



Literature Overview: The Talent Crisis in Science and Engineering



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There is a talent crisis in science and engineering that constrains America's economic productivity, competitiveness, quality of life, and security (Committee on Prospering in the Global Economy of the 21st Century, 2006; National Academy of Engineering, 2005; National Academy of Engineering, 2004; National Science Board, 2003; NSB, 2004; Council on Competitiveness, 2004; Building Engineering and Science Talent, 2004b; BEST, 2005). Our educational system is not producing the workforce – in numbers of people, skills, or diversity – we need to continue a position of international leadership in innovation and technology. Technology is key to our growth: “as much as 85% of measured growth in U.S. income per capita was due to technological change” (Committee on Prospering in the Global Economy of the 21st Century, 2006, p. 1). A recent National Academies report recommends significant new investment and initiatives to produce more K-12 science and mathematics teachers and to increase the number and proportion of U.S. citizens who earn bachelor's degrees in S&E (Committee on Prospering in the Global Economy of the 21st Century, 2006). Improvement in science and mathematics teaching is needed not only to increase the number of students aiming for the S&E workforce, but also to improve science literacy as our society enters an era of greater complexity.

Reliance on Foreign Talent

Our reliance on imported talent is high and increasing. The special H1-B visa program opened opportunity for foreign professionals with high-demand skills at the rate of 115,000 per year starting in 2000, increased to 195,000 per year for 2001 to 2003 (Committee on Prospering in the Global Economy of the 21st Century, 2006). Recently Homeland Security measures slowed the entry of foreign students. The National Academy of Engineering recommends that we ease the entry of more international students through improved visa processing and preferential visas for doctoral-level students (Committee on Prospering in the Global Economy of the 21st Century, 2006). In 2005, students on temporary visas earned more than a third (36%) of all S&E doctorates awarded. Of the Ph.D. engineering, mathematics, computers sciences, physics, and economics graduates from U.S. colleges and universities – the pool for our future faculty – over 50% are foreign students. The supply of foreign students is likely to diminish as they find increased opportunity in their home countries, rising U.S. tuition, competition for students from other countries, and difficulties in obtaining U.S. visas. Although most international students plan to stay in the U.S., the numbers of those who plan to stay are dropping, particularly in computer sciences and engineering, as they choose to return to work in their native countries (National Science Board, 2008).

National Productivity Comparisons

In other countries, the graduation rate in S&E is increasing. Where the U.S. is producing S&E undergraduates at the rate of 15% of all undergraduates, South Korea is at 38%, France is at 47%, China at 50%, and Singapore 67%. China and India have doubled their rate of production of graduating engineers and computer scientists, more than twice the rate of the U.S. (Committee on Prospering in the Global Economy of the 21st Century, 2006). The European Commission established a special group to monitor the status of women in science, and the issue is prominent in the EU's strategic plans for investment in science, engineering, and technology (The European Union, 2008).

U.S. graduate programs are not able to recruit and graduate American students to meet the demand. There were almost twice as many physics college degrees awarded in 1956, the last graduating class before Sputnik, as there were in 2004 (Committee on Prospering in the Global Economy of the 21st Century, 2006). The number of degrees in computer science decreased in 2005. Undergraduate enrollment in engineering is declining (National Science Board, 2008).

Tapping Local Talent

The need for greater diversity in higher education and in the S&E workforce is widely recognized (U.S. Government Accountability Office, 2004; Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development, 2000; Building Engineering and Science Talent, 2004b). Given the trends in demographics in the U.S. and the globalization of commerce and communication, the U.S. can no longer depend on one segment of the population – white males – to populate the workforce domain on which our prosperity and competitiveness depend. In many top departments in science and engineering, the faculty does not reflect the diversity of graduating Ph.D. students, showing a failure to encourage, recruit, hire, and support women and minorities entering critical fields (Nelson & Rogers, 2005). The lack of diversity in the faculty is one of several barriers to new students, because it signals that a field is exclusive and possibly discriminatory (Nelson, 2007; Jaschik, 2009; Hanson, 2008). University students and faculty recruitment pools are increasingly more diverse, thanks to increased opportunity, but universities are behind in addressing the lack of diversity in the S&E faculty.

Participation of Women - Status

Large segments of our population are not participating fully in science and engineering, though they could be available to fill the talent gap. Women comprise 43.5% of the workforce with a degree (in 2006), but they are only 26% of people in S&E occupations with a degree (NSB, 2008, Table H-5). Participation in S&E varies by field of occupation. Women were 46% of social scientists (with degrees in 2006), but only 28% of physical scientists, 26% of computer scientists, and 11.5% of engineers (NSB, 2008, Table H-5).

