rule was first piloted during contract negotiations in 1996 with the University of California over the management and operation of Los Alamos National Laboratory in New Mexico. The University agreed to contract provisions designed to improve diversity in subcontracting, workforce hiring, educational outreach, economic development, and civic participation. During the two years since the contract was finalized, the University has tracked a significant increase in minority subcontracting, hiring and educational programs.

With the adoption of the diversity clause in 1997, major contractors must now submit a diversity plan within 90 days after award of a new major facilities management plan that focuses on workforce planning, educational outreach, subcontracting practices, community involvement, and economic development. The plan must be updated annually thereafter. Compliance and performance of the plans is assessed as part of the contractor's annual performance.

Note: This Appendix is not intended to be all-inclusive, either in terms of agencies or programs. Individual agencies should be contacted for information on programs that may not be included and for more complete information on those that are.

Figure References

Figure 2-1. Source: Resident population of the United States: *U.S. Bureau of the Census, Resident Population Estimates of the United States, by Sex, Race, and Hispanic Origin: April 1, 1990 to July 1, 1999*. On-line at: www.census.gov/population/estimates/nation/intfile3-1.txt

Earned Bachelor's Degrees in S&E: Figures are for 1996 and for U.S. citizens and permanent residents only. Total includes persons with unknown race/ethnicity. *NSF/SRS, Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-1996*. NSF 99-332. Tables 4, 5, 6.

S&E Graduate School Enrollment: Figures are for U.S. citizens and permanent residents only. Total includes persons with unknown race/ethnicity. NSF/SRS, *Graduate Students and Postdoctorates in Science and Engineering: Fall 1997*. NSF 99-325. Tables 27, 28, and 29.

S&E Labor Force: Includes scientists and engineers currently employed in S&E occupations, or unemployed scientists and engineers whose last job was an S&E occupation. Scientists and engineers include all persons who have ever received a bachelor's degree or higher in a science or engineering field, plus persons with a non-S&E bachelor's degree or higher employed in an S&E occupation during the 1993, 1995, and/or 1997 SESTAT surveys. NSF/SRS, *1997 SESTAT (Scientists and Engineers Statistical Data System).*

Figure 3-1. Source: Day, Jennifer Cheeseman, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*, U.S. Bureau of the Census, Current Population Reports, P25-1130, U.S. Government Printing Office, Washington, DC. The middle series projections were used. The workforce was taken as the group, ages 18 – 64 years. Data for those ages 18 and older and those ages 65 and older were used to derive the numbers for the group with ages 18 – 64 years. The U.S. Bureau of the Census Population Projections Program produces projections of the United States resident population by age, sex, race, and Hispanic origin. The projections are based on assumptions about future births, deaths, and international migration. Although several alternative series are produced, the preferred, or middle series—based on the assumption that past and current trends will continue—is most commonly used and is the one used here.

Figure 3-2. Source: Day, Jennifer Cheeseman, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*, U.S. Bureau of the Census, Current Population Reports, p25-1130, U.S. Government Printing Office, Washington, DC; and National Science Foundation. *Women, Minorities, and Persons With Disabilities in Science and Engineering*: 1998. Arlington, VA, 1999. (NSF 99-338). S&E in the workforce for 1995 are from Table 5-22 in NSF 99-338.

Figure 3-3. Source: For 1977-1991, National Science Foundation, *Science and Engineering Degrees, by Race/Ethnicity: 1977-91*, NSF 94-306, Tables 1, 2, and 3. For 1993-1997, National Science Foundation, Division of Science Resources Studies, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-97*, NSF 00-311, Author, Susan T. Hill (Arlington, VA 2000), Tables 4, 5, 6 and 31. All years include engineering technology degrees, and totals include those with unknown race/ethnicity.

