Advancing Diversity in the US Industrial Science and Engineering Workforce: Summary of a Workshop

DETAILS

80 pages | 8.5 x 11 | HARDBACK
ISBN 978-0-309-38655-5 | DOI 10.17226/13512

CONTRIBUTORS

Rita S. Guenther and Catherine J. Didion, Rapporteurs; National Academy of Engineering

Advancing Diversity in the US Industrial Science and Engineering Workforce

SUMMARY OF A WORKSHOP

Rita S. Guenther and Catherine J. Didion, *Rapporteurs*

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street NW Washington, DC 20001

This project was supported by the Northrop Grumman Corporation. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations that provided support for the project.

International Standard Book Number 13: 978-0-309-26505-8
International Standard Book Number 10: 0-309-26505-3

Additional copies of this report are available from the National Academies Press, 500 Fifth Street NW, Keck 360, Washington, DC 20055; (800) 624-6242; Internet, www.nap.edu

Printed in the United States of America.

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

www.national-academies.org

COMMITTEE ON CAPITALIZING ON THE DIVERSITY OF THE SCIENCE AND ENGINEERING WORKFORCE IN INDUSTRY

AMY E. ALVING, *Co-Chair*, Member, Board of Directors, Fannie Mae, and former Chief Technology Officer & Senior Vice President, Science Applications International Corporation

ANN L. LEE (NAE)*, *Co-Chair*, Vice President, Process Development, Genentech, Inc.

RODNEY C. ADKINS (NAE), Senior Vice President, Corporate Strategy, International Business Machines Corporation

ROBERT P. CASILLAS, Vice President, Strategic Global Health & Security, MRIGlobal

CELESTE A. CLARK, Consultant, Abraham Clark Consulting, LLC, and Board of Directors, W.K. Kellogg Foundation

RICHARD B. FREEMAN, Herbert Ascherman Professor of Economics, Harvard University, and Faculty Co-Director, Labor and Worklife Program, Harvard Law School

MAURICIO FUTRAN (NAE), Vice President, Process and Advanced Analytics, Johnson & Johnson

LUENY MORELL, Provost and Chief Academic Officer, New Engineering University, and Program Manager (ret.), Strategy Team, Hewlett Packard Laboratories

RICHARD D. STEPHENS, Senior Vice President (ret.), Human Resources and Administration, The Boeing Company

HERMAN B. WHITE, JR., Senior Scientist, Fermi National Accelerator Laboratory

STAFF

PROCTOR REID, Director, Program Office, NAE
CATHERINE DIDION, Senior Program Officer, NAE
RITA S. GUENTHER, Program Officer, Policy & Global Affairs, NRC
CAMERON H. FLETCHER, Senior Editor, NAE
SARA FRUEH, Communications Writer, NRC
WEI JING, Research Associate, NAE and Policy & Global Affairs, NRC

*Member of the National Academy of Engineering (NAE).

PREFACE AND ACKNOWLEDGMENTS

Over the past several decades, two intertwining trends have caused academic, industrial, and political leaders to think carefully, creatively, and critically about the future of the scientific, engineering, and technical workforce in the United States. The first of these trends is the increasingly dynamic pace of change in the global economy in which the United States must compete. Second, the human resource base of the United States is increasingly demographically diverse. In order to not only compete but also succeed in the global economy, the nation must make better use of the scientific and technical talent in its diverse population. At the nexus of these trends are thousands of gifted individuals, including women and underrepresented minorities, who remain a disproportionally small fraction of those in science, technology, engineering, and math (STEM) careers.

According to the National Science Foundation (NSF), of the 19 million people trained or working in STEM and related fields or occupations, 53 percent, or 10.2 million, worked in industry in 2008.[1] Industry, as the largest employer category of those with STEM backgrounds, stands to benefit considerably from greater inclusion of women and underrepresented minorities in the workforce.[2] However, significant challenges remain in recruiting, retaining, and advancing these valuable employees. Given these global and national trends, nothing short of a game-changing environment must be created to harness the talent of those not fully represented in the STEM workforce.

The effort, of which this workshop summary is a part, began with the 2007 National Academies report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*[3] and continued with the 2011 National Academies' report *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*.[4] This workshop, entitled "Creating a Game-Changing Environment for All in the Industrial Workforce," was envisioned as a continuation of these efforts, focusing on the needs and challenges facing industry in particular, and it is intended to facilitate further discussion and actions to address these complex issues.

Convened on May 21, 2012, by the National Academy of Engineering in Washington, DC, the workshop provided a forum for leaders from industry, academia, and professional associations to share best practices and innovative approaches to recruiting, retaining, and

---

[1] "Diversity in Science and Engineering Employment in Industry." Presentation by Jaquelina C. Falkenheim. Creating a Game-Changing Environment for All in the Industrial Workforce: A Workshop, May 21, 2012, at the National Academies, Washington, DC.

[2] See Appendix F: Jaquelina C. Falkenheim and Joan S. Burrelli. 2012. "Diversity in Science and Engineering Employment in Industry." InfoBrief. Arlington, VA: National Science Foundation/National Center for Science and Engineering Statistics. Available at www.nsf.gov/statistics/infbrief/nsf12311/ (accessed on February 8, 2013).

[3] Institute of Medicine, National Academy of Sciences, and National Academy of Engineering. 2007. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington: National Academies Press.

[4] Institute of Medicine, National Academy of Sciences, and National Academy of Engineering. 2011. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads.* Washington: National Academies Press.

advancing women and underrepresented minorities in the scientific and engineering workforce throughout the nation's industries.

The presentations and discussions at the workshop considered some of the most recently available NSF data on women and underrepresented minorities in scientific and engineering fields in industry and identified gaps in the data. The workshop also provided an opportunity for open and frank discussion among participants representing a spectrum of perspectives, although not all aspects of the Statement of Task for the workshop (Appendix A) could be thoroughly addressed due to time constraints. Further, as stated, the aim of the workshop was to produce new and innovative solutions to address this problem. Workshop participants offered many ideas, but more work clearly needs to be done on this subject to fully reach a "game-changing environment." One opportunity for additional work would be to obtain more detail on industry practices; industry executives at the workshop shared their experiences in varying levels of detail, as this summary reflects.

The purpose of the discussion was not to achieve consensus but rather to bring to the fore innovative ideas and creative approaches. Consistent with this goal, a list of literature and resources made available to workshop participants is included in this report (Appendix G). This summary was prepared by the rapporteurs as a factual summary of the workshop presentations and discussions.

This report has been reviewed in draft form by persons chosen for their diverse perspectives and scientific expertise in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for quality and objectivity. The review comments and draft manuscript remain confidential to protect the integrity of the process. We thank the following individuals for their review of the report:

Cathleen Barton, Intel Corporation
Melissa Carl, American Society of Mechanical Engineers
Roger Humphreville, BP America, Inc.
Robin Jeffries, Google, Inc. (retired)
Saundra Johnson Austin, National Action Council for Minorities in Engineering, Inc.
Caroline Simard, School of Medicine, Stanford University

Although the reviewers listed provided many constructive comments and suggestions, they were not asked to endorse the content of the report, nor did they see the final draft before its release. The review of the report was coordinated by Greg Pearson, senior program officer at NAE, and was overseen by Elisabeth M. Drake (NAE member), researcher emerita for Massachusetts Institute of Technology Energy Initiative. Appointed by NAE, the monitor was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors and the institution. This material is based on work supported by Northrop Grumman Corporation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Northrop Grumman Corporation or the National Academy of Engineering.

CONTENTS

1. Where Are Scientists and Engineers Working Today? Data from the National Science Foundation **1**
Diversity in Science and Engineering Employment in Industry 1
Discussion of Data and Suggestions for Future Research 11

2. Harnessing Experience to Improve Opportunities: Best Practices and Innovative Ideas **14**
Professional Associations, Organizations, Affinity Groups, and Industry Programs 14
Discussion of Best Practices in Attracting, Retaining, and Advancing S&E Employees in Industry 17

3. Changing the Game: Key Themes and Suggested Actions **23**
Ensuring a Growing Pool of Women and Underrepresented Minority Scientists and Engineers 23
Recruiting, Retaining, and Advancing Women and Underrepresented Minority Scientists and Engineers 24
Better Understanding the Challenge Through Additional Data and Research 25

APPENDIXES

A Statement of Task **27**

B Questions for Discussion **28**

C Workshop Agenda **30**

D Biographies of Speakers **32**

E Speakers and Participants **36**

F National Science Foundation Info Brief – Diversity in Science and Engineering Employment in Industry **39**

G List of Selected Literature **48**

1

Where Are Scientists and Engineers Working Today? Data from the National Science Foundation

DIVERSITY IN SCIENCE AND ENGINEERING EMPLOYMENT IN INDUSTRY

Efforts to maximize the recruitment, retention, and advancement of women and underrepresented minorities (URMs)[1] in industries that have a large science and engineering (S&E) component require better understanding of where scientists and engineers are working today. Based on a congressional mandate, the National Science Foundation's (NSF) National Center for Science and Engineering Statistics (NCSES) collects and distributes a wide range of data relevant to policy in a policy-neutral manner.

Jaquelina C. Falkenheim, senior analyst at NSF, opened the workshop with a detailed review of the most recent data on "sex, racial/ethnic, and disability characteristics of scientists and engineers employed in industry, including breakouts by highest educational degree, occupation, primary and secondary work activity, and management occupations,"[2] defining scientists and engineers as those who either are trained in or work in S&E or S&E-related fields or occupations (Table 1.1).

In 2008, Falkenheim explained, 19 million scientists and engineers were employed in the United States, of which 4.9 million were employed in S&E occupations, 5.5 million in S&E-related occupations, and 8.8 million with S&E-related degrees were employed in non-S&E occupations (Figure 1.1). About 53 percent (10.2 million) of these 19 million scientists and engineers were employed in industry. NSF defines industry as including private, for-profit noneducational institutions; persons who are self-employed and incorporated; and other for-profit noneducational employers.[3]

---

[1] URM is an acronym for underrepresented minorities. The National Science Foundation, in the fields of science, engineering, mathematics, and technology (STEM), includes African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, other Pacific Islanders, and individuals reporting more than one race in this definition.

[2] Her presentation drew from Jaquelina C. Falkenheim and Joan S. Burrelli. 2012. "Diversity in Science and Engineering Employment in Industry." InfoBrief. Arlington, VA: National Science Foundation/National Center for Science and Engineering Statistics. Available at www.nsf.gov/statistics/infbrief/nsf12311/ (accessed May 16, 2014). Quoted material, p. 1.

[3] See Appendix F: Jaquelina C. Falkenheim and Joan S. Burrelli. 2012. "Diversity in Science and Engineering Employment in Industry." InfoBrief. Arlington, VA: National Science Foundation/National Center for Science and Engineering Statistics. Available at www.nsf.gov/statistics/infbrief/nsf12311/ (accessed February 8, 2013).

Table 1.1 NSF Classification of Science and Engineering (S&E), S&E-related, and Non-S&E Degree Fields and Occupations.

Classification	Degree Fields	Occupations
S&E	Biological, agricultural, and environmental life sciences; Computer and mathematical sciences; Physical sciences; Social sciences; and Engineering	Biological, agricultural, and environmental life scientists; Computer and mathematical scientists; Physical scientists; Social scientists; Engineers; and S&E postsecondary teachers
S&E-related	Health fields; Science and math teacher education; Technology and technical fields; Architecture; and Actuarial science	Health-related occupations; S&E managers; S&E precollege teachers; S&E technicians and technologists; Architects; Actuaries; and S&E-related postsecondary teachers
Non-S&E	Management and administration; Education (except science and math teacher education); Social services and related fields; Sales and marketing; Arts and humanities; and Other fields	Non-S&E managers; Management-related; Non-S&E precollege teachers; Non-S&E postsecondary teachers; Social services; Sales and marketing; Arts and humanities; and Others.

SOURCE: *Science and Engineering Indicators 2012,* Table 3-2.

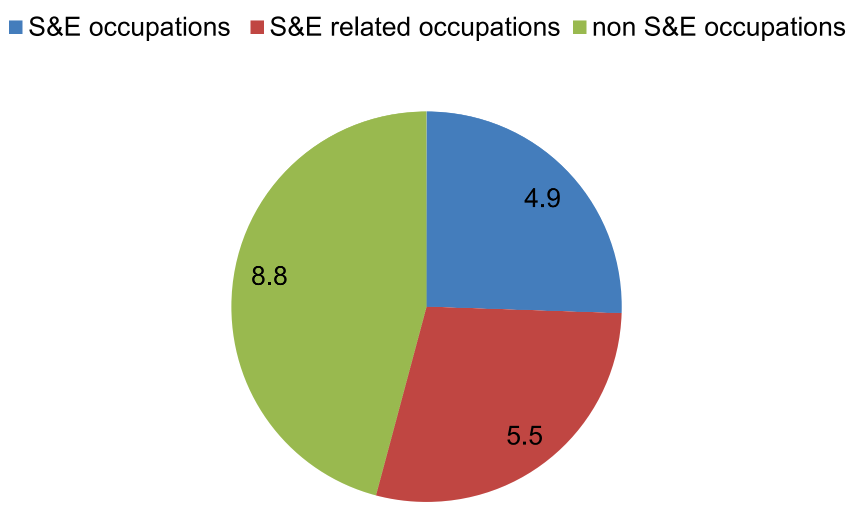


FIGURE 1.1 Number of Scientists and Engineers Employed in S&E Occupations, S&E-related Occupations, and Non-S&E Occupations (in millions), 2008.
SOURCE: National Science Foundation (NSF)/National Center for Science and Engineering Statistics (NCSES), SESTAT 2008.[4]

[4] SESTAT is the NSF Scientists and Engineers Statistical Data System. This integrated data system is a unique source of longitudinal information on the education and employment of the college-educated US science and engineering workforce. These data are collected through three biennial surveys: (1) the National Survey of College Graduates (NSCG); (2) the National Survey of Recent College Graduates (NSRCG); and (3) the Survey of Doctorate Recipients (SDR). The 2008 data were the most recent available at the time of the workshop.

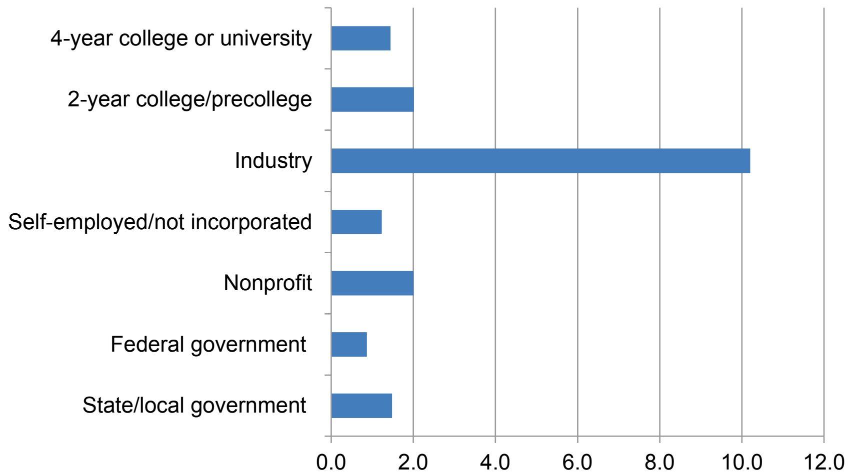


FIGURE 1.2 Employed Scientists and Engineers by Sector of Employment (millions), 2008.
SOURCE: NSF/NCSES, SESTAT 2008.