Women are seeking college degrees in greater numbers than men are – a phenomenal and controversial trend given their status at the beginning of the 20th Century. Women have outnumbered men in undergraduate education since 1982 and earned 58% of all bachelor's degrees in 2006 (NSB, 2008, Figure C-1). Despite increased enrollments of women in many fields, their college graduate rate in computer science was 20.5% in 2006, with percentages in engineering at 19.5% and physics 20.7% (NSB, 2008, Table C-5).

Diversity Among Women

The demographic designation “women” tends to disguise groups that have special challenges due to race, ethnicity, disability, socio-economic status, religion, and immigration status. Only recently have more studies addressed populations that included multiple sub-groups, and/or disaggregated their data and their analyses by sub-group. Even fewer studies concentrate on them. Research on “minorities,” and even “Hispanics” also needs to be more specific and explicit about which segment of the population is addressed. There are different patterns in the educational paths of African-American men and women, Hispanic men and women, Native Americans, persons with disabilities, members of conservative religious groups, and their participation in S&E careers.

Demographic data (2006) shows that Blacks are 11.1% of the adult population, Hispanics 12.3%, and Native Americans 1.7% (NSB, 2008, Figure A-1). Their rates of participation S&E fields clearly lag, showing potential for recruitment. For example, Blacks in the S&E workforce with degrees were at 3.9% in 2008. Hispanics in the S&E workforce with degrees were at 4.5%. Native Americans were at .4% (NSB, 2008, Table H-6).

Minority degrees in critical fields are also lagging and show potential. Again, Blacks who are at 11.1% of the population (2006) are earning 4.7% of B.A. degrees in engineering (2006) and 10.8% of degrees in computer science. Hispanics, at 12.3% of the population (2006) are earning 7.2% of engineering B.A.'s and 6.7% of computer science B.A.'s in 2006. Native Americans who are 1.7% of the population (2006) are earning .5% of the B.A.'s in engineering and .5% of the B.A.'s in computer science in 2006. Minority faculty are severely under-represented in the top 100 S&E departments (Nelson & Rogers, 2005), a sign that there are still barriers to success at top departments, indirectly discouraging students.

Why The Continuing Gap?

Why hasn't the United States succeeded in tapping under-utilized populations for the sake of competitiveness and prosperity? There are a number of reasons: tradition, discrimination, work/family pressures, narrow and inaccurate images of S&E professions, inadequate educational preparation, and weak legal or moral pressure to change educational practice.

Tradition and Stereotypes

Tradition has many people still believing that men and women are innately different in intellectual capacity; that women belong in nurturing roles; that when women work, they should stick to low-investment (and low-paying) jobs that involve serving people. The arguments used against giving women the vote and giving girls access to sports are similar to those used against sending women into technical fields – they don't want it, they can't, and they belong elsewhere (Sommers, 2008).

Unconscious assumptions about gender – called gender schemata – are formed from birth on and lead us to over-rate men and under-rate women even when they are the same on objective measures. We expect men to be independent and reasoned while women are expected to be cooperative, expressive, and caring (Valian, 1998). These assumptions can lead to unequal treatment in small ways – lack of encouragement, lack of access to certain opportunities, redirection away from certain classes, slightly worse grades, weak recommendations, etc. Small disadvantages accrue and can explain imbalances and gaps over time, especially at higher levels of advancement (Martell, Lane & Emrich, 1996). Negative stereotypes can play a role in differential performance on tests. The stereotyped group with heightened awareness of an alleged "deficiency" may fulfill that prophecy by obtaining lower scores on standardized tests like the national SATs (Steele & Aronson, 1995). Sex differences in quantitative skills emerge after elementary school, partly due to stereotypes (Steele et al., 2007).

A common view is that women are not interested in careers, especially professional careers that require long preparation and demanding work pressures. Yet women are graduating from medical school at a rate approaching parity (47%) (Association of American Medical Colleges, 2006). Women are earning more than half of law degrees (American Bar Association Commission on Women in the Profession, 2005). Another analysis is that women are intellectually not interested in the physical sciences, because the courses are "hard," yet since 1985 women have nearly closed the gaps in environmental sciences, agricultural sciences, chemistry, and mathematics (National Science Board, 2008).