Notes

[1] National Science and Technology Council, *Science in the National Interest*", August 3, 1994.
[2] See for example the report from the workshop held in July 1998 that helped establish the basis for this report: IWG workforce workshop proceedings publication, National Science and Technology Council, Committee on Science, Interagency Working Group on the U.S. Science and Technology Workforce of the Future, The U.S. Science, Engineering and Technology Workforce of the Future: National Strategy, National Portfolio, National Resource Base (NSF99-132).
[3] NSB 98-1. Arlington, VA: National Science Foundation, 1998:Fig. 6- National Science Board, *Science & Engineering Indicators—1998.*
[4] National Center on the Educational Quality of the Workforce, "The Other Shoe: Education's Contribution to the Productivity of Establishments." University of Pennsylvania, Philadelphia, PA, 1995.
[5] George T. Silvestri, Occupational employment projections to 2008, *Monthly Labor Review* (November 1999): 51-77.
[6] Jennifer C. Day, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995-2050*. Bureau of the Census, Current Population Reports, P25-1130, 1996. The middle series projections were used. Data for those ages 18 and older and those ages 65 and older were used to derive the numbers for the group, ages 18 – 64 years. The U.S. Bureau of the Census Population Projections Program produces projections of the United States resident population by age, sex, race, and Hispanic origin. The projections are based on assumptions about future births, deaths, and international migration. Although several alternative series are produced, the preferred, or middle series—based on the assumption that past and current trends will continue—is most commonly used and is the one used herein.
[7] Data are from the SESTAT Integrated Database, Division of Science Resources Studies, NSF. SESTAT, which contains information about the employment, educational, and demographic characteristics of scientists and engineers in the United States, is on-line at: <srsstats.sbe.nsf.gov/>. Counted are federal employees with a bachelor's degree or higher who are working as scientists or engineers (most have S&E degrees). Those with S&E degrees—bachelor's, master's, or doctorates—who are in non-ST&E jobs are not included.
[8] National Science Foundation, *Federal Scientists and Engineers: 1989-93*, NSF 95-336. Arlington, VA: National Science Foundation, 1995:Table B-1.
[9] National Science Foundation, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-1996*. NSF 99-332. Arlington, VA: National Science Foundation, 1999.
[10] National Science Foundation, *Science and Engineering Degrees, by Race/Ethnicity: 1997*, Early Release Tables, Table 4, 5, 6, and 31.
[11] "Bill and Melinda Gates Pledge $1-Billion for Minority Scholarships." The grant will finance 1,000 new awards annually for the next 20 years, *The Chronicle of Higher Education*, Seattle, September 24, 1999.
[12] National Science Foundation, *Science and Engineering Degrees, by Race/Ethnicity: 1977-91*, NSF 94-306, Tables 1, 2, and 3. For 1993-1995, National Science Foundation, *Science and Engineering Degrees, by Race/Ethnicity: 1997*, Early Release Tables, Table 4, 5, 6, and 31. All years include engineering technology degrees, and totals include those with unknown race/ethnicity.
[13] William A. Wulf, "Diversity in Engineering," *The Bridge*, Volume 28, Number 4 (Winter 1998): 8-13.
[14] Joel C. Cantor, EL Miles, LC Baker, and CD Barker, "Physician service to the underserved: Implications for affirmative action in medical education," *Inquiry*, 33 (1996):167-180; Miriam Komaromy, Kevin Grumbach, Karen Vranizan, Nicole Lurie, Dennis Keane, Andrew B. Bindman, "The role of black and Hispanic physicians in providing health care for underserved populations," *New England Journal of Medicine*, 334 (20) (1996): 1305-1320, E Moy, BA Bartman, "Physician race and care of minority and