Figure 1.2 illustrates the fields, in addition to industry, in which scientists and engineers work. Drilling down further, Falkenheim reported on scientists and engineers by sex and race/ethnicity (Figure 1.3). Of the 10.2 million scientists and engineers employed in industry in 2008, 50 percent were white men and 25 percent white women; Asian men and women accounted for 8 percent and 5 percent, respectively, and URM men and women 6 percent and 4 percent. The 2008 data show that in both the industrial and total S&E workforce, compared to the total US population broken down by sex, men are disproportionally represented (Figure 1.4).[5]

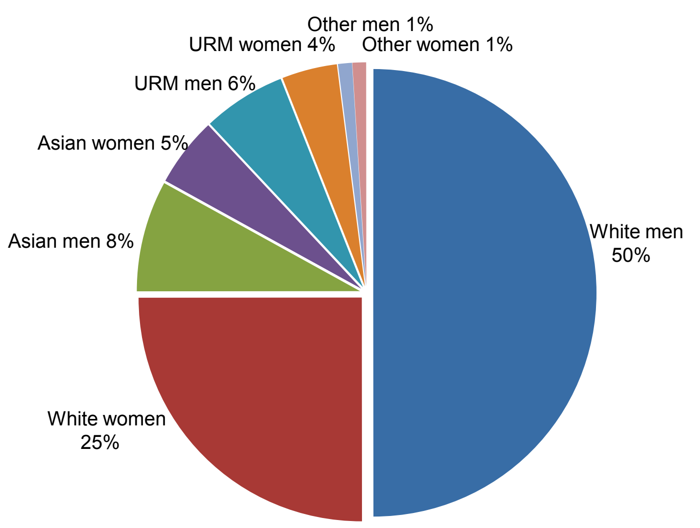


FIGURE 1.3 Scientists and Engineers Employed in Industry by Sex and Race/Ethnicity in 2008.
NOTE: URM = underrepresented minority (Hispanics, blacks or African Americans, and American Indians/Alaska Natives); Other = Native Hawaiians or other Pacific Islanders and individuals reporting more than one race.
SOURCE: NSF/NCSES, SESTAT 2008.

[5] As a point of clarification, Falkenheim noted that for the purposes of the data collected, "functional disabilities" were recorded. The number of respondents with disabilities is small, and they tend to be older people whose disabilities appear over time rather than those who enter their careers with functional disabilities.

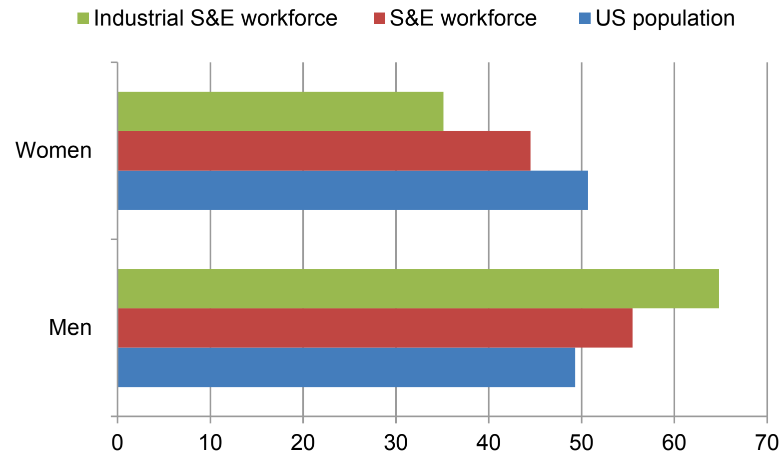


FIGURE 1.4 Percentage of the Science and Engineering (S&E) Workforce by Sex, 2008.
SOURCES: Women, Minorities, and Persons with Disabilities in Science and Engineering (www.nsf.gov/statistics/wmpd, accessed September 1, 2012); and NSF/NCSES, SESTAT 2008.

The breakdown of the S&E workforce by race/ethnicity (Figure 1.5) shows that whites are overrepresented in comparison to the total US population, as are Asians. In contrast, certain groups are significantly underrepresented in the S&E workforce: black or African American men and women each accounted for 2 percent, Hispanic men 3 percent and women 2 percent, and American Indian men 0.2 percent and women 0.1 percent. Thus, although African Americans, Hispanics, and American Indians constitute more than a quarter of the total US population, they account for only about 10.8 percent of the S&E workforce and 10.4 percent of the S&E industrial workforce.

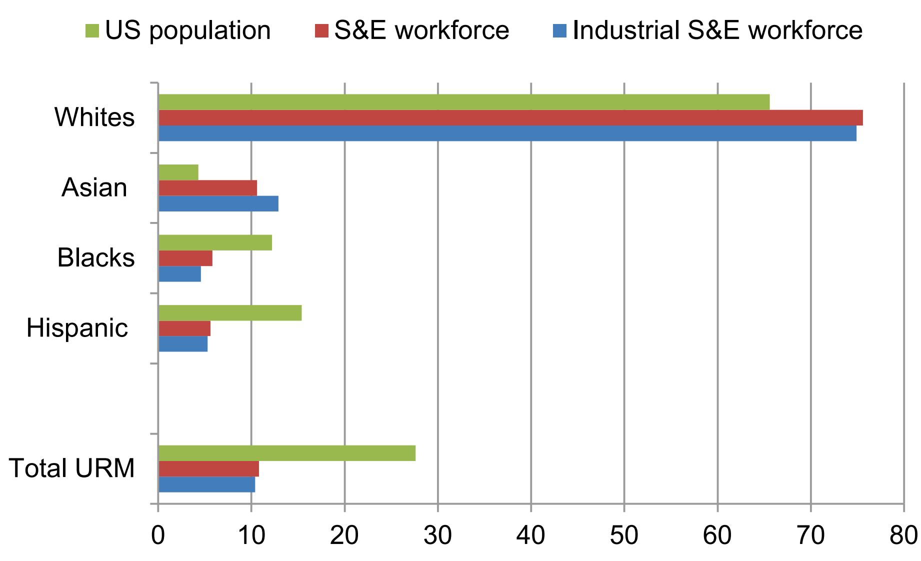


FIGURE 1.5 Percentage of the Science and Engineering (S&E) Workforce by Race/Ethnicity, 2008.
NOTE: URM = underrepresented minority (Hispanics, blacks, and American Indians/Alaska Natives).
SOURCES: Women, Minorities, and Persons with Disabilities in Science and Engineering (www.nsf.gov/statistics/wmpd, accessed September 1, 2012); and NSF/NCSES, SESTAT 2008.

Falkenheim noted that of the 10.2 million scientists and engineers who work in industry, more than 6 million hold bachelor's degrees (63 percent), another 25 percent have master's degrees, and 3 percent have doctoral degrees. About 9 percent of scientists and engineers who work in industry hold professional degrees.[6,7] Male scientists and engineers have higher levels of education than do women scientists and engineers, and Asian scientists and engineers hold more master's and doctoral degrees than do whites, blacks, or Hispanics (Figure 1.6).

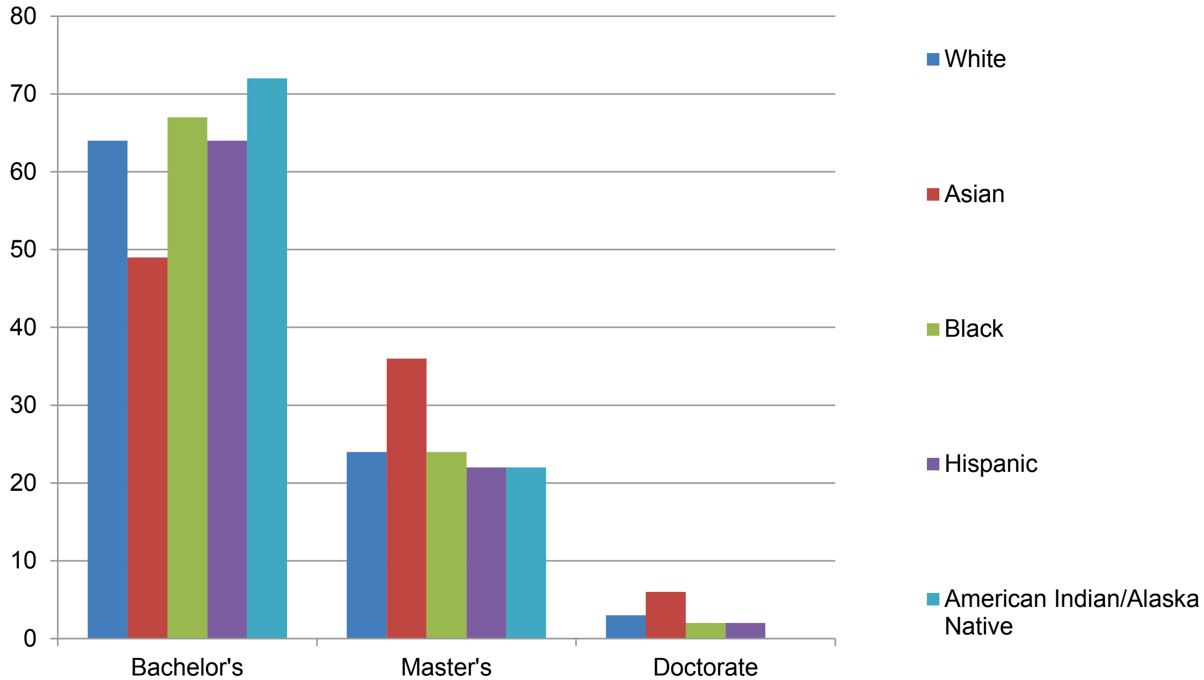


FIGURE 1.6 Highest Educational Degree in the Science and Engineering Industrial Workforce by Race/Ethnicity, 2008 (percent).
NOTES: For the purposes of its survey, NSF defined "industry" to include for-profit institutions and organizations. These figures do not include professional degrees.
SOURCE: NSF/NCSES, SESTAT 2008.

Analysis of the occupations of the 10.2 million scientists and engineers in industry reveals that over 40 percent of men and nearly 50 percent of women work in non-S&E occupations[8] (Figure 1.7).

---

[6] "Professional Science Master's (PSM) programs were designed to prepare people to work primarily in nonacademic sectors as laboratory administrators or project directors in, for example, large government or industrial laboratories or in small startup companies. They serve people who need advanced technical training (beyond the bachelor's degree) within an S&E field combined with knowledge of and skills in business fundamentals, management, team building, and communication." For more details about Professional Science Master's degrees, please refer to Science and Engineering Indicators, 2010, page 2-22. Available at www.nsf.gov/statistics/seind10/pdf/seind10.pdf.
[7] Falkenheim and Burrelli, p. 2.
[8] See Table 1.1 for the listing of S&E occupations, S&E-related occupations, and non-S&E-related occupations. For more detailed classification of occupations and degrees by S&E, S&E-related, and non-S&E, see NSF Scientists and Engineers Statistical Data System (SESTAT), http://sestat.nsf.gov/docs/occ03maj.html and http://sestat.nsf.gov/docs/ed03maj.html (accessed May 16, 2014).

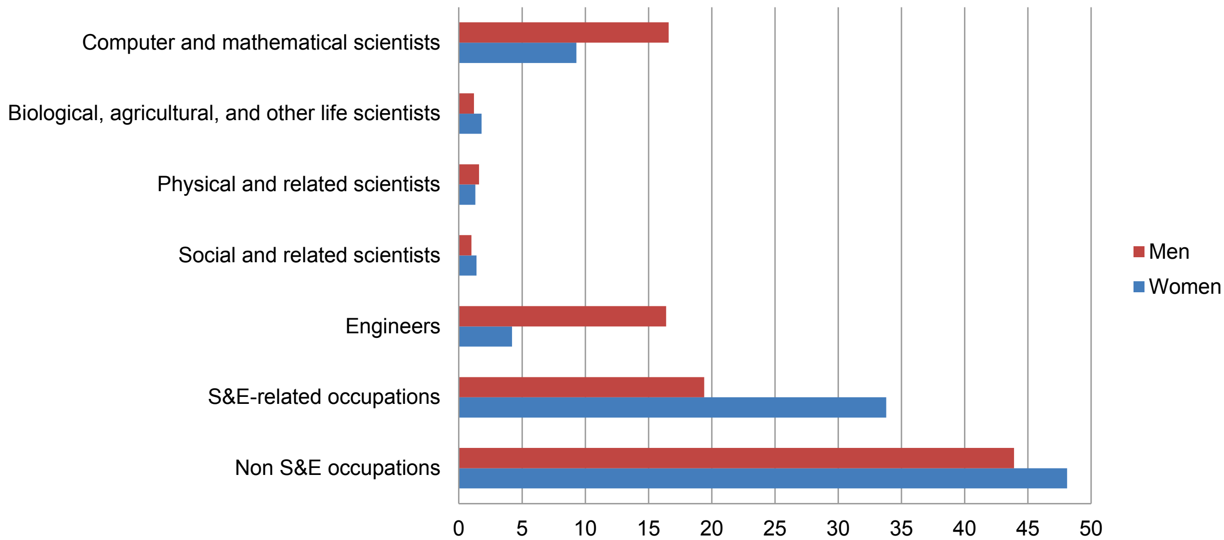


FIGURE 1.7 Occupations of Scientists and Engineers Employed in Industry by Sex, 2008 (percent).
SOURCE: NSF/NCSES, SESTAT 2008.

The NSF data on the industry-based fields in which scientists and engineers of different races and ethnicities work show that Asians are the largest group working in computer and mathematical sciences and blacks the smallest group working as engineers, Falkenheim said. Hispanics are the smallest group in the computer and mathematical scientists category (Figure 1.8).

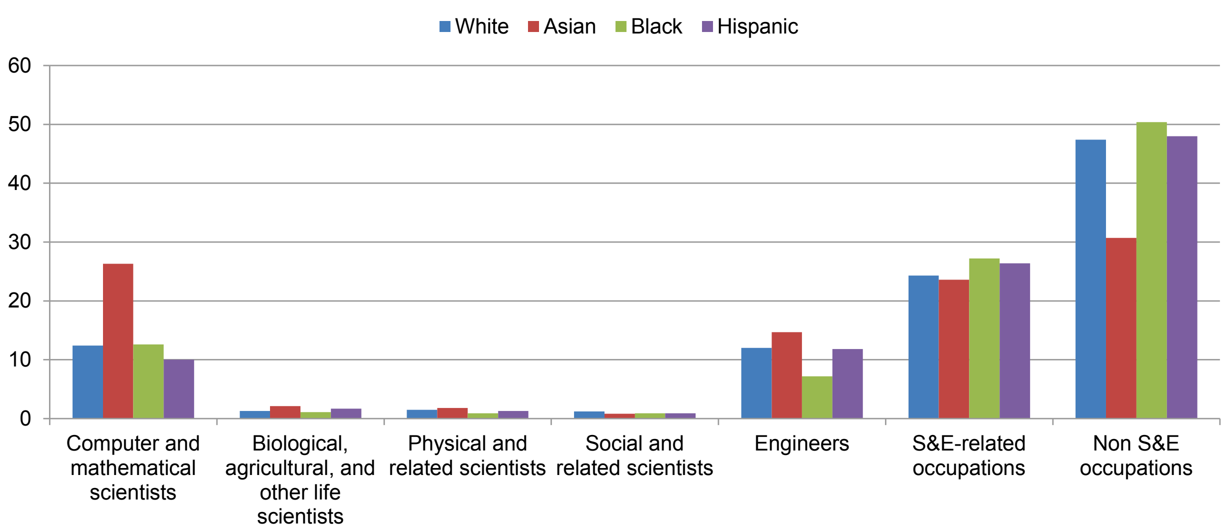


FIGURE 1.8 Occupations of Scientists and Engineers Employed in Industry by Race/Ethnicity, 2008 (percent).
SOURCE: NSF/NCSES, SESTAT 2008.