Another view is that girls and women are inherently less capable in mathematics, which is a necessary skill in preparing for a career in many S&E fields. There were persistent gender gaps in performance on national tests for decades after the tests came into use and they confirmed this belief. However, the gaps have gradually closed over time. Recently a study found no gender differences in math performance (Hyde et al., 2008). Factors other than alleged innate ability are behind differentials in interest and performance, such as parental support and expectations, engaging teachers, positive experiences, and self-confidence (University of Wisconsin-Milwaukee, 2008). In looking for reasons behind gender gaps, researchers may have been exaggerating differences. A study of 46 meta-analyses looking at research on psychological differences shows that males and females are similar on most psychological variables. Differences have been overinflated (Hyde, 2005).

The Compounding Effects of Other Factors

Many of the findings about the role of tradition and stereotypes about women are implicitly about “all women,” disguising or not raising differences due to race, ethnicity, disability, socio-economic status, religion, and immigration status. The “double bind” for minority women in science is the subject of many studies (for example, Malcom, 1976; Hanson, 2008). Findings from research particularly addressing under-represented minorities are available (George, Neale, Horne & Malcom, 2001). A recent study, for example, found that Black and Hispanic students enter college as interested in majoring in S&E fields as whites, but they run into problems that reduce their numbers (Schmidt, 2006; Anderson & Kim, 2006). Low expectations and race discrimination in particular have negative consequences for African American girls (Hanson, 2008). African American girls in general have more positive attitudes about science than African American boys (Hanson, 2008). Only a few sources both quantify and analyze racial and ethnic gaps as they intersect with gender, for example, differences between African American males and females, and Hispanic males and females (U.S. Department of Education, National Center for Education Statistics, 2000).

Discrimination

There is evidence of bias and discrimination in general and in the academic workplace in particular. The Harvard Implicit Bias Project has a Web site demonstrating to anyone that most of us are unconsciously biased, much to our own surprise (Harvard University, 2007). In a study of the peer review system of the Swedish Medical Research Council for post-doctoral fellowships, female applicants needed more credentials than men to get the same competence rating from reviewers (Wenneras & Wold, 1997). A study of the influence of gender in the review of curricula vitae for faculty found that both men and women favored male job applicants. One study took actual curricula vitae, created male and female versions, and sent them for review as candidates for faculty positions. It found that both men and women preferred male job applicants (Steinpreis, Anders & Ritzke, 1999). Another study compared letters of recommendation for medical faculty candidates and found that the letters differed “systematically” in preference toward men, in terms of length, “doubt-raising” language, and references to status (Trix & Psenka, 2003). There are still accounts of blatant discrimination in the news, for example, an advisor refusing to write a letter of recommendation after a postdoc student in particle physics got pregnant (Mason, 2008).

Work/Family Pressures

An academic career in science and engineering is expected to be a full, intensive commitment especially until a beginning faculty member reaches tenure. The period of intense career demands coincides with optimal childbearing years. Very few institutions have made allowances for maternity or paternity leave, flexible or reduced hours, or delaying the tenure clock. The conflict is not unique to the domain of science and engineering, but it is complicated by the academic pattern of fierce competition for tenure, and often,

the need to conduct lab experiments that are especially labor intensive. One of the greatest frustrations experienced by women faculty in S&E is the conflict with family life (Rosser & Daniels, 2004). A common solution for improving the retention of female faculty is to provide relief from the traditional tenure process (NSF, 2007). The work of raising a family represents the equivalent of an uncompromising part-time job that burdens the woman in the family at least twice as much as the man (Bujaki & McKeen, 1998). Family care is stereotyped as women's work (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). Parents now try to spend more time with their children and to provide more stimulation and enrichment than ever before. Research argues for the value of early enrichment for children, setting a high standard for optimal parenting (Heckman, 2006). Our work culture does not make many allowances for more time at home. In terms of family-friendly policies in the workplace, the United States lags far behind all other wealthy countries ("U.S. workplace not family-oriented," 2007).

Women's expectations that they will work and have careers have risen dramatically and rapidly, as shown by rates of college enrollment (over 55%), BA attainment (52%), professional degrees (36%), and Ph.D.'s (32%) (U.S. Department of Education, 2006, Table 9). Women with degrees are more likely to work (Coontz, 2007). Opportunities for professional advancement have opened more positions, more kinds of positions, and higher positions (Catalyst, 2007). Early in the 20th Century, women who wanted a career renounced motherhood. A later generation entered the job market and then quit to raise a family. In the 1950s, women raised families first and then got jobs, but most professions were closed to them later in life. Among the boomer generation, fully half of women who attained a career by midlife were childless. Employers of high-achieving women are dismayed when they "opt-out" and leave behind an investment in expensive professional training, experience, and good jobs in order to care for children. There are signs that the conflict is a taboo subject in professional life, and there is a perceived stigma to taking advantage of family-friendly benefits even when they are offered (Crittenden, 2001).

