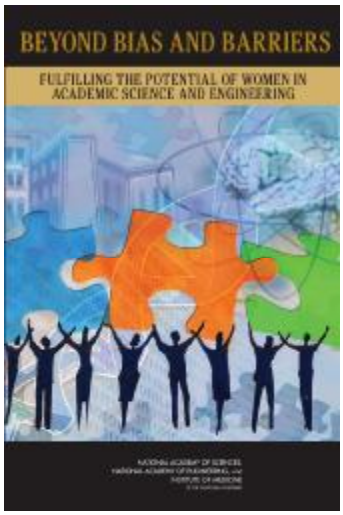
THE NATIONAL ACADEMIES
REPORT IN BRIEF



BEYOND BIAS AND BARRIERS
FULFILLING THE POTENTIAL OF WOMEN IN ACADEMIC SCIENCE AND ENGINEERING
(2006)

Over the last 30 years, women have made great progress in science and engineering. The number and proportion of women obtaining science and engineering degrees have increased dramatically. In the life sciences, women now outnumber men in both undergraduate and graduate programs. They earn one-third of the PhDs granted by the 50 leading departments in chemistry, mathematics, and statistics, and one-fourth in physics and astronomy. In the top 50 engineering departments, women earn one-sixth of degrees and one-fourth of the PhDs in chemical engineering.

What happens after women earn their science and engineering degrees is another story. Women constitute about half of the total workforce in the United States but make up only one-fifth of the nation's scientific and technical workers. Women are also a small portion of the science and engineering faculty members at research universities, and they typically receive fewer resources and less support than their male colleagues. The representation of women in leadership positions in academic institutions, scientific and professional societies, and honorary organizations is low relative to the number of women qualified to hold these positions.

It is not lack of talent, but unintentional biases and outdated institutional structures that are hindering the advancement of women. For women to participate to their full potential across all science and engineering fields, they must be part of a career path that allows them to reach their full intellectual potential. Much remains to be done to achieve that goal. This report provides a synthesis of existing research to examine the implicit and explicit obstacles to educational and academic career advancement of women scientists and engineers, and the effects of race and sex in academic science and engineering careers.

BARRIERS TO SUCCESS

Representation of women in science and engineering drops substantially with each step up the academic ladder, from high school on through full professorships. As they move from high school to college, more women than men who have expressed an interest in science or engineering decide to major in something else; in the transition to graduate school, more women than men with science and engineering degrees opt into other fields of study; and there are proportionately fewer women than men in the applicant pool for tenure-track positions. In examining the transition into academic positions, the declines are greatest in fields requiring a period of postdoctoral study, such as the life sciences, chemistry, and mathematics. The situation is even worse for minority-group women in science and engineering. Subject to dual discrimination, they are virtually absent from the nation's leading science and engineering departments. Doctorates in this group are less likely to be in tenure position than men of any racial group or white women.

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CURRENT KNOWLEDGE

Women have the ability and drive to succeed in science and engineering. Studies of brain structure and function, hormonal modulation of performance, human cognitive development, and human evolution have not found any significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women in academic faculty and scientific leadership positions.

Scientists and engineers who are women or members of racial or ethnic minority groups must function in environments that favor the men who have traditionally dominated the fields. Well-qualified and highly productive women scientists have had to contend with questioning of their abilities in science and mathematics and their commitment to an academic career. As a result, women have not received the opportunities and encouragement provided to their male counterparts to develop their interests and abilities to the fullest. Table 2 presents evidence refuting commonly held beliefs about women in science and engineering discussed in detail in the report.

TABLE 2 Evidence Refuting Commonly Held Beliefs About Women in Science and Engineering