Falkenheim reported that further examination of the data reveals that 18.8 percent of engineers employed in industry are Asian men, compared to just over 16 percent for white and Hispanic men and just over 11 percent for black men. Compared to women engineers of other racial/ethnic groups, Asian women represented the largest percentage (7 percent) of those employed in industry. Hispanic women represent approximately 5 percent of engineers working in industry, white women nearly 4 percent, and black women approximately 3 percent.[9]

The proportions of computer and mathematical scientists employed in industry, by sex and race/ethnicity, were similar to those of engineers, Falkenheim continued. Asian men again represented the largest number, accounting for about 31 percent of computer and mathematical scientists employed in industry; black men and white men represented roughly 15 and 14 percent respectively, and Hispanic men represented about 13 percent of the same group. Among women, Asians were again the highest percentage of computer and mathematical scientists employed in industry, at roughly 18 percent. Black women represented 10 percent, white women roughly 8 percent, and Hispanic women about 6 percent.[10]

The data that generated the most discussion among workshop participants were those associated with primary and secondary work activities of scientists and engineers employed in industry, particularly with respect to management work activities. Falkenheim summarized the survey results on the respondents' primary and secondary work activities: (1) research and development; (2) management, sales, or administration; (3) computer applications; and (4) teaching. Respondents were asked to note which of 14 work activities best represented the work they did at their jobs. Then their responses were grouped into the four areas of primary or secondary work activities.[11] The survey results, presented based on sex (Figure 1.9) and race/ethnicity (Figure 1.10), reveal that men employed in the S&E industrial workforce are significantly more likely to be engaged in scientific and technical work such as research and development and computer applications, while women's job responsibilities are relatively more likely to include teaching.

[9] Falkenheim and Burrelli. 2012. Diversity in Science and Engineering Employment in Industry. NSF 12-311, available at www.nsf.gov/statistics/infbrief/nsf12311/.

[10] Falkenheim, workshop presentation.

[11] The description of the primary and secondary work activities as provided on the survey is as follows: (1) research and development work activities include basic research, development, and design; (2) computer applications includes computer programming, systems or applications development; (3) teaching includes teaching; (4) management, sales, or administration includes accounting, finance or contracts, employee relations, quality or productivity management, sales and marketing, or managing and supervising; and (5) other includes categories of production, operations, or maintenance; professional services; or other activities. "Other" work activities were included in the total but were not broken out separately. The specific wording of the survey question was: "The next question is about your work activities on your principal job. Which of the following work activities occupied at least 10 percent of your time during a *typical* work week on this job?" Respondents were to mark "Yes" or "No" for each of the following: (1) Accounting, finance, contracts; (2) Basic research – study directed toward gaining scientific knowledge primarily for its own sake; (3) Applied research – study directed toward gaining scientific knowledge to meet a recognized need; (4) Development – using knowledge gained from research for the production of materials and devices; (5) Design of equipment, processes, structures, models; (6) Computer programming, systems of applications development; (7) Human resources – including recruiting, personnel development, training; (8) Managing or supervising people or projects; (9) Production, operations, maintenance (e.g., chip production, operating lab equipment); (10) Professional services (e.g., health care, counseling, financial services, legal services); (11) Sales, purchasing, marketing, customer service, public relations; (12) Quality or productivity management; (13) Teaching; (14) Other (applicants were allowed to write in an answer). Next, applicants were asked "On which *two* activities in [the question above] did you work the *most* hours during a typical week on this job?" For details about the specific wording of the questions, see: http://nsf.gov/statistics/srvyrecentgrads/surveys/srvyrecentgrads_2008.pdf, page 7.

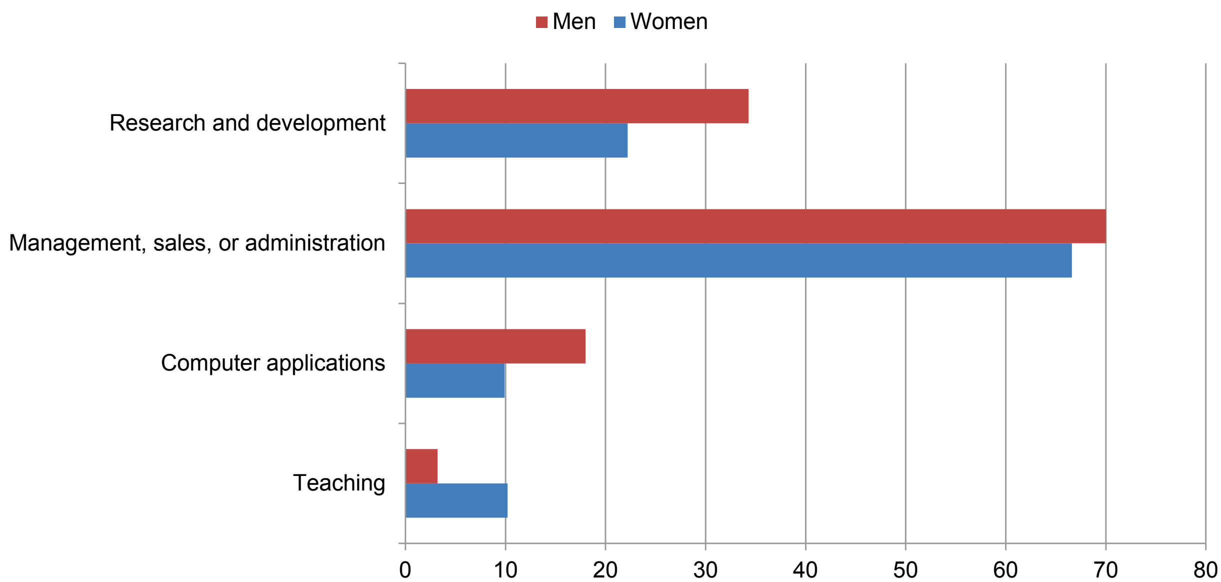


FIGURE 1.9 Primary/Secondary Work Activity of Scientists and Engineers Employed in Industry by Sex, 2008 (percent).
NOTE: Totals sum to more than 100 percent because respondents could select both a primary and secondary work activity.
SOURCE: NSF/NCSES, SESTAT 2008.

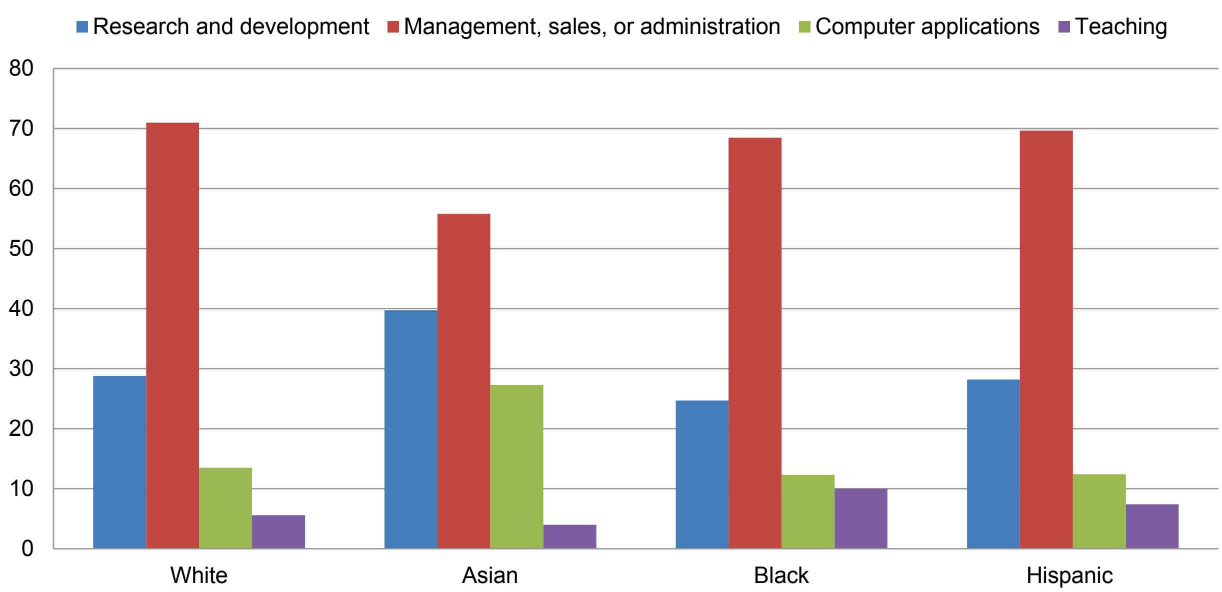


FIGURE 1.10 Primary/Secondary Work Activity of Scientists and Engineers Employed in Industry by Race/Ethnicity, 2008 (percent).
NOTE: Totals sum to more than 100 percent because respondents could select both a primary and secondary work activity.
SOURCE: NSF/NCSES, SESTAT 2008.

Management jobs accounted for approximately 1 million of the 10.2 million scientists and engineers working in industry in 2008. Among male scientists and engineers who are employed in industry, 15 percent are in managerial positions. Only 5 percent of female scientists and engineers employed in industry are managers.[12] Broken down by management level, the data show that among scientists and engineers in industry, men were more likely than women to be top-level executives, managers, and administrators, and mid-level S&E managers. Non-S&E mid-level managers are also more likely to be men than women (Figure 1.11).

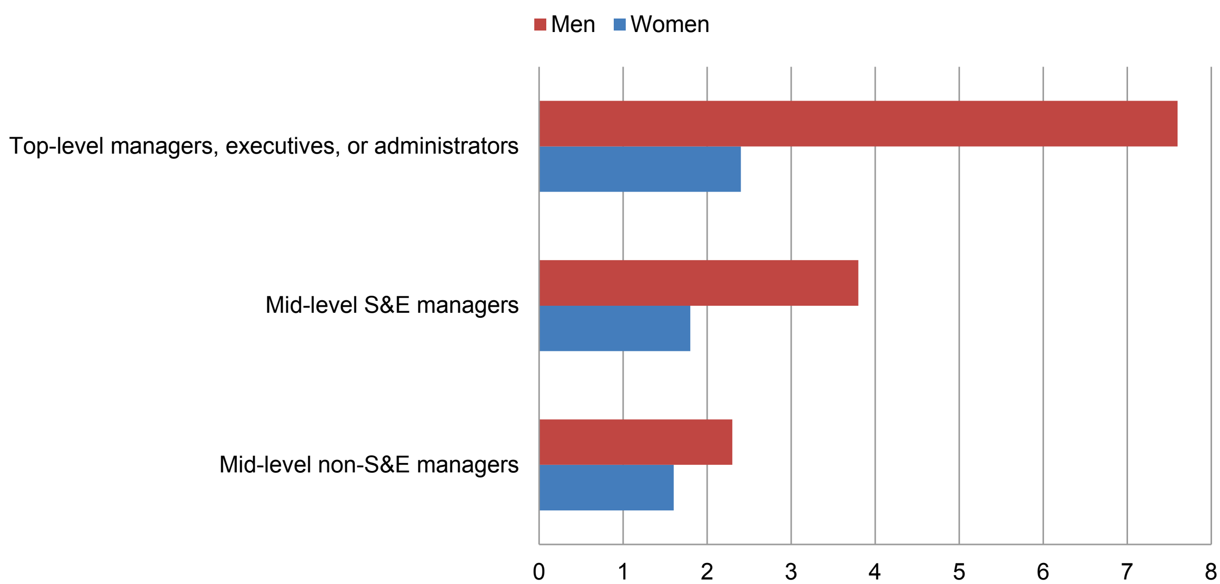


FIGURE 1.11 Percentage of Scientists and Engineers Employed in Industry, by Managerial Occupation and Sex, 2008.
NOTE: Percent is based on those who are managers.
SOURCE: NSF/NCSES, SESTAT 2008.

Further analysis of the management data reveals that male Asian, black, and Hispanic scientists and engineers working in industry are less likely than whites to be managers.[13] Indeed, white male scientists and engineers in industry are much more highly represented among managers (72 percent) than either white women (about 11 percent) or representatives of any other race or ethnicity regardless of sex (Figure 1.12C). Asian men represented 5.8 percent of top-level managers, Asian women 2.2 percent, URM men 5.2 percent, URM women 4 percent, and “other” men and women (native Hawaiians or other Pacific Islanders and individuals reporting more than one race) 0.9 percent each.

Falkenheim concluded by presenting data comparing the percentages of the total US population by sex and race/ethnicity with all scientists and engineers employed in industry by sex and race/ethnicity, and those who are top-level managers by sex and race/ethnicity (Figure 1.12).

[12] Falkenheim, workshop presentation.
[13] Falkenheim, workshop presentation.

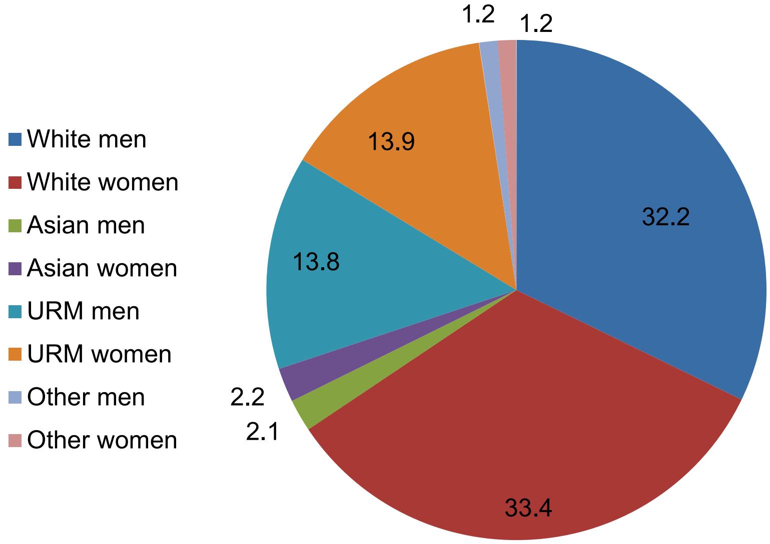


FIGURE 1.12 (A) US Population by Sex and Race/Ethnicity, 2008.