Image of S&E Professions

Portrayals of scientists in the media unfortunately present an image of a scientist in a lab coat performing tedious, repetitive tasks. Stereotypes about STEM professionals discourage students at a time in middle school and high school when students should take courses to prepare for advanced study. The need for social marketing aimed at positive images was recognized in *The land of plenty*, a national report on the talent crisis (Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development, 2000). A recent market study determined the best messaging to promote engineering as a career (National Academy of Engineering, 2008).

Educational Preparation

Having an adequate foundation in mathematics and basic science is another barrier to recruiting all students to advanced study and eventually careers, not just those from underrepresented groups. Ubiquitous access to quality courses and teachers is a challenge in our national educational system (Committee on Prospering in the Global Economy of the 21st Century, 2006).

Legal and Moral Incentives

A number of laws forbid discrimination that impedes the participation of women in S&E. Most prominent is the Civil Rights Act of 1964 that outlawed racial segregation in schools and employment discrimination on the basis of race, color, religion, sex, or national origin. Title IX of the Educational Amendments of 1972 outlawed discrimination on the basis of sex in any educational program receiving Federal funding. The Perkins Act of 1978 addressed women's lack of access to vocational training. Finally, the Equal Opportunities for Women and Minorities in Science and Technology Act of 1981 mandated that the National

Science Foundation report statistics on underrepresented groups and initiate a suite of programs to increase diversity in the science and engineering workforce. To this day, NSF is the only R&D science agency with this mandate.

The Equal Opportunities Act of 1981 led to sustained action on the part of the National Science Foundation, including the frequent publication of national authoritative statistics that are unique in the world; programs that have resulted in increased diversity and knowledge of root causes through research; and knowledge of model educational practices. The value on outreach to underrepresented groups and society is embedded in every request for funding and in every review of those requests. The National Science Board continually revisits progress and issues special reports. A legislatively-mandated standing Committee on Equal Opportunity in Science and Engineering rotates national leaders for continual oversight (National Science Foundation CEOSE, 2008).

For over thirty years, Title IX was applied primarily to increase girls' access to sports and to address sexual harassment, although the law does not mention either explicitly. Its impact on sports is a great civil rights success story having tremendous positive benefits for American society (National Collegiate Athletic Association, 2005). Some (Musil, 2007) think it boosted the entry of women into higher education. Recently the application of the law to science and engineering education, especially higher education, became a policy cause. Because the science agencies are providing billions of dollars in Federal funding to universities, the argument is that the universities should be held accountable for progress toward the inclusion of women, and that the agencies should take more action (Rolison, 2000; Wyden, 2002; Zare, 2006). The Government Accountability Office was mandated to report on the issue (U.S. GAO, 2004), which triggered publicity and Congressional hearings. A new policy report, *Beyond bias and barriers*, fleshed out what we know about the status of women in S&E, research, and educational strategies to improve the situation. The report also endorsed a new national entity to follow up (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). In 2007, legislation was introduced to implement many of the recommendations, under the name Gender Bias Elimination Act of 2007 (U.S. House of Representatives, 2007). It remains to be seen whether the momentum (which built over seven years) yields results. It has yielded greater understanding, national discussion, and an awareness of the potential for legal pressure – pressure from funding agencies and from individual lawsuits.

Solutions Are Available & Benefits Demonstrated

The S&E departments in many universities have shown that change is possible and feasible. Their success is documented in dozens of national reports and academic publications as "promising," "proven," or "best" practices. There is no shortage of specific recommendations for action, some repeated over decades of commissions and task forces on women in science and engineering or diversity (BEST, 2004a; Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). For example, MIT had a task force that found they had low numbers of women and minorities on the faculty, and patterns of bias that persisted for decades (Massachusetts Institute of Technology, 1999). During those same decades, MIT and other top institutions were graduating qualified Ph.D.'s among the neglected groups. At the same time, reports, research, and helpful guidance on diversity proliferated. Recent action plans such as those formulated at Harvard University provide excellent, current summaries of options for revising structural barriers that make working conditions better for all faculty and particularly for women (Harvard University, 2005).