Belief	Evidence
(1) Women are not as good in mathematics as men.	**Female performance in high school mathematics now matches that of males.**
(2) The matter of "under-representation" on faculties is only a matter of time; it is a function of how many women are qualified to enter these positions.	**Women's representation decreases with each step up the tenure-track and academic leadership hierarchy, even in fields that have had a large proportion of women doctorates for 30 years.**
(3) Women are not as competitive as men. Women don't want jobs in academe.	**Similar proportions of men and women science and engineering doctorates plan to enter postdoctoral study or academic employment.**
(4) Behavioral research is qualitative; why pay attention to the data in this report?	**The data are from multiple sources, were obtained using well-recognized techniques, and have been replicated in several settings.**
(5) Women and minorities are recipients of favoritism through affirmative-action programs.	**Affirmative action is meant to broaden searches to include more women and minority-group members, but not to select candidates on the basis of race or sex, which is illegal.**
(6) Academe is a meritocracy.	**Although scientists like to believe that they "choose the best" based on objective criteria, decisions are influenced by factors—including biases about race, sex, geographic location of a university, and age—that have nothing to do with the quality of the person or work being evaluated.**
(7) Changing the rules means that standards of excellence will be deleteriously affected.	**Throughout a scientific career, advancement depends upon judgments of one's performance by more senior scientists and engineers. This process does not optimally select and advance the best scientists and engineers, because of implicit bias and disproportionate weighting of qualities that are stereotypically male. Reducing these sources of bias will foster excellence in science and engineering fields.**
(8) Women faculty are less productive than men.	**The publication productivity of women science and engineering faculty has increased over the last 30 years and is now comparable to men's. The critical factor affecting publication productivity is access to institutional resources; marriage, children, and eldercare responsibilities have minimal effects.**
(9) Women are more interested in family than in careers.	**Many women scientists and engineers persist in their pursuit of academic careers despite severe conflicts between their roles as parents and as scientists and engineers. These efforts, however, are often not recognized as representing the high level of dedication to their careers they represent.**
(10) Women take more time off due to childbearing, so they are a bad investment.	**On the average, women take more time off during their early careers to meet their caregiving responsibilities, which fall disproportionately to women. But, by middle age, a man is likely to take more sick leave than a woman.**
(11) The system as currently configured has worked well in producing great science; why change it?	**The global competitive balance has changed in ways that undermine America's traditional S&E advantages. Career impediments based on gender or racial or ethnic bias deprive the nation of talented and accomplished researchers**

SOURCES OF THE PROBLEM

The barriers that women face in science and engineering careers are due to implicit biases, certain organizational structures and rules, and employee evaluation criteria that contain arbitrary and subjective components. Decades of cognitive psychology research reveals that most men and women are unknowingly prejudiced; this plays a large role in evaluating others and their work. On average, people are less likely to hire a woman than a man with identical qualifications; are less likely to give credit to a woman than to a man for identical accomplishments; and, when information is scarce, will far more often give the benefit of the doubt to a man than to a woman. Even in science and engineering, measures of success are often applied in a biased manner. Characteristics that are believed to relate to scientific creativity—assertiveness and single-mindedness—are given greater weight than other characteristics such as flexibility, diplomacy, curiosity, motivation, and dedication, which may be more vital to success in science and engineering. At the same time, assertiveness and single-mindedness are socially unacceptable traits for women.

In addition, academic organizational structures and rules contribute significantly to the underuse of women in science and engineering. Rules that appear quite neutral may function in a way that leads to differential treatment or produces different outcomes for men and women. For example, it is often assumed that faculty members have substantial spousal support at home to ensure their success in the field. However, the majority of faculty no longer have such support. About 90 percent of the spouses of women science and engineering faculty are employed full-time; close to half the spouses of male faculty also work full-time.

A CALL TO ACTION

Career barriers for women deprive the nation of an important source of talented and accomplished scientists and engineers who could contribute to the nation's competitiveness. Transforming institutional structures and procedures to eliminate gender bias is a major national task that will require strong leadership and continuous attention, evaluation, and accountability. The following recommendations are large-scale and interdependent, requiring the interaction of university leaders and faculties, scientific and professional societies, funding agencies, federal agencies, and Congress. If implemented and coordinated across educational, professional, and government sectors, the following recommendations will transform institutions, improve the working environment for women and men, and profoundly enhance the nation's talent pool.

- **Trustees, university presidents, and provosts** should provide clear leadership in changing the culture and structure of their institutions to recruit, retain, and promote women—including minority women—into faculty and leadership positions.
- **Deans and department chairs and their tenured faculty** should take responsibility for creating a productive environment and immediately implement programs and strategies shown to be successful in minimizing the effect of biases in recruiting, hiring, promotion, and tenure.
- **University leaders should work with their faculties and department chairs** to examine evaluation practices to focus on the quality of contributions and their impact.
- **Professional societies and higher education organizations** have a responsibility to play a leading role in promoting equal treatment of women and men and to demonstrate a commitment to it in their practices.
- **Federal funding agencies and foundations** should ensure that their practices—including rules and regulations—support the full participation of women and do not reinforce a culture that fundamentally discriminates against women.
- **Federal agencies** should lay out clear guidelines, leverage their resources, and rigorously enforce existing laws to increase the science and engineering talent developed in this country.
- **Congress** should take steps necessary to encourage adequate enforcement of antidiscrimination laws, including regular oversight hearings to investigate the enforcement activities of the Department of Education, Equal Employment Opportunity Commission, Department of Labor, and science granting agencies—including National Institutes of Health, National Science Foundation, Department of Defense, Department of Agriculture, Department of Energy, National Institute of Standards and Technology, and National Aeronautics and Space Administration.

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For More Information

Copies of *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* are available from the National Academy Press (NAP); (800) 624-6242 or (202) 334-3313, or visit the NAP website at www.nap.edu. For more information on the program, contact staff at (202) 334-2915 or visit the Policy and Global Affairs website at www.nationalacademies.org/pga.