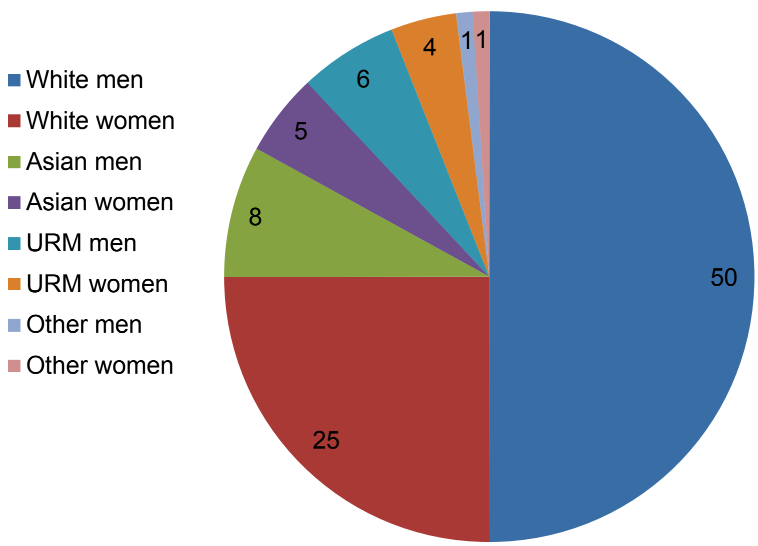


FIGURE 1.12 (B) Scientists and Engineers Employed in Industry, by Sex and Race/Ethnicity, 2008.

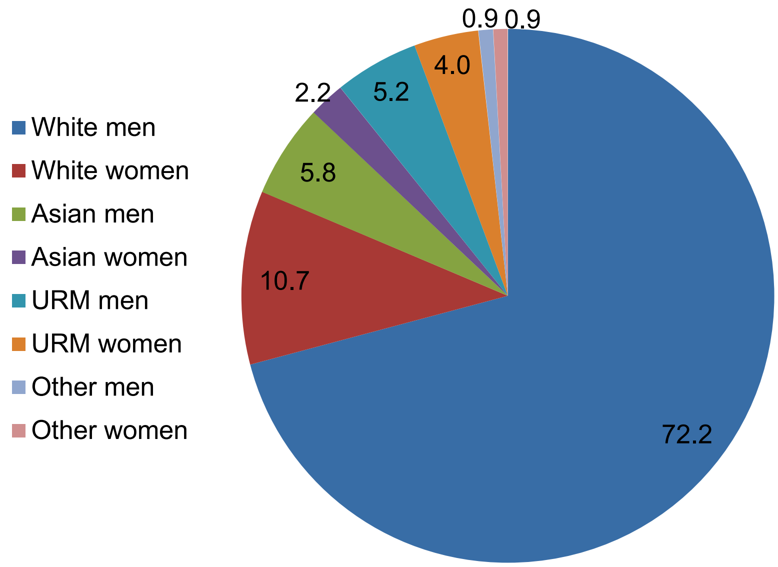


FIGURE 1.12 (C) Scientists and Engineers Employed in Industry Who Are Top-level Managers/Executives, by Sex and Race/Ethnicity, 2008.
NOTES: URM = underrepresented minority (Hispanics, blacks, and American Indians/Alaska Natives); other = native Hawaiians or other Pacific Islanders and individuals reporting more than one race.
SOURCES: NSF/NCSES, Women, Minorities, and Persons with Disabilities in S&E, 2011; SESTAT, 2008.

The data reveal stark contrasts for women and URMs who work in S&E industries. In 2008, white men made up 32 percent and white women 33 percent of the US population. Yet white men accounted for 50 percent of the scientists and engineers employed in industry, and they are further overrepresented as top-level managers (72 percent). White women represented 25 percent of scientists and engineers employed in industry, but only 11 percent of the top-level managers. Black men and women each represented 6 percent of the US population but only 2 percent of the S&E workforce, where black men represented 2 percent of top-level managers and black women 1 percent; thus, although they are underrepresented in the S&E industrial workforce, they are proportionally represented as top-level managers. Hispanic men and women, who each made up 8 percent of the US population, accounted for 3 percent and 2 percent, respectively, of scientists and engineers working in industry and 4 percent and 1 percent of top-level managers in industry.[14] Several workshop participants hypothesized that a disaggregation of these data by industry would show further variance.

DISCUSSION OF DATA AND SUGGESTIONS FOR FUTURE RESEARCH

Participants raised questions and made suggestions for future research that may provide a more comprehensive and nuanced picture of female and underrepresented minority scientists and engineers working in industry.

It was pointed out by some workshop participants that accounting for age might yield a better sense of trends over time; for example, baby boomers are working longer, and this lack of job turnover may exacerbate the challenge of recruiting more underrepresented minorities to science and engineering jobs in the coming decade. In addition, while many believe that the situation of

[14] Falkenheim, workshop presentation.

URMs has improved over the last 25 years, this assumption should be scrutinized with data. Falkenheim noted that while available data indicate that younger respondents are more diverse, the situation is complex; for example, there are many Asian immigrants in the science and engineering workforce, but they are not always younger. It is clear that the absolute number of underrepresented minority scientists and engineers is growing, however. Duane Dunlap, associate dean at Purdue University, cautioned that if the trends in industry are similar to those in academia, people may tend to stay in their jobs longer due to the economic downturn, which may affect trends in the career paths of women and URMs. The long-term trends therefore remain uncertain.

Considering the data indicating that underrepresented minorities constitute roughly the same proportion of both scientists and engineers in industry and top-level S&E managers in industry, Herman White, senior scientist at Fermi National Accelerator Laboratory, suggested that this may reflect a selection bias at the point of hiring. In other words, perhaps the only underrepresented minorities being hired are those who are perceived to have the greatest potential to advance. Falkenheim responded that she and her colleagues interpreted the data differently: They concluded that there is no drop-off of underrepresented minority men moving up into management, but there is for other groups. For example, Asians are overrepresented in the S&E industrial workforce but underrepresented in top-level management. Also, while women are represented in the S&E workforce, they are not moving up into management at the rates one might expect. Falkenheim suggested that these data may be the result of policies in effect for previous generations.

As a point of clarification, Falkenheim noted that for the purposes of this dataset, “functional disabilities” were recorded. The number of respondents with disabilities is small, and they tend to be older people whose disabilities appear over time rather than those who enter their careers with functional disabilities.

When Rick Stephens, senior vice president at the Boeing Company, asked if more recent data exist, Falkenheim explained that the NSF data are very high-quality but take time to collect and analyze. One participant suggested that NSF might collaborate with other organizations that collect industry-specific data, such as the annual *Aviation Week* survey, thereby gaining access to more recent data.

For discussions of primary and secondary work activity versus level of career attainment, Suzanne Jenniches, vice president and general manager (retired) at Northrop Grumman Corporation, cautioned against confusing “field” (e.g., pharmaceuticals) with “occupation” (e.g., research and development).

Regarding areas that may need further research, a question arose about the correlation between degree levels and advancement to management for underrepresented minorities: Is a PhD a ticket to rise in management for women and URMs? Or is race perhaps a larger determining factor in career pathways to management for underrepresented minorities? Because available data do not enable researchers to answer these questions, they were suggested for research and discussion.[15]

Some participants noted that experience indicates the substantial and beneficial effects of mentoring; further research could assess whether mentoring changes perceptions of minorities’ ability to advance—both self-perceptions and perceptions of those in a position to make decisions regarding advancement. One way to get at this correlation may be to ask respondents

[15] Another suggestion for further research would be to learn whether those who left stayed in S&E fields overall, left for promotions in the S&E fields overall, or left S&E fields entirely due to bias, perceptions, or inadequate support.

whether they have access to mentors, what helps them feel qualified, and what factors affect whether or not they look for a new job.

A final research question suggested by some participants concerned internal mobility. Many participants perceive that the way to work up to management positions is through the ranks of a single company. Others believe that one can attain a management position by leaving one's company and seeking advancement through a more senior position in a different company. To study these issues, additional questions for research could include whether senior technical positions—those at a pay and recognition level equivalent to management—exist in these companies, and whether the visibility of these S&E senior technical positions helps retention. There may also be a correlation between length of time at one company and achievement of a top-level management position. White remarked that it is appropriate to bear in mind, however, that not all scientists and engineers working in industry want a management position, preferring instead to remain practicing scientists and engineers.

The session concluded with Falkenheim's invitation for workshop participants to submit further feedback and suggestions for questions to include on future surveys on any topics of relevance, including questions about primary and secondary work activities. More focused and targeted questions may address a range of concerns and provide a more nuanced understanding of differences across fields, as well as a better understanding of what S&E employees actually do on their jobs.

2

Harnessing Experience to Improve Opportunities: Best Practices and Innovative Ideas

PROFESSIONAL ASSOCIATIONS, ORGANIZATIONS, AFFINITY GROUPS, AND INDUSTRY PROGRAMS

Industry leaders face a critical challenge in ensuring that talented scientists and engineers from underrepresented populations are recruited to the industrial workforce, remain employed in that sector, and advance throughout their careers. These employees bring a diversity of views and thus benefit the companies for which they work as well as industry as a whole. Efforts to address the challenge of securing talented employees from underrepresented population groups begin by encouraging girls and young people of color to become interested in science and engineering at an early age. These efforts must then continue by ensuring their success through high school and postsecondary education in science- and engineering-related disciplines, fostering their continuous employment in these fields, and building a sense of pride among these employees in their companies' science, technology, engineering, and mathematics (STEM) activities and diverse workforce. Connecting each stage to the next requires the active involvement of leaders in industry, academia, professional organizations, and other stakeholders. Three industry executives actively engaged in efforts to recruit, retain, and advance underrepresented men and women participated in a panel discussion to share their best practices and suggestions for action.

Barry Cordero, principal project engineer at Medtronic and national vice president of the Society of Hispanic Professional Engineers (SHPE), offered examples of how his company has worked with professional societies and employee resource groups and networks to recruit, retain, and advance talented minority and women scientists and engineers. In addition to traditional approaches to recruit potential employees as college seniors graduating from science and engineering programs, Medtronic draws on employee resource groups, professional associations, and networks to assist with their recruitment and advancement strategy. One such group, the Medtronic Latino Culture Network (MLCNet),[1] has members from all professional fields and backgrounds who consider themselves Hispanic or Latino. Because Medtronic is a technical company, many of the network's members are engineers. Among other things, MLCNet conveys the members' cultural perspective to the company, an important contribution as Latin America is one of the fastest growing markets for Medtronic.

Cordero then described SHPE, which aims to "[change] lives by empowering the Hispanic community to realize its fullest potential and to impact the world through STEM awareness,

[1] Cordero also cited the National Society of Black Engineers, American Indian Science and Engineering Society, Society of Women Engineers, SHPE, Great Minds in STEM, Mexican American Engineering Society, and Society for the Advancement of Chicanos and Native Americans in Science as examples of organizations that Medtronic works with on a regular basis.

access, support and development." The professional association was developed by those who support the goal of helping women and underrepresented minorities find and secure jobs in companies and, once there, remain employed and advance. SHPE pursues its mission through company chapters across the United States.

Establishing and maintaining effective mentorship for S&E women and underrepresented minorities (URMs) in the industrial workforce remains a challenge—one that SHPE company chapters try to address, often as a complement to corporate mentoring efforts. A further difficulty facing companies that wish to hire and keep Hispanic S&E employees is the relatively small pool of candidates from which they can hire. Moreover, once hired by a company, for many Hispanic employees, not unlike other employees, the decision to stay is often influenced by their ability to engage in activities that matter to them.

Sylvester Mendoza, Jr., corporate director for diversity and inclusion and EEO at Northrop Grumman Corporation, underscored the need for mentorship and added that in his experience coaching and sponsorship[2] also are critical to retaining and advancing women and underrepresented minority scientists and engineers in industry. All three—mentorship, coaching, and sponsorship—are essential, he said, if Northrop Grumman and others are going to meet the challenges laid out by the National Defense Industrial Association (Box 2-1). He argued that industry needs to hire individuals from underrepresented groups in order to survive amid US demographic shifts.

Mendoza explained that Northrop Grumman is attempting to address the challenge of diversity[3]: 28 percent of all employees are women and 29 percent are people of color. Of the company's engineers, 16 percent are women and 28 percent people of color, and of its computer scientists, 22 percent are women and 30 percent people of color. He acknowledged, however, that these underrepresented populations hold fewer positions farther up the corporate ladder, and speculated that the underrepresentation might be due in part to self-perceptions and/or to feelings of marginalization after three to five years working at the company. Efforts such as this workshop can help address this, he said.

Rick Stephens, senior vice president for human resources and administration at the Boeing Company, began by stating that people are the company's most valuable resource, enabling the company to compete in the marketplace; their diversity of perspectives is greatly valued. The challenge, however, is to get everyone engaged and involved. Boeing has attempted to address this challenge through its Global Diversity and Employee Rights office, which opened ten years

---

[2] Sponsorship, mentoring, and coaching, while related, play different roles in career advancement, particularly for women and URMs. Sponsorship is an active support by someone appropriately placed in the organization who has significant influence on decision-making processes or structures and who is advocating for, protecting, and fighting for the career advancement of an individual. The benefits of mentoring generally include personal support, role modeling, and friendship. While a mentor may be a sponsor, sponsors go beyond the traditional social, emotional, and personal growth development provided by many mentors. See: Catalyst. 2011. *Sponsoring Women to Success*. New York, NY: Catalyst; and Herminia Ibarra, Nancy M. Carter, and Christine Silva. September 2010. "Why Men Still Get More Promotions than Women." *Harvard Business Review*, pp. 80-85. Coaching begins with agreement on goals, and moving on to an action plan. It is usually instructional, with a particular goal of focus, such as developing technical or soft skills, or it can be used as a way to train someone on a discrete task or series of tasks. See: Luecke, R., and I. Herminia. 2004. *Harvard Business Essentials: Coaching and Mentoring: How to Develop Top Talent and Achieve Stronger Performance*. Boston, MA: Harvard Business Press; and Frankel, B. February 2011. "What's the difference between mentoring, coaching and sponsorship?" *DiversityInc*. Magazine, p. 23.

[3] For more information regarding Northrop Grumman's efforts, see: www.northropgrumman.com/corporate-responsibility/diversity/index.html (accessed March 31, 2014).

ago and reports directly to Stephens. Through this office, processes and procedures are established to identify and address issues related to recruitment, retention, and advancement.

Box 2-1 Challenges Identified by the National Defense Industrial Association

- Aerospace and defense (A&D) workforce is losing jobs due to a shrinking federal defense budget and not gaining new young professionals due to a lack of retirements.
- The long-term outlook is different but not well known.
- The demographics of our domestic population are shifting:
    - The historically majority-white United States is transitioning to a more racially/ ethnically diverse populace.
    - The school-age population is especially reflective of this trend.
    - This new labor pool has to be tapped to continue US dominance in STEM fields.
- Underrepresented minority groups constituted 28.5 percent of our national population in 2006, but only 9.1 percent of college-educated Americans in science and engineering occupations (academic and nonacademic).[4]
- Diversity:
    - The A&D industry draws from an increasingly diverse pool of candidates.
    - Not all potential STEM talent is activated because of unfortunate social misperceptions.

SOURCE: Mendoza, workshop presentation.

Boeing has also hosted an annual Diversity Summit for the last ten years. The summit, attended by about 1,000 people, has two objectives: to share the company's position on diversity and to provide training on subjects such as differing cultural perspectives, how to find a mentor, and what it means to be ready for development and advancement. Boeing now requires that employees who wish to attend the summit be accompanied by their managers, in order to bring the two groups together and raise awareness among managers. Each year 90 percent of those who attend are first-time participants. In addition to affinity groups for women and those of various ethnicities, Boeing will soon offer affinity groups for members of the military.