For example, three case studies of physics departments yielded a set of characteristics that produce a high percentage of female graduates in physics (Whitten, 2003; Whitten, 2004; Whitten, 2007). A case study of a successful industrial engineering department found similar characteristics (Harris et al, 2004).

- Faculty support structure
 - More women on the faculty
 - Family-friendly policies, addressing child care, family leave, and the “two-body” (e.g. hiring of couples) problem
 - A tolerant atmosphere (no sexist remarks, invited speakers include females)
 - Good team work
 - Support for junior faculty, especially in the first year
- Recruiting and outreach
 - An inviting departmental Web site
 - Community presence at science fairs, summer programs, school visits
 - Department and admissions office work together
 - Offer bridge programs
- Role of alumni and alumnae
 - Department maintains relationships with former students
 - Use alums to illustrate career options
 - Highlight alum accomplishments
 - Invite alums to talk about role models and career awareness
- Departmental culture
 - Students have an active role in maintaining supports for others
 - Strong sense of community
- Introductory courses and early course experience
 - Courses are interactive
 - Value for and use of team work
 - Courses include learning the culture of the profession
 - Offer special math skills development, such as 3-D spatial skills
 - Courses convey applications of the field to the environment and social issues
 - Students participate in research with faculty
 - Safe labs
- Student care
 - Mentoring for four years
 - Student lounge
 - Tutorial service
 - Lab assistants
 - Seminars on career aspects
 - Club and social activities

Among the best recent work on promising practices are the model packages for practitioners by the National Center for Women in Information Technology, for example, Outreach-in-a-Box: Discovering IT; Survey-in-a-Box: Student Experience of the Major; Mentoring-in-a-Box: Technical Women at Work, Mentoring-in-a-Box: Academic Women in Computing; International Women’s Day-in-a-Box: Raising Awareness; and Computer-Science-in-a-Box: Unplug Your Curriculum (NCWIT, 2008). NSF’s ADVANCE funding program created a network of universities experienced with introducing a wide range of

improvements for faculty, including a rich information portal. The portal collates strategies used, lessons learned, toolkits for surveys and metrics, and dozens of papers on experience. It offers sample policies and detailed descriptions of actual initiatives organized by problem area (e.g., institutional change, faculty development, and work life). There are links to other major Web sites that cover related material such as research literature (Virginia Tech, 2008).

There is a growing literature on interventions for minority students. A number of programs have risen to prominence for proven effectiveness, such as the Meyerhoff Scholarship Program at the University of Maryland, Baltimore County. A national dialog is taking place through a series of conferences titled "Understanding Interventions That Encourage Minorities to Pursue Research Careers" (DePass & Chubin, 2009).

The research evidence for the benefits of diversity for learning was extensively documented in the form of *amici curiae* briefs in support of the University of Michigan, in 2003, which was challenged for giving minority students preference in two programs (University of Michigan, 2003). There are many studies that describe inefficient and wasteful student programs that need attention (e.g., Boylan, 2004). The drop-out rate for women in engineering after the first year of study is twice that for men (Adelman, 1998). The ultimate goal behind the push for diversity is to improve education, particularly education in science and engineering in order to produce more graduates. Many of the improvements recommended in order to attract and retain more female and minority students will improve the experience for all students.

Measures of Change

Measures are available that allow us to characterize and monitor the status of women in society generally, and in S&E professions specifically. The United Nations has worked to adopt and refine measures related to discrimination and inequity, recognizing that the status of women is key to economic development. A Gender Development Index measures, by country, disparities in longevity (life expectancy at birth), knowledge (adult literacy rate and educational enrollments), and standard of living (GDP per capita). Following conferences in 1994 and 1995, a Gender Empowerment Measure was introduced. It calibrates economic participation, political participation, and power over economic resources (UN Economic Commission for Europe, 2007).

In the U.S., the Department of Labor's Bureau of Labor Statistics provides Occupational Employment Statistics. These show the distribution of women across more than 400 job categories, with information about wages by sex. The National Alliance for Partnerships in Equity has tracked this data for the analysis of "traditional" versus "non-traditional" jobs for women (NAPE, 2007), showing extreme differences in employment opportunities afforded women.

The National Science Foundation publishes *Science and engineering indicators* biennially, and a more detailed volume *Women, minorities and persons with disabilities* (NSF Division of Science Resources Statistics, 2007). The reports give authoritative statistics on enrollments in higher education by field at the undergraduate and graduate levels, disaggregated by race/ethnicity, disability status, and sex, as well as employment in science and engineering.