medically indigent patients," *Journal of the American Medical Association*, 273(19) (1995): 1515-1520.
[15] The research is summarized in Taylor Cox, Jr., *Cultural Diversity in Organizations: Theory, Research & Practice*. San Francisco, CA: Berrett-Koehler, 1993.
[16] For a recent review, see Jeffrey F. Milem, The educational benefits of diversity: Evidence from multiple sectors, in *Compelling Interest: Examining the Evidence on Racial Dynamics in Higher Education*, edited by Mitchell Chang, Daria Witt, James Jones, and Kenji Hakuta. A report of the American Educational Research Association Panel on Racial Dynamics in Colleges and Universities. Palo Alto, CA: Stanford University Center for Comparative Studies in Race and Ethnicity, 1999.
[17] Rosabeth Moss Kanter, *The Change Masters: Innovation and Entrepreneurship in the American Corporation*. NY: Simon & Schuster, 1983.
[18] Jean M. Johnson, Alan Rapoport, and Mark Regets, "U.S. doctoral education: Overview and international comparisons," paper presented at NSF Workshop on Graduate Education Reform in Asia, Europe, and Latin America and International Mobility of Scientists and Engineers, November 17, 1998.
[19] Organization for Economic Cooperation and Development, *Education at a Glance: OECD Indicators 1998*.
[20] Dennis Normile, "New Incentives Lure Chinese Talent Back Home." *Science*, Vol. 287, 1/21/2000, pp. 417 – 418.
[21] National Science Foundation, *Human Resources for Science and Technology: The Asian Region*, NSF 93-303. Arlington, VA: National Science Foundation, 1993.
[22] National Science Board, *Science & Engineering Indicators—1998*, NSB 98-1. Arlington, VA: National Science Foundation, 1998:p. 2-31.
[23] National Science Foundation, *Statistical Profiles of Foreign Doctoral Recipients in Science and Engineering: Plans to Stay in the United States*. NSF 99-304. November. Arlington, VA: National Science Foundation, 1998.
[24] These are all undergraduates, not just S&E majors. This analysis is based on tables provided by the University of California Washington office. The recent data for fall 2000 are from the UC web site at: http://www.ucop.edu/ucophome/uwnews/
[25] Claudia Sandlin, The negative effects of affirmative action showing in medical school enrollments, says AAMC, *Washington Fax*, November 2, 1998.
[26] National Science Foundation, "Graduate Enrollment in Science and Engineering Continued to Decline in 1998," Data Brief, December 15, 1999. Available on line at: .http://www.nsf.gov/sbe/srs/databrf/db00307.htm
[27] American Association for the Advancement of Science, *Losing Ground: Science and Engineering Graduate Education of Black and Hispanic Americans*. AAAS, 1998.
[28] Dan Carnevale, "Enrollment of Minority Freshmen Nears Pre-Hopwood Levels at U. of Texas at Austin," *The Chronicle of Higher Education*, September 3 1999.
[29] Patrick Healy, "U. of California to Admit Top 4% From Every High School," *The Chronicle of Higher Education*, April 2, 1999.
[30] Jeffrey Selingo, "Florida Plan to End Racial Preferences in Admissions Attracts Attention -- and Criticism," *The Chronicle of Higher Education*, November 26, 1999.
[31] "President Clinton Issues a Call to Action for Corporate Diversity", The White House, Office of the Press Secretary, April 6, 2000.
[32] Leo Reisberg, "SAT scoring gap widens along gender, geographic, and racial lines," *The Chronicle of Higher Education*, September 11, 1998.
[33] Scott Carlson, "College Board Reports Little Change in Average SAT Scores," *The Chronicle of Higher Education*, September 10, 1999.
[34] William G. Bowen and Derek Bok, The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions. Princeton, NJ: Princeton University Press, 1998:106-110.
[35] National Science and Technology Council, *Renewing the Federal Government-University Partnership for the 21st Century*. Washington, DC: Executive Office of the President, April 1999.
[36] Full-time students in doctorate-granting institutions. National Science Foundation, *Graduate Students and Postdoctorates in Science and Engineering: Fall 1997*. Early Release Tables. Available at: <www.nsf.gov/sbe/srs/srs99405/start.htm>.

[37] National Research Council, *Meeting the Nation's Needs for Biomedical and Behavioral Scientists*. Washington, DC: National Academy Press, 1994.