Stephens explained Boeing's progress in workforce diversity. The primary statistic that the company tracks is the number of women and URMs who are executives at the vice president level and above: 24 percent are women and 10 percent minorities. These statistics are reported to senior leadership quarterly to ensure progress. Growth of 2 percent to 3 percent is considered a success, and if this rate is not achieved, senior leaders attempt to understand the problem. While the company is fairly good at promotions, leadership is concerned about the ability of a sufficient pipeline of women and minority scientists and engineers to continue to advance. Retention is essential; at the most junior level, women and minorities make up 40 percent to 50 percent of Boeing's employees, but they need to advance through the pipeline.

One of the best ways to assist this advancement is for employees to be paired with a good mentor with whom they can have honest conversations about what it takes to move forward. Boeing takes mentoring so seriously that all of the 288 executives at the vice president level must

[4] See *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (www.nap.edu/catalog.php?record_id=12984, accessed March 31, 2014).

mentor a minimum of two employees, and 50 percent of the mentees must be women and minorities, said Stephens. The effects of these efforts are being seen throughout the company, although weakness remains at the senior and technical middle-management levels, he noted. Hopefully, mentorship will help. Nonetheless, the first five years—when women, minorities, and other good employees are most likely to leave for other companies—remain the most challenging for employee retention.

Stephens went on to describe his work with Santa Ana High School, located in a predominantly Hispanic area in California. When the school first started the Latino Educational Attainment Program, students' college readiness rate was 17 percent. After joining together with the *Orange County Register*, local business leaders, local churches, and other organizations, the school doubled that rate in five years.

The program revealed that cultural perceptions and media views of scientists and engineers greatly influenced students' decisions. To begin to change these perceptions, Boeing works closely with the Entertainment Industries Council on the accuracy of depictions of scientists and engineers in the media. This is important, Stephens explained, because young people spend approximately 50 hours per week connected to media outside the classroom, and it is from media, as well as from parents and friends, that they get their views and perceptions of scientists and engineers, which in turn inform their behavior.

A set of awards has been created to acknowledge those in media for the accuracy of their depictions of science, engineering, and technology. This emphasis on accurate portrayals also benefits the entertainment industry because it too is dependent on scientists, engineers, and technologists and will continue to need capable employees in the future to meet business needs. To facilitate this interaction, Boeing has 20 engineers "on call" for Hollywood to answer questions about the accuracy of depictions of scientists and engineers, who represent 10 percent of all the characters in the media. Of these characters, 70 percent are portrayed as the ones who create the problems (e.g., "mad scientists"). One might well wonder how many of the 4.3 million children born in the United States this year, after watching these media depictions, will choose scientific and engineering careers, Stephens said. He concluded by reiterating the importance of involving media in efforts to recruit future scientists and engineers.

DISCUSSION OF BEST PRACTICES IN ATTRACTING, RETAINING, AND ADVANCING S&E EMPLOYEES IN INDUSTRY

Understanding and Valuing S&E Employees

Participants considered how to build on current best practices to attract, retain, and advance more women and underrepresented minority scientists and engineers in industry.[5] The discussion began with the observation by some participants that many young people who obtain STEM degrees either do not work in the field or choose to leave the field, and that to slow this trend it is essential to involve them in organizations that can support them over time.[6] If these scientists

[5] Nonprofit organizations, such as STEMconnector, help companies address many of these issues.

[6] Research questions that may be asked to better understand graduates' choices include: If only 50 percent of those graduating with S&E degrees are going into S&E careers, what are the leading reasons for this trend? Are there only jobs for 50 percent of the S&E graduates? Are students being offered STEM jobs and turning them down and if so,

and engineers feel marginalized or undervalued, they will opt out of a company to go elsewhere. It is essential that support come from all parts of the company, from the human resources department all the way up to senior management, one participant said. Some underrepresented minorities choose to turn instead to entrepreneurship, which may allow them to advance their S&E careers. While this may be of benefit to the scientists and engineers personally, they are no longer working in the industries that want to retain them.[7] It is therefore important to understand the multiple variables that factor into people's choices over time and to acknowledge that the growing pursuit of entrepreneurial careers in S&E, while important, may impact the technical workforce in many industrial sectors, some participants said.

To that end, it will be useful to better define what engineers do, another participant pointed out. For example, if an engineer spends 90 percent of her time doing something other than engineering, she may not identify as an engineer. The lack of definition affects perceptions of both opportunities and salaries available to those with engineering degrees or backgrounds. In other words, if students or parents have a misunderstanding about what an engineer does, who an engineer is, how engineering skills can be used in the workplace, and what the earning potential of engineers can be, the student may be discouraged from entering the profession. These degrees are foundational and contribute to career success, but if this information is not conveyed well to parents and students, they may not view engineering as a desirable degree or career option. Tackling the problem of perceptions is essential both to make the engineering profession attractive to talented people and to retain them once they are hired.[8]

Rick Stephens of Boeing observed that engineers are needed in many different fields. Many jobs require some level of technical knowledge, and industry needs to do a better job of attracting women and underrepresented minorities with those skills.

Mentoring, Coaching, Sponsorship

Mentoring is generally the practice of assigning a junior member of staff to receive advice from a more experienced person who assists him or her in navigating a career path. The benefits of mentoring usually include personal support, role modeling, and friendship.[9] Coaching begins with agreement on goals and then moves on to an action plan; it is usually instructional, with a particular goal of focus, such as developing technical or soft skills, or it can be used as a way to train someone on a discrete task or series of tasks.[10] Sponsorship is active support by someone

---

why, and for what other fields? Are the graduates in disciplines that are overrepresented in terms of talent needed or at degree attainment levels inconsistent with the desired degree levels?

[7] For more information on entrepreneurship and S&E, see *From Science to Business: Preparing Female Scientists and Engineers for Successful Transitions into Entrepreneurship: Summary of a Workshop* (www.nap.edu/catalog.php?record_id=13392; accessed March 31, 2014); and *The Kauffman Firm Survey: Who Are User Entrepreneurs? Findings on Innovation, Founder Characteristics and Firm Characteristics* (www.kauffman.org/research-and-policy/the-kauffman-firm-survey-who-are-user-entrepreneurs-findings-on-innovation-founder-characteristics-and-firm-characteristics.aspx; accessed March 31, 2014).

[8] The NAE Changing the Conversation project has developed effective messages on engineering (www.engineeringmessages.org/).

[9] Catalyst. 2011. *Sponsoring Women to Success*. New York: Catalyst; and Herminia Ibarra, Nancy M. Carter, and Christine Silva. September 2010. "Why Men Still Get More Promotions than Women." *Harvard Business Review*, pp. 80-85.

[10] Luecke, R., and I. Herminia. 2004. *Harvard Business Essentials: Coaching and Mentoring: How to Develop Top Talent and Achieve Stronger Performance*. Boston: Harvard Business Press; and Frankel, B. February 2011. "What's the difference between mentoring, coaching and sponsorship?" *DiversityInc*. Magazine, p. 23.

appropriately placed in the organization who has significant influence on decision-making processes or structures and who is advocating for, protecting, and fighting for the career advancement of an individual.[11] Mentoring, coaching, and sponsorship, while related, play different roles in career advancement, especially for women and URMs. The impact of sponsors goes beyond the traditional social, emotional, and personal growth development provided by many mentors.

The importance of a combination of mentoring, coaching, and sponsorship[12] was reinforced by Mendoza when he described Northrop Grumman's online and face-to-face mentoring programs. The company has 30 employee resource groups[13] with 12,000–13,000 employees enrolled, and these groups are an important way to demonstrate to employees that they are valued in the company. He acknowledged that more needs to be done to track the results of these efforts, but said the company has found that employees who are not part of a buddy system or who are quiet may feel isolated and not learn how to get things done, which will negatively affect their chances of moving ahead in the company. The company is therefore making a concerted effort to ensure that all its employees, particularly those newly hired, have a corporate buddy. As an employee goes forward, coaching and sponsorship should continue as a means of explaining the culture of the company and how to move up—for example, through the development of soft skills. Such skills may, for instance, help technically trained employees better articulate what they do and how they contribute to the company. At each career step in Northrop Grumman's corporate structure, Mendoza said, the company's leaders are accountable for their success in retaining and advancing women and URM S&E employees.

Alice Agogino, Roscoe and Elizabeth Hughes Professor of Mechanical Engineering, University of California, Berkeley, noted that mentoring activities are sometimes viewed negatively—for example, as a diversion from the employee's core activities—so incentives should be provided to encourage and reward active mentorship and to acknowledge the value of employees' taking the time to be mentors.

Cordero said Medtronic has no formal, centralized mentoring programs but that they are being created, in particular to target women and minorities. In production areas, however, coaching does occur between senior and junior engineers. He has noticed that employees who are not coached tend to seek advancement by going to another company. In addition, there is a perception that the way to advance to management is to get an MBA, so some employees either leave their company or leave engineering, and end up competing for managerial positions that are fewer and fewer as one climbs the corporate ladder.

---

[11] Ibid.

[12] For further information on mentoring and sponsorship, see *Sponsoring Women to Success* (http://catalyst.org/publication/485/sponsoring-women-to-success; accessed March 31, 2014); and *Women and the Trouble with Mentors* (www.washingtonpost.com/national/on-leadership/women-and-the-trouble-with-mentors/2011/10/14/gIQAeOF7jL_story.html; accessed March 31, 2014).

[13] Many corporations refer to resource or networking groups as affinity groups. Affinity groups provide forums for employees to gather socially and share ideas outside of their particular business units. In addition to racial, ethnic-background, and gender-based affinity groups, there are also affinity groups that bring together employees based on country of origin, religion, physical disabilities, military service, age, sexual orientation, and many other parameters. See: Bonetta, L. 2008. "Affinity groups for diversity." *Science Careers Magazine*; and Forsythe, J. 2004. "Affinity and networking groups." *New York Times* (www.nytimes.com/ marketing/jobmarket/diversity/affinity.html; accessed March 31, 2014).

Aiding Advancement of Women and URMs

Stephens explained that at Boeing, the policy is to ensure that women and minority candidates are included on all slates for open positions. The company also requires that succession plans include two ready candidates and three candidates in development for each position. Since internal analysis showed that candidates were being counted multiple times when they appeared on multiple slates, candidates are now counted only once. This adjustment better enables the company to ensure a more diverse pipeline of candidates for advancement.

When asked about Boeing's effectiveness in advancing women and minorities, Stephens replied that the company's slate process has demonstrated success in doing so. Suzanne Jenniches, vice president and general manager (retired) at Northrop Grumman Corporation, pointed out, however, that often one gets the results that one measures, so it is important to make certain that the actual desired outcome is measured—in this case, the number of women and minorities advancing into middle management.[14]

The importance of implicit bias was raised. Biases influence how people view their own capabilities and those of diverse employees and can affect attitudes about advancement. Affinity groups and professional associations can help solve this challenge by offering training to recognize implicit bias to industry partners and by including its members in outreach efforts regarding implicit biases. Specifically, discipline-based associations and university liaisons should be called upon to play a larger role in addressing recruitment and retention difficulties, including efforts beyond bias awareness, said one participant.

Cordero referred to his efforts through SHPE to work with discipline-based organizations on outreach to URMs and women who may be candidates for S&E careers to educate and recruit them, but he added that many of these organizations do not focus on diversity and are sometimes not very diverse in their own membership. Constance Thompson, a workshop participant, responded that the discipline-based associations with which she was involved are actively engaged in outreach activities and are searching for opportunities to be more involved. These efforts were applauded by many other workshop participants, who urged that discipline-based organizations, affinity groups, minority-based organizations, and others work together to aid URM S&E employees for both their own benefit and that of industry.

Some companies support employees' membership in one or more professional organizations. At Northrop Grumman, for example, an employee who wishes to join an organization pays the membership fees of the first organization, and the company pays for subsequent organizations. In this way, an employee expands his or her knowledge and networks, benefiting both the individual and the company.

Retaining Undergraduates in S&E Disciplines

Mendoza suggested that it would be beneficial to further examine where the leaks in the pipeline occur. Stephens reported that some universities with which he has worked have been successful in stopping leaks from undergraduate engineering programs through the following four steps. First, when a student arrives, he/she is put into a group of 50 students with a professor who is responsible for helping the cohort. Second, because math and physics classes have the highest

---

[14] Metrics associated with accountability for executives in their success at retaining and advancing women and underrepresented minorities, as well as metrics for efforts to incentivize, reward, recognize, and/or ultimately penalize managers who are unable to meet retention and advancement expectations, seem worth more study.

dropout rates, universities are now asking engineers to teach these classes to emphasize how the skills help solve real-world problems. Third, in the first two years, students are given projects to work on, which helps raise engineering completion rates to 80 percent. Fourth, between their sophomore and junior years, students have internships, which give them a sense of what the profession is actually like, and they can make adjustments in their coursework based on their developing interests in various engineering fields. If the retention rate of students graduating from engineering programs could be increased from 60 to 90 percent, another 30,000 candidates would be added to the pool of engineers from which companies could hire, Stephens said.[15]

In an effort to promote retention within industry, Boeing created the REACH program, which partners new college-graduate employees with other new employees, regardless of discipline, and provides them with a social network, Stephens continued. There are REACH chapters throughout the company, each of which is supported by an executive. Further, through Boeing's Leadership Institute, employees learn leaders' actual experiences and tackle difficult-to-raise topics that are otherwise often avoided. At times, issues of bias and how to better recruit, retain, and promote underrepresented minorities in the S&E workforce are difficult subjects to address.

Outreach to K-12 Students

Workshop participants returned to the fundamental importance of K-12 education. The leadership of school principals and teachers is vital to ensuring that all children, regardless of background or economic means, reach the highest possible levels of academic achievement. Without this critical foundation, there will not be enough qualified people to meet the science and engineering needs of companies going forward.[16]

By way of illustration, Stephens described an inspirational principal at a lower-income elementary school in Gary, Indiana. The principal's success was due in large part to her focus on dedication, determination, and discipline for all people in the school, from herself to teachers to students. In addition to leadership by principals, workshop participant Herman White cited the importance of teachers with the necessary capabilities and skills to teach these subjects: skills will enable students to be competitive, and if teachers' skills improve, those of their students will too.[17]

---

[15] In addition to focusing on retaining students throughout their degree programs, alternatives to internships should be considered because internships are very resource intensive in terms of dollars and human resources. While cost may be prohibitive, exploration of online or virtual "internships," simulations, and/or gaming experiences might allow for valuable internship experiences for larger numbers of students.

[16] While difficult and expensive, perhaps this is the time to conduct more longitudinal research on the impact of changes in K-12 education, including implementation of programs like Engineering Is Elementary, expansion of Project Lead the Way, TV programming like Design Squad, and the high school-level expansion of the EPICS project. Additionally, programs like Early College High School models and dual enrollment that focus on STEM, as well as the success of STEM CTE programs, might be reviewed for impact, outcomes, and emerging positive trends in leading indicators of success.