The most detailed statistics on education at the K-12 level are available from the National Center for Education Statistics. Indicators on learning with breakdowns by race/ethnicity and gender are given in the publication of national statistics, for example, the National Assessment of Education Progress (NAEP). Also, special publications such as *Trends in educational equity of girls & women: 2004* assemble a series

of indicators that examine the extent to which males and females have access to the same educational opportunities, avail themselves equally of these opportunities, perform at similar levels throughout schooling, succeed at similar rates, and reap the same benefits from their educational experiences (U.S. Department of Education, National Center for Education Statistics, 2004). It shows, for example, the rates of enrollment in Advanced Placement courses, and compares median scores on national mathematics and science tests.

The Commission on Professionals in Science and Technology (CPST) monitors national statistics on human resources in science, engineering, and technology. CPST regularly publishes *Professional women and minorities*, which is a detailed reference book of data presented in over 300 tables with breakouts by sex and minority status. *Professional women and minorities* is widely regarded as an authoritative source of data and trends in science and technology. Data on enrollments, degrees, and the general, academic, and federal workforce by field and subfield are included. It has been published biennially for nearly three decades (CPST, 2007).

A special project looked at the top fifty research departments in universities in science and engineering. It compared statistics on graduation rates by sex and race/ethnicity and with profiles of the faculty (Nelson & Rogers, 2005; Beutel & Nelson, 2005). Comparing these two datasets showed that leading departments were not hiring women and minorities at nearly the rate as they were graduating. It also showed that less than 15% of full professors in top research departments are women or non-Whites. In the fields of biological sciences, psychology, and social sciences, women were up to 15% of the faculty, but they were much lower in physical sciences and engineering. In addition, Blacks and Hispanics made up 4.1% of faculty, with female Blacks and Hispanics at only 1%.

The American Association of University Professors looked at four indicators for “faculty gender equity” across all fields in higher education, not just science and engineering (AAUP, 2006):

1. Employment status (are women employed as faculty full-time tenure-track or other?)
2. Tenure status (non-tenure track, tenure-track, tenured by type of institution)
3. Full professor rank (percentage of women by type of institution)
4. Average salary (salaries by rank and across all academic ranks)

The National Science Foundation’s ADVANCE program (NSF, 2007) funded a number of institutions with the aim of institutional transformation in advancing female faculty. A number of projects have developed very detailed measurements to quantify progress. One evaluation report (De Cohen & Clewell, 2006) listed the following data measures used by many ADVANCE projects:

- Faculty in science and engineering by gender
- Faculty in tenured/tenure-track positions by gender and rank
- Faculty in non-tenure-track positions by gender and rank
- Faculty in administrative positions by gender
- Faculty in endowed/named chairs/professorships by gender
- Faculty on promotion and tenure committees by gender
- Tenure promotion outcomes (baseline and during grant) by gender
- Years in rank by gender
- Time at institution and differential attrition by gender

- Salaries of scientists and engineers (faculty) by gender (with controls)
- Space allocation by gender (with controls)
- Start-up packages of newly hired S&E faculty by gender (with controls)

Summary

We know that women and minorities want to join the S&E workforce. Since 1980 the share of S&E occupations for blacks has doubled, and more than doubled for women and Hispanics (National Science Board, 2008). Women's share of doctoral degrees in S&E overall is near parity (46% in 2005). Two frontiers are prominent: greater recruitment to engineering and computer science education, and employment and advancement through faculty ranks in most fields. Because of the tenure system and slow faculty turnover due to later retirements, the opportunity for change is limited, and it can take decades to change both minds and numbers (Hopkins, 2006).

Further research and action to solve the talent crisis must continue on a number of fronts that have been identified for a long time:

1. Improve the image of professions in science and engineering to raise awareness of their richness, appeal, and social contributions, in order to attract students.
2. Make everyone – the public, parents, counselors, teachers, faculty, and employers aware of stereotypes and biases that operate to limit opportunities to recruit talent.
3. Change educational practices – courses, social environments, pedagogy, admissions policies – to attract and retain a wider spectrum of students, and improve basic early preparation for S&E careers.
4. Review and improve faculty recruitment and advancement processes and conditions of work to increase diversity, thereby demonstrating that S&E fields are indeed open to all.
5. Identify and address the particular needs of groups based on race, ethnicity, disability, socio-economic status, religion, and immigration status, to better recruit them to S&E.
6. Make educators aware of the foundations and support for targeted programs in the law and in national policy.
7. Make our investments in targeted programs count by assessing their effectiveness, and make effective programs widely known.

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