[17] For additional information, see *Report of the 2012 National Survey of Science and Mathematics Education* (www.horizon-research.com/2012nssme/wp-content/uploads/2013/02/2012-NSSME-Full-Report1.pdf; accessed August 21, 2013). This report indicates that "According to the 2012 National Survey of Science and Math Education: only 5 percent of elementary teachers had a degree in science or science education, and 4 percent had a math or math education degree. 41 percent of middle school science teachers reported having earned degrees in science or science education, and only 35 percent of middle school mathematics teachers had degrees in mathematics or math education. The comparable figures for high school teachers were 82 percent and 73 percent for science and mathematics, respectively." See also another report from National Center for Education Statistics at http://scholar.lib.vt.edu/ejournals/ JTE/v21n2/obrien.html): "Some science and mathematics teachers without

Cordero explained that SHPE chapters engage with local colleges and high schools to encourage young people to choose engineering.[18] Participating SHPE members have observed that some students at the high school level do not know what engineering is or what skills are required to pursue studies or work in engineering. By reaching out to high school students, SHPE members hope to raise awareness and help students stay engaged and join a SHPE chapter at their college or university. Karyn Trader-Leigh, chief executive officer, KTA Global Partners, LLC, noted that such efforts may also be beneficial in reaching underrepresented minorities who are concerned with social justice.

The combination of effective and inspiring school leadership and classroom teaching will significantly contribute to a larger and more diverse pool of scientists and engineers who are ready and willing to enter the industrial workforce in the future.

degrees obtain certification to teach those subjects, and this provides another measure proxy of for content knowledge. For example, data from the 2007-2008 school year indicate that 12 and 16 percent of high school science and mathematics teachers, respectively, without a college degree in their subject received state certification to teach those subjects."

[18] Online internships or other creative innovations might also be explored for high school students as well as teachers, and may provide additional means of introducing students to engineering by giving them real world problems to solve.

3

Changing the Game: Key Themes and Suggested Actions

To explore and further develop key themes that emerged during the workshop, attendees participated in three breakout groups and a closing plenary discussion. The breakout groups considered the following topics:

1. Technical career paths versus management career paths in science and engineering industry: differences for underrepresented populations?
2. Lessons from practices on recruiting, retaining, and advancing underrepresented minorities in science and engineering industries;
3. Lessons from practices on recruiting, retaining, and advancing women (and women of color) in science and engineering industries.

Participants shared their ideas and suggestions for best practices and innovative strategies—spanning the continuum from K-12 education, to undergraduate training, to professional recruitment, retention, and advancement, and further outreach—to enhance the pipeline of successive generations of women and underrepresented minority (URM) scientists and engineers.

ENSURING A GROWING POOL OF WOMEN AND UNDERREPRESENTED MINORITY SCIENTISTS AND ENGINEERS

Many workshop participants readily acknowledged that in order to ensure that there are sufficient trained, qualified, and interested employees in the science and education workforce long into the future, particularly underrepresented minorities and women, attention must be focused on introducing children at the K-12 level to science and engineering and the careers available to them. This is critically important to meeting the overall challenge.[1]

Specifically, female and underrepresented minority students need a better understanding of the career paths available to scientists and engineers.[2] For example, many students do not know what engineering is and therefore do not know if it would be of interest to them as a career option, or what is required to succeed in that field. Further, once students graduate from high school and enter college, students and parents should be made aware of the solid foundation that education in science and engineering can provide and the relative earning power that those careers can generate in the corporate environment. This may increase the attractiveness of these subjects to college students and subsequently the attractiveness of S&E positions once students graduate.

[1] Comment made by participants of breakout groups 2 and 3.
[2] Comment made by participants of breakout group 1.

Community colleges offer an alternative means of acquiring a science and engineering education, but their graduates may be at a disadvantage because of negative perceptions of these degrees.[3] Along with broad-based outreach, direct outreach to potential employers and to existing S&E employees in companies may help overcome these negative perceptions and provide opportunities for well-qualified students who have obtained their education through paths other than a traditional four-year college or university. Involving students themselves in these discussions about greater inclusion of women and URMs at all levels, as well as about their perceptions and career plans, is also vital. In other words, talking "with" students rather than "at" them is essential to breaking down perception barriers.[4] Along with involving students in outreach efforts, the media should also be involved in attracting URMs and women to science and engineering (e.g., a "Got engineering?" campaign).[5]

RECRUITING, RETAINING, AND ADVANCING WOMEN AND UNDERREPRESENTED MINORITY SCIENTISTS AND ENGINEERS

Once women and URMs are prepared to enter the S&E workforce, significant challenges remain in terms of their recruitment, retention, and advancement. In many respects, however, these challenges may be easing given overall changes in the workplace and given the accumulated effects of efforts over many years. For example, as the workplace becomes more diverse and more tolerant, and as individual difference is more openly embraced, positive perceptions of women and URMs in the S&E workforce are increasing.[6] The challenges of dual-career families can be a significant factor in retaining women in S&E positions; many companies have programs to address these challenges.[7] Similarly, for many women the first five years, often the transition point from "entry level" to "middle management" (either technical or managerial), also coincide with pregnancy and starting families.[8]

Diversity is not just represented by different groups of people, such as women, African-Americans, and Hispanics; there is also considerable diversity within these groups that must be considered if these valuable employees are to be recruited, retained, and advanced. These different groups have different needs and challenges (e.g., single women, women with children, women without children).[9] To accommodate these differences, employees may require greater flexibility in the workplace (e.g., flexible hours).

One way to address the challenge of attracting diverse candidates is to have a diverse recruitment team with whom women and underrepresented minorities can more easily identify.[10] Another avenue is for senior leadership of companies to connect with universities to share best practices for recruitment and retention and to work together to develop the pipeline from university programs to companies.[11]

---

[3] Comment made by participants of breakout group 3.
[4] This younger group of online, social media–active S&E professionals can also help to identify alternative approaches to successful mentoring.
[5] Comment made by workshop participants.
[6] Comment made by participants of breakout group 1.
[7] Comment made by participants of breakout group 3.
[8] Comment made by participants of breakout group 3.
[9] Comment made by participants of breakout group 3.
[10] Comment made by participants of breakout group 2.
[11] Comment made by participants of breakout group 2.

It may be beneficial to study possible parallels between leaks in the pipeline in science and engineering undergraduate programs and those that occur in the first five years of a person's employment. Research on this potential parallel may yield insights into how solutions that have aided academic programs may aid industry.[12]

Another important aspect of recruiting, retaining, and advancing woman and URM scientists and engineers is providing them with additional necessary training. Given that "soft skills" (such as communication and interpersonal skills) are important in enabling scientists and engineers to advance to management-level positions, specific training in these areas may be needed. MBA programs early in one's career might allow technical employees to develop these critical skills much sooner.[13] Another example of necessary training is helping employees better understand expectations about how candidates are evaluated for advancement: Are candidates evaluated based on management skills or technical skills or both?[14] In addition to traditional upward advancement, lateral career moves and/or advancement along technical tracks (i.e., a "dual-track" model) should be supported for scientists and engineers who wish to remain engaged in technical work instead of management.[15]

A critical aspect of ensuring successful careers for women and URMs is mentoring. However, as mentioned above, employee groups are not monolithic, and mentoring should be adapted accordingly. For example, peer group or cohort mentoring may be better for some cultures than one-on-one mentoring.[16] Further, mentoring and sponsorship[17] have different contributions to make in helping candidates understand what is needed to advance.[18]

BETTER UNDERSTANDING THE CHALLENGE THROUGH ADDITIONAL DATA AND RESEARCH

While more data are available than ever before, there is still a need to better understand the complex situation facing women and URMs in the S&E industrial workforce from the very beginning of the pipeline through advancement to the highest corporate levels. In addition, more analysis of what students at the K-12 and undergraduate levels know about potential science and engineering career paths would enhance understanding of how their knowledge, or lack thereof, shapes their expectations and career decisions.[19]

Further, because industries vary greatly, rather than combining employment and advancement data for all industries together, it would be beneficial to study differences among industries.[20] There are differences among industrial sectors (e.g., pharmaceutical, aerospace, and information technology) that impact sector-specific requirements (e.g., US citizenship) for hiring a STEM workforce. These differences, real and perceived, impact not only recruitment but also

---

[12] Comment made by participants of breakout group 1.
[13] Comment made by participants of breakout group 1.
[14] Comment made by participants of breakout group 1.
[15] Comment made by participants of breakout group 2.
[16] Comment made by participants of breakout group 2.
[17] For further information on mentoring and sponsorship, see *Sponsoring Women to Success* (http://catalyst.org/publication/485/sponsoring-women-to-success; accessed September 17, 2013); and *Women and the Trouble with Mentors* (http://catalyst.org/publication/485/sponsoring-women-to-success; accessed September 17, 2013).
[18] Comment made by participants of breakout group 2.
[19] Comment made by participants of breakout group 1.
[20] Comment made by workshop participants.

retention of diverse STEM employees. More research on barriers for women and underrepresented minorities in different industry settings would shed light on how certain corporate cultures and/or systemic issues may inhibit recruitment, retention, and advancement.[21] More focused data collection and analysis of the technical workforce is needed for a more nuanced view of employment trends in companies by industry/sector (e.g., data on technically trained employees working in management).[22] Data demonstrate that retention of URMs and women in industry is essential, but little is known about when and why they leave industry. To move forward, more data are needed, as is more sharing of best practices.[23]

Although some trends in the advancement of women into management are observable, the causes behind those trends are less well understood. More research is needed to understand why women do or do not choose the management track.[24] In other words, are there gender differences in how men and women thrive?[25] "Climate studies,"[26] common in academia, are needed in companies as well to better understand how and why employees make decisions to stay in or leave the S&E workforce (e.g., the "scissors effect"[27]).[28]

Finally, more research is necessary to illuminate the broader spectrum of societal factors that influence decisions that affect the inclusion of women and URMs in the S&E industrial workforce and how to ensure their greater recruitment, retention, and advancement going forward. For example, how do socioeconomic factors affect individuals' perceptions and choices regarding science and engineering careers?[29] And how will generational changes reflect broader socioeconomic shifts in the population?[30] Many minorities are first-generation college graduates, but this will change over time. These changes and their effects should also be studied.[31]

---

[21] Comment made by workshop participants.
[22] Comment made by participants of breakout group 1.
[23] Comment made by workshop participants.
[24] Additionally, one could research whether or not equity in female role models in management positions is critical in increasing the number of women overall and the number of women choosing to pursue management roles, if other environmental policies and considerations are in place to support them in whatever roles they play.
[25] Comment made by participants of breakout group 3.
[26] One example of a climate study of women and minorities in the workplace was *Good for Business: Making Full Use of the Nation's Human Capital*. The Environmental Scan. A Fact-Finding Report of the Federal Glass Ceiling Commission. Washington, March 1995. The report found that "in the private sector, equally qualified and similarly situated citizens are being denied equal access to advancement into senior-level management on the basis of gender, race, or ethnicity" (pp. 10-11).
[27] The scissors diagram illustrates that girls do well in STEM up through the receipt of their bachelor's degree. However, the scissors cross once they reach the doctoral preparation stage and farther. In other words, fewer and fewer women advance up the professional hierarchy. See, for example, *Mapping the Maze: Getting More Women to the Top in Research*. 2008. European Commission (http://ec.europa.eu/research/science-society/document_library/pdf_06/mapping-the-maze-getting-more-women-to-the-top-in-research_en.pdf; accessed March 31, 2014). The same phenomenon is observable among underrepresented minorities as well, the *Civil Rights Monitor* found: "in the private sector, equally qualified and similarly situated citizens are being denied equal access to advancement into senior-level management on the basis of gender, race or ethnicity" (www.civilrights.org/monitor/vol8_no1/art7.html; accessed March 14, 2014).
[28] Comment made by participants of breakout group 3.
[29] Comment made by workshop participants.
[30] The current and long-term impacts of the economic downturn and students' ability to afford college, especially minority students often overrepresented in lower socioeconomic status, should be considered. Review of existing strategies and programs from scholarships to student research, work study, community college, and 4-year partnerships could be explored.
[31] Comment made by workshop participants.

Appendix A

Statement of Task

Committee on Capitalizing on the Diversity of the Science and Engineering Workforce in Industry

An ad hoc committee was organized to conduct a study on how to maximize the recruitment, retention, and advancement of women and underrepresented minorities in industries that have a large science and engineering (S&E) component. The committee focused on the following questions which were used to plan this workshop:

(1) What is the representation of women and underrepresented minorities in the industrial workforce? Do women and underrepresented minorities hold significant leadership positions? Does this differ by sector? What is the rate of change? Is it sufficient relative to the overall workforce population of women and underrepresented minorities?

(2) What is the typical route of advancement in science and engineering firms? Do the routes of advancement for women and minorities in industry differ from majority men in industry? Have the efforts by industry to recruit greater participation of women and minorities been effective? Do the critical points for advancement in technical careers differ from that of nontechnical careers?

(3) What current challenges exist in the recruitment, retention, and advancement of women and underrepresented minority scientists and engineers working in industry? Do these challenges differ by S&E sector? Large and small corporations? Research and technical versus business and management? Do corporations and individual scientists and engineers hold the same view?

(4) How do workplace recruitment, retention, and advancement policies influence the competitiveness of individual firms in the marketplace? The competitiveness of industrial sectors? Are there exemplars that illustrate this?

(5) How can industrial policies encourage the recruitment, retention, and advancement of women and underrepresented minorities? What works and what does not work? Does one type of policy work better than another (e.g., “push” vs. “pull strategies”)? What are the best practices? Are they distinctive for women? For underrepresented groups? For women of color?

(6) Are there best practices in industry that could be replicated in academia to increase the recruitment, retention, and advancement of women and underrepresented groups?

Appendix B

Questions for Discussion

Business Imperatives and Best Practices: Lessons on Recruiting, Retaining, and Advancing Underrepresented Populations in the S&E Industrial Workforce

Section I Getting started (taking on the challenge)

A. *Why begin?* What led your company to address the challenge? What change, internal or external, was the impetus for getting started?

B. *Hard choices:* What trade-offs did you have to make in order to address the challenge? What did you have to stop doing, or do less of, in order to undertake this effort?

C. *Initial approach:* What was/were your initial program, initiatives, policies, etc.? For example, did you use affinity groups, company-wide goals, manager training, regional or global programs, pipeline ("K-to-Workplace") programs, quotas, other? Was your approach different for women and underrepresented minorities?

Section II Under way (on the journey)

A. *Revectoring:* Over time, what did you add to or drop from the scope of your program, and why? How, if at all, did you need to change your implementation plan from its original form?

B. *Today's program:* What is your current approach/program?

Section III Lessons from the journey (what you wish you had known when you started!)

A. *Successes:* What worked better than expected? What have you found to be the most critical ingredients for success, the most important "best practices," etc.?

B. *Barriers overcome:* What unexpected roadblocks did your program(s) have to overcome along the way?

C. *Failures:* For any part of your program(s) that did not succeed, what caused the failure? What can others learn to increase their own likelihood of success?

Section IV Results (are you getting anywhere?)

A. *Metrics:* How do you measure progress relative to your program goals?

B. *Outcomes:* Are you achieving your desired outcomes in the recruitment, retention, and advancement of women and underrepresented minorities?

C. *Continuous improvement:* Do you modify your program structure, content or schedule based on performance results?

Section V Remaining challenges (what's still hard?)

A. *What's hard?* What barriers remain – persistent, resistant, and stubborn?

B. *Seeking ideas?* What inputs would be helpful to get from your industry peers?

Section VI Beyond your control

A. *Policies:* What government policies, US or foreign, could aid or impede your ability to build a diverse workforce?

B. *Trends:* What new trends are most concerning?

Appendix C

Workshop Agenda

Creating a Game-Changing Environment for All in the Industrial Workforce
May 21, 2012
Washington, DC

9:00 – 9:30 AM	**Registration and Breakfast**
9:30 – 9:45 AM	**Welcome and Overview of the Workshop** ***Proctor Reid****, Director, Program Office, National Academy of Engineering (NAE)* ***Catherine Didion****, Senior Program Officer, NAE*
9:45 – 10:45 AM	**Opening Plenary: New Release of the National Science Foundation Report on Scientists and Engineers Statistical Data System (SESTAT) on Diversity in Industry** **Moderator:** ***Alice Agogino****, Roscoe and Elizabeth Hughes Professor of Mechanical Engineering, University of California, Berkeley; Councillor, NAE* **Speaker:** ***Jaquelina Falkenheim****, Senior Analyst, National Center for Science and Engineering Statistics, National Science Foundation*
10:45 – 11:45 AM	**Discussion Panel: Business Imperatives and Best Practices: Lessons on Recruiting, Retaining, and Advancing Underrepresented Populations in the Science and Engineering (S&E) Industrial Workforce** **Moderator:** ***Suzanne Jenniches****, Vice President and General Manager (Retired), Northrop Grumman Corporation; and Chair, EngineerGirl! Steering Committee, NAE* **Panelists:** ***Barry Cordero****, Principal Project Engineer, Medtronic; National Vice President, Society of Hispanic Professional Engineers (SHPE)* ***Sylvester Mendoza, Jr.****, Corporate Director, Diversity & Inclusion and EEO, Northrop Grumman Corporation* ***Rick Stephens****, Senior Vice President, Human Resources & Administration, The Boeing Company*
11:45 – 12:15 PM	**General Discussion**

12:15 – 1:30 PM **Luncheon Discussion Groups**

Group One: Technical Career Paths versus Management Career Paths in S&E Industry: Differences for Underrepresented Populations?
Room: Keck 400

Moderator: ***Herman White, Jr.***, *Senior Scientist, Fermi National Accelerator Laboratory*
Rapporteur: ***Wei Jing***, *Research Associate, Policy and Global Affairs, The National Academies*

Group Two: Lessons from Practices on Recruiting, Retaining, and Advancing Underrepresented Minorities in S&E Industries
Room: Keck 105

Moderator: ***Barry Cordero***, *Principal Project Engineer, Medtronic; National Vice President, SHPE*
Rapporteur: ***Catherine Didion***, *Senior Program Officer, NAE*

Group Three: Lessons from Practices on Recruiting, Retaining, and Advancing Women (and Women of Color) in S&E Industries
Room: Keck 500

Moderator: ***Suzanne Jenniches***, *Vice President and General Manager (Retired), Northrop Grumman Corporation; Chair, EngineerGirl! Steering Committee, NAE*
Rapporteur: ***Rita Guenther***, *Program Officer, Policy and Global Affairs, The National Academies*

1:30 – 1:45 PM **Key Elements from Luncheon Discussions**
Room: Keck 201

1:45 – 2:00 PM **Next Steps & Adjournment**

Appendix D

Biographies of Speakers

(Speakers' biographies at the time of the workshop)

Alice M. Agogino (National Academy of Engineering member) is the Roscoe and Elizabeth Hughes Professor of Mechanical Engineering and an affiliated faculty member at the University of California, Berkeley (UCB) Haas School of Business. She also directs the Berkeley Expert Systems Technology Laboratory and the Berkeley Instructional Technology Studio. She has served in a number of administrative positions at UCB, including associate dean of engineering and faculty assistant to the executive vice chancellor and provost in educational development and technology. She continues as principal investigator for the National Engineering Education Delivery System and the digital libraries of courseware in science, mathematics, engineering, and technology. She received a BS in mechanical engineering from the University of New Mexico (1975), an MS in mechanical engineering (1978) from UCB, and a PhD from the Department of Engineering-Economic Systems at Stanford University (1984). She is a member of the Association of Women in Science and was awarded the National Science Foundation (NSF) Director's Award for Distinguished Teaching Scholars in 2004. She served on the National Research Council's Committee on Women in Academic Science and Engineering and is a member of the NAE Council.

Barry Cordero is the national vice president for the Society of Hispanic Professional Engineers (SHPE) and a principal project engineer at Medtronic's Cardiac Rhythm Device Management business unit. At night and on weekends he manages the strategic plans of seven board members representing over 10,000 members seeking professional and skills development through SHPE programs and initiatives. During the day, he uses his Lean Sigma Black Belt Certification to mentor and lead Medtronic Operations' process improvement projects locally and at their strategic suppliers. Prior to joining Medtronic, Cordero worked as a manufacturing engineer and a quality engineer at Abbott Labs and Alphatec Spine, Inc., where he made significant contributions to design for manufacturability and qualification/validation efforts. Simultaneously, he chaired the SHPE 2008 National Conference Hosting Committee, for which he managed a multimillion-dollar budget, 35 volunteers, and hundreds of stakeholder needs and requests, achieving one of the biggest conference attendance rates to date and the largest professional member attendance at an SHPE National Conference. Cordero attributes his unique perspectives at work and SHPE to his enlistment as a Nuclear Power Plant Electrician aboard the USS Nimitz CVN68. He proudly served his country for six years as a Reactor Drill Team Leader, Nuclear Electric Plant Load Dispatcher, and Reactor Electrical Training Office lead. The Nuclear Navy taught him the true meaning of "cost of quality," the power of integrity, and the value of working in teams. Advancing in rank at every possible opportunity, he completed his enlistment as a First Class Petty Officer in 2003.

Jaquelina Falkenheim is a senior analyst in the Science and Engineering Indicators Program at the NSF National Center for Science and Engineering Statistics (NCSES). Her research focuses on higher education trends and diversity in science and engineering. She authored the higher education chapter in the 2012 *Science and Engineering Indicators* report and *Women, Minorities, and Persons with Disabilities in Science and Engineering*. Prior to working at NCSES she was a research program manager at the Center for Women's Business Research in Washington, DC and an analyst at Gallup Argentina. She holds a BA in Statistics from the Hebrew University of Jerusalem, an MA in Communication Studies from the University of Michigan-Ann Arbor, and a PhD in International Communication from the University of Texas at Austin.

Suzanne Jenniches retired as vice president and general manager of Northrop Grumman Government Systems Division in March 2010, following a 41-year professional career in education and engineering. Jenniches taught for five years as a high school biology teacher in Westminster, Maryland, while pursuing her master's degree in environmental engineering at Johns Hopkins University. She has completed extensive postgraduate work in international affairs at the Catholic University of America and attended the Harvard Business School Program for Management Development. She joined Westinghouse Electric Corporation as a computerized test engineer in 1974 and later was the supervisory engineer of robotics development for electronics manufacturing. She then served as operations program manager from 1981 to 1985. In 1986, Jenniches was appointed manager of Systems & Technology Operations, where she was responsible for transitioning defense avionics hardware programs from engineering to smooth high-rate production. From 1989 she managed a broad cross-section of defense and nondefense profit and loss operating units with increasingly larger responsibilities for Westinghouse Defense, and in 1996 Northrop Grumman Corporation acquired the Westinghouse Electronics Systems. Jenniches is past president of the Society of Women Engineers and in June 2000 received its Achievement Award "in recognition of outstanding leadership in manufacturing innovation and for setting the highest standards of excellence in producibility engineering." Jenniches served as a member of the United States Army Science Board from 1999 to 2005. She was a member of the National Research Council (NRC) Committee on Commercial/Military Integration. She served on the board of directors of MICROS, a publicly traded NASDAQ corporation, from 1996 to 2003 and again from 2006 to present. She was the 2005 American Association of Engineering Societies Chair and received the Chair's Award in 2008 for "continued advancement of the engineering profession." She is on the Johns Hopkins University Whiting School of Engineering National Advisory Council and was the founding chair of the Engineering Programs for Professionals Advisory Council (2003–2006); she was named a Johns Hopkins Distinguished Alumna in 2006. She has chaired the NAE "EngineerGirl!" Website Steering Committee since 1997.

Sylvester Mendoza, Jr., is the corporate director for diversity and inclusion and EEO for Northrop Grumman in Falls Church, VA, where he leads the strategic design and execution of its programs, including Work/Life Integration. Before joining Northrop Grumman, he held a position as the senior director for global diversity strategies at Schering-Plough in New Jersey, where he led the pharmaceutical company's diversity and inclusion strategy and implementation worldwide. Mendoza's extensive experience also includes a role as director of diversity and talent acquisition for Quest Diagnostics, the country's largest medical laboratory, headquartered in New Jersey, and a similar corporate position at Merrill Lynch in New York. Previously, he worked at Hughes Electronics in Los Angeles, and with General Telephone of California in a senior human resources management capacity. Mendoza has been an active board member with a number of community-based organizations, including the Asian Pacific American Legal Center, Search to Involve Filipino Americans, and the Los Angeles Southwest College Foundation. He is a current member of the Business Advisory Council of the Asian American Justice Center, Washington, DC, and a former board member of the Asian American Federation of New York and the Employment Committee for the Office of Disability Employment Program, US Department of Labor. His professional affiliations include the Conference Board (Council of US Diversity and Inclusion Executives), Equal Employment Advisory Council, and Mercer/Organization Resource Counselors. Mendoza received his BA from California State University, San Francisco, and his JD from the University of California, Hastings College of the Law. He also completed the advanced program in Human Resource Management at the University of California, Los Angeles, and Six Sigma training.

Richard (Rick) Stephens is senior vice president for human resources and administration for the Boeing Company and a member of the Boeing Executive Council. Stephens, a 31-year Boeing veteran, oversees leadership development, training, employee relations, compensation, benefits, Global Corporate Citizenship, diversity initiatives, and the Shared Services Organization, which is responsible for providing common infrastructure and services to Boeing businesses. During his career with Boeing, Stephens has led a number of business areas at sites across the United States and around the world including Homeland Security and Services, Space Shuttle, Tactical Combat Systems, and Internal Services. He serves on a number of nonprofit and business-focused boards and has been recognized for his longstanding leadership in local and national organizations. Passionate about improving education both in and outside the classroom, he works directly with community and education leaders to prepare future workers to meet the challenges necessary to succeed in an ever-changing and competitive business environment. A former US Marine Corps officer, Stephens serves on the National Governors Association Center for Best Practices Science, Technology, Engineering, and Math (STEM) Advisory Committee, designed to assist governors in developing comprehensive STEM agendas. He is a fellow of the American Institute of Aeronautics and Astronautics, where he is chair of the Career and Workforce Development Steering Committee, a member of the Business-Higher Education Forum, founding member of the Business and Industry STEM Education Coalition, member of the Illinois P-20 Council, chair of the Global Midwest Alliance, and chair of the Illinois Business Roundtable. Stephens also is part of the Chairman's CEO Leadership Caucus for the Orange County, CA, Business Council. He has served on the Department of Homeland Security Advisory Council, the Secretary of Education's Commission on the Future of Higher Education, the President's Board of Advisors on Tribal Colleges and Universities, and the National Science Resources Center Advisory Board. Stephens received his BS degree in mathematics in 1974 from the University of Southern California, where he is the Boeing executive, and his MS degree in computer science in 1984 from California State University, Fullerton. Stephens is an enrolled member of the Pala Band of Mission Indians and served as tribal chairman in 1988–1989.

Herman B. White, Jr., is a scientist at the Fermi National Accelerator Laboratory. He is an expert in particle physics and the only African American in his field at this facility. He completed his BA at Earlham College, his MA at Michigan State University, and his PhD at Florida State University, all in physics. He was a resident research associate in nuclear physics at Argonne National Laboratory, an Alfred P. Sloan Foundation Travel Fellow at the CERN

Laboratory for particle physics research in Geneva, Switzerland, and University Fellow in Physics at Yale University. His research has covered a range of topics in particle and nuclear physics, including neutrino and kaon physics, as well as work with accelerators and particle beams. He has been involved with many communication efforts to bring information, concerns, and focus about the workforce and about physics and physical science research to the US Congress and government agencies. He has also made invited presentations to business and law school students at the University of Caen in Normandy, France, on the value of science in their professions. White has mentored and interacted with underrepresented minority students who participate in Fermilab's pioneering internship program since 1974, and has a working relationship with a number of minority-serving institutions to encourage more underserved students to enter the scientific workforce. He has served on the American Physical Society (APS) National Committee on Minorities in Physics, APS International Physics Group, and is an adjunct professor of physics at North Central College in Naperville, IL. White has also served on the joint US Department of Energy/NSF High Energy Physics Advisory Panel, and on a number of institutional and corporate boards of directors.

Appendix E

Speakers and Participants

(listed alphabetically with affiliations at the time of the workshop)

Alice Agogino (NAE)
Roscoe and Elizabeth Hughes Professor of Mechanical Engineering
University of California, Berkeley

Carol Bowers
Interim Executive Director
American Association of Engineering Societies

Melissa Carl
Manager
American Society of Mechanical Engineers

Brooke Coley
Science and Technology Policy Fellow
American Association for the Advancement of Science
National Science Foundation

Nancy Conrad
Chairman
Conrad Foundation

Christi Corbett
Senior Researcher
American Association of University Women

Barry Cordero
Principal Project Engineer
Medtronic; and
National Vice President
Society of Hispanic Professional Engineers

Melissa Dark
Professor
Purdue University

Duane Dunlap
Associate Dean
Purdue University

Earnestine Easter
Program Director
National Science Foundation

Omnia El-Hakim
Program Director
Diversity and Outreach
National Science Foundation

Jaquelina Falkenheim
Senior Analyst
National Center for Science and Engineering Statistics
National Science Foundation

Denise Gammal
Director
Research and Corporate Partnerships
Anita Borg Institute for Women and Technology

Virgil Griffin
Director
Government Operations
The Boeing Company

Beth Hoagland
Intern
American Geosciences Institute

DaNel Hogan
Einstein Educator Fellow
Office of Energy Efficiency and Renewable Energy
Department of Energy

Stephenie Husband
Project Manager
SAIC

Arundhati Jayarao
Educator

Suzanne Jenniches
Vice President and General Manager (ret.)
Northrop Grumman Corporation;
Chair
NAE EngineerGirl! Steering Committee

Roosevelt Johnson
Deputy Associate Administrator
National Aeronautics and Space Administration

Nirmala Kannankutty
Senior Advisor
National Science Foundation

Elizabeth Kradjian
Assistant to the Dean
Binghamton University

Meka Laster
Program Planning Specialist
Office of Education
National Oceanic and Atmospheric Administration

Claire Leduc
Statistician, Office of Education
Educational Partnership Program
National Oceanic and Atmospheric Administration

Michele Lezama
Executive Director
The National GEM Consortium

Abbie Liel
Assistant Professor
University of Colorado, Boulder

Susan Martin
Associate Director
University of Maryland, Baltimore County

Ernest Marquez
President
Society for Advancement of Hispanics/Chicanos and Native Americans in Science

Sylvester Mendoza, Jr.
Corporate Director
Diversity and Inclusion, and EEO
Northrop Grumman Corporation

Lueny Morell
Program Manager
Hewlett Packard Laboratories

Don Nelson, Jr.
Director
Corporate Relations
National Society of Black Engineers

Ann Redelfs
Chief Executive Officer
Redelfs LLC

Rosario Robinson
Program Manager
Anita Borg Institute for Women and Technology

Kathleen Ross
Research Scientist
George Washington University

Carol Rudisill
Director
Anita Borg Institute for Women and Technology

Caroline Simard
Associate Director
Stanford University School of Medicine

Michael D. Smith
Deputy Executive Director
National GEM Consortium

Rick Stephens
Senior Vice President
Human Resources and Administration
The Boeing Company

Umesh Thakkar
Science and Technology Policy Fellow
American Association for the Advancement of Science

Constance Thompson
Senior Manager
Diversity
American Society of Civil Engineers

Karyn Trader-Leigh
Chief Executive Officer
KTA Global Partners, LLC

Pamela Truesdell
Einstein Fellow
National Science Foundation

Richard Weibl
Director
Center for Careers in Science and Technology
American Association for the Advancement of Science

Herman White
Senior Scientist
Fermi National Accelerator Laboratory

Sylvanus Wosu
Associate Dean for Diversity Affairs
University of Pittsburgh

National Academies Staff

Proctor Reid
Director, Program Office
National Academy of Engineering

Catherine Didion
Senior Program Officer
National Academy of Engineering

Rita Guenther
Program Officer
Policy and Global Affairs

Wei Jing
Research Associate
Policy and Global Affairs

Subhash Kuvelker
Study Director and Senior Program Officer
Policy and Global Affairs Division

Appendix F

National Science Foundation Info Brief
Diversity in Science and Engineering Employment in Industry

Jaquelina C. Falkenheim and Joan S. Burrelli[1]

In 2008, 19 million scientists and engineers were employed in the United States.[2] This figure includes 4.9 million employed in science and engineering (S&E) occupations, 5.5 million employed in S&E related occupations, and 8.8 million employed in non-S&E occupations with S&E related degrees.[3] More than half (53%) of these scientists and engineers worked in industry (Figure F-1).

This InfoBrief examines sex, racial/ethnic, and disability characteristics of scientists and engineers employed in industry, including breakouts by highest educational degree, occupation, primary and secondary work activity, and management occupations.

Compared with their proportions in the U.S. population, women, blacks, Hispanics (regardless of racial background), American Indians and Alaska Natives, and persons with disabilities are underrepresented in the industrial S&E workforce; Asians and whites are overrepresented.[4] White men who are not of Hispanic origin account for half of the scientists and engineers working in industry, and white women who are not of Hispanic origin account for another 25% (Table F-1). Minority women account for 10% and minority men account for 15% of scientists and engineers working in industry, with about half of all minorities being Asian.[5] Six percent of scientists and engineers employed in industry have disabilities.

[1]Jaquelina C. Falkenheim (jfalkenh@nsf.gov; 703-292-7798) and Joan S. Burrelli (retired), Science and Engineering Indicators Program, National Center for Science and Engineering Statistics, National Science Foundation, 4201 Wilson Boulevard, Suite 965, Arlington, VA 22230.

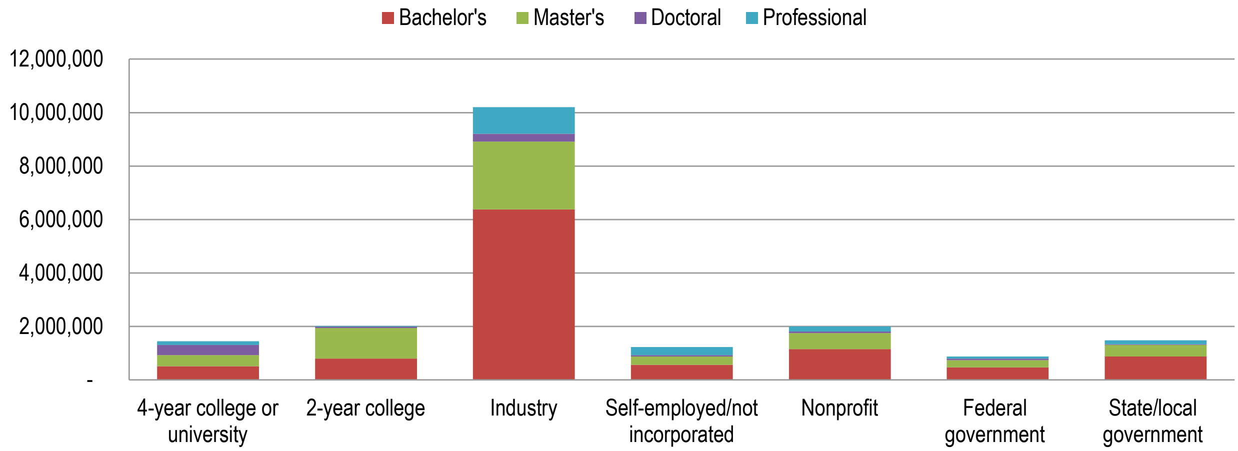
[2] In this report, "industry" includes private for-profit noneducational institutions, persons who are self-employed and incorporated, and other for-profit noneducational employers.

[3] National Science Board (NSB). 2012. Science and Engineering Indicators 2010. NSB 12-01. Arlington, VA: National Science Foundation.

[4] For data on demographic characteristics of the U.S. population, see National Science Foundation, Division of Science Resources Statistics (NSF/SRS). 2011. *Women, Minorities, and Persons with Disabilities in Science and Engineering*. Special Report NSF 11-309. Arlington, VA. Available at www.nsf.gov/statistics/wmpd/.

[5] A minority is a racial/ethnic group that is a small percentage of the U.S. population. Minority groups include blacks or African Americans, Hispanics, American Indians or Alaska Natives, Native Hawaiians or Other Pacific Islanders, Asians, and persons who reported multiple races.

FIGURE F-1 Employed scientists and engineers, by sector of employment and level of highest degree: 2008



NOTES: Scientists and engineers include persons who have ever received a U.S. bachelor's or higher degree in a science and engineering (S&E) or S&E-related field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003. Industry includes private for-profit noneducational institutions, persons who are self-employed and incorporated, and other for-profit noneducational employers. Numbers are rounded to the nearest thousand. Detail may not add to total because of rounding.
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System (SESTAT): 2008.

Highest Educational Degree

Most scientists and engineers (63%) employed in industry have a bachelor’s degree as their highest degree (Figure F-1, Table F-1). Another 25% have master’s degrees, and 3% have doctoral degrees. Although the percentage with doctoral degrees is small, the number of scientists and engineers with doctorates in industry (300,000) is second only to the number of scientists and engineers with doctorates who are employed by 4-year colleges and universities (381,000).

Male scientists and engineers employed in industry have higher levels of education than their female counterparts. Among scientists and engineers employed in industry, women are more likely than men to have a bachelor’s as their highest degree and men are more likely than women to have a doctoral degree. Black, Hispanic, and white scientists and engineers in industry have fairly similar educational attainment, but Asians, Asian men in particular, are more likely than any other group to have master’s or doctoral degrees (Table F-1). Compared with scientists and engineers without disabilities, those with disabilities are more likely to have a bachelor’s as their highest degree and are less likely to have a master’s as their highest degree.

TABLE F-1 Scientists and engineers employed in industry, by sex, race/ethnicity, disability status, and level of highest degree: 2008

Sex, race/ethnicity, and disability status	All degree levels[a]		Bachelor's		Master's		Doctoral	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Both sexes	10,204,000	100.0	6,374,000	62.5	2,536,000	24.9	300,000	2.9
White	7,639,000	100.0	4,886,000	64.0	1,792,000	23.5	196,000	2.6
Asian	1,311,000	100.0	646,000	49.3	471,000	35.9	84,000	6.4
Black or African American	470,000	100.0	313,000	66.6	112,000	23.8	8,000	1.7
Hispanic	542,000	100.0	351,000	64.8	121,000	22.3	8,000	1.5
American Indian or Alaska Native	36,000	100.0	26,000	72.2	7,000	19.4	*	*
Native Hawaiian or Other Pacific Islander	44,000	100.0	34,000	77.3	6,000	13.6	1,000	2.3
Multiple race	161,000	100.0	118,000	73.3	26,000	16.1	3,000	1.9
Without disability	9,561,000	100.0	5,940,000	62.1	2,396,000	25.1	283,000	3.0
With disability	643,000	100.0	434,000	67.5	140,000	21.8	17,000	2.6
Female	3,587,000	100.0	2,310,000	64.4	872,000	24.3	70,000	2.0
White	2,575,000	100.0	1,687,000	65.5	607,000	23.6	45,000	1.7
Asian	471,000	100.0	258,000	54.8	148,000	31.4	17,000	3.6
Black or African American	232,000	100.0	156,000	67.2	54,000	23.3	4,000	1.7
Hispanic	208,000	100.0	136,000	65.4	48,000	23.1	3,000	1.4
American Indian or Alaska Native	13,000	100.0	10,000	76.9	2,000	15.4	*	*
Native Hawaiian or Other Pacific Islander	16,000	100.0	12,000	75.0	1,000	6.3	*	*
Multiple race	72,000	100.0	52,000	72.2	12,000	16.7	1,000	1.4
Without disability	3,397,000	100.0	2,176,000	64.1	832,000	24.5	68,000	2.0
With disability	190,000	100.0	134,000	70.5	41,000	21.6	2,000	1.1
Male	6,617,000	100.0	4,064,000	61.4	1,664,000	25.1	229,000	3.5
White	5,063,000	100.0	3,200,000	63.2	1,185,000	23.4	151,000	3.0
Asian	840,000	100.0	389,000	46.3	323,000	38.5	67,000	8.0
Black or African American	238,000	100.0	156,000	65.5	59,000	24.8	4,000	1.7
Hispanic	334,000	100.0	216,000	64.7	73,000	21.9	5,000	1.5
American Indian or Alaska Native	23,000	100.0	16,000	69.6	5,000	21.7	*	*
Native Hawaiian or Other Pacific Islander	29,000	100.0	21,000	72.4	5,000	17.2	*	*
Multiple race	89,000	100.0	67,000	75.3	13,000	14.6	2,000	2.2
Without disability	6,164,000	100.0	3,764,000	61.1	1,564,000	25.4	215,000	3.5
With disability	453,000	100.0	301,000	66.4	99,000	21.9	15,000	3.3

* = estimate < 500.

[a] Total includes professional degrees not broken out separately.

NOTES: Scientists and engineers include persons who have ever received a U.S. bachelor's or higher degree in a science and engineering (S&E) or S&E-related field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003. American Indians or Alaska Natives, Asians, blacks or African Americans, Native Hawaiians or Other Pacific Islanders, whites, and persons reporting more than one race refer to individuals who are not of Hispanic origin. Persons of Hispanic origin may be of any race. Numbers are rounded to the nearest thousand. Detail may not add to total because of rounding.
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System (SESTAT): 2008.

Occupation

Of the 10 million scientists and engineers employed in industry, about 3 million work in S&E occupations, over 2 million work in S&E-related occupations (primarily doctors and nurses), and nearly 5 million work in non-S&E occupations (primarily top-level management, management-related occupations, and sales). Among those employed in S&E occupations, by far the largest numbers are employed as computer and mathematical scientists and engineers (Table F-2).

Men and women differ in occupation within the industry sector. Men are more likely than women to be engineers and computer and mathematical scientists, and women are more likely than men to work in S&E-related occupations. With the exception of Asians, most racial/ethnic groups differ little in occupation within industry. Asians are more likely than other racial/ethnic groups to be computer and mathematical scientists and less likely to work in non-S&E occupations. Persons with and without disabilities work in largely similar occupations.

Primary or Secondary Work Activity

In contrast to academia, where most scientists and engineers are engaged in teaching and research, the majority of scientists and engineers working in industry reported that their primary or secondary work activity was management, sales, or administration (69%). Another 30% reported research and development, 15% reported computer applications, and 6% reported teaching (Table F-3).[6]

Partly reflecting differences in occupation discussed above, men are more likely than women to report research and development or computer applications as their primary or secondary work activity, whereas women are more likely to name teaching, regardless of race/ethnicity or disability status. Asians are more likely than any other racial/ethnic group to report research and development or computer applications as their primary or secondary work activity, and they are less likely than most other racial/ethnic groups to report management, sales, or administration. Compared with most other racial ethnic groups, blacks are less likely to report research and development and more likely to report teaching as their primary/secondary work activity. Persons with and without disabilities differ little in work activity.

[6] Totals sum to more than 100% because respondents could select both a primary and a secondary work activity.

TABLE F-2 Scientists and engineers employed in industry, by sex, race/ethnicity, disability status, and occupation: 2008 (Percent)

		S&E occupations						
Sex, race/ethnicity, and disability status	All occupations (*n*)	Computer and mathematical scientists	Biological, agricultural, and other life scientists	Physical and related scientists	Social and related scientists	Engineers	S&E-related occupations	Non-S&E occupations
Both sexes	10,204,000	14.1	1.4	1.5	1.1	12.1	24.4	45.4
White	7,639,000	12.4	1.3	1.5	1.2	12.0	24.3	47.4
Asian	1,311,000	26.3	2.1	1.8	0.8	14.7	23.6	30.7
Black or African American	470,000	12.6	1.1	0.9	0.9	7.2	27.2	50.4
Hispanic	542,000	10.0	1.7	1.3	0.9	11.8	26.4	48.0
American Indian or Alaska Native	36,000	13.9	D	S	S	8.3	33.3	41.7
Native Hawaiian or Other Pacific Islander	44,000	13.6	*	D	D	15.9	27.3	40.9
Multiple race	161,000	13.7	1.2	1.9	1.2	12.4	22.4	47.8
Without disability	9,561,000	14.1	1.4	1.5	1.2	12.1	24.7	45.1
With disability	643,000	12.8	0.9	1.7	0.8	12.6	21.2	49.9
Female	3,587,000	9.3	1.8	1.3	1.4	4.2	33.8	48.1
White	2,575,000	7.9	1.7	1.2	1.6	3.5	34.6	49.3
Asian	471,000	18.5	2.8	1.9	1.1	7.4	29.5	38.9
Black or African American	232,000	9.9	1.3	0.9	0.4	3.0	37.5	47.0
Hispanic	208,000	5.8	1.9	1.0	1.0	4.8	30.3	55.3
American Indian or Alaska Native	13,000	S	D	D	D	7.7	46.2	38.5
Native Hawaiian or Other Pacific Islander	16,000	D	D	D	D	S	37.5	43.8
Multiple race	72,000	8.3	S	S	1.4	5.6	29.2	52.8
Without disability	3,397,000	9.3	1.9	1.3	1.4	4.3	34.0	47.9
With disability	190,000	8.9	1.6	1.6	1.6	2.1	31.1	53.2
Male	6,617,000	16.6	1.2	1.6	1.0	16.4	19.4	43.9
White	5,063,000	14.6	1.1	1.6	1.0	16.3	19.0	46.4
Asian	840,000	30.7	1.7	1.7	0.8	18.8	20.4	26.1
Black or African American	238,000	15.1	0.8	0.8	S	11.3	17.2	53.8
Hispanic	334,000	12.6	1.5	1.8	0.6	16.2	24.0	43.4
American Indian or Alaska Native	23,000	17.4	D	*	D	8.7	26.1	43.5
Native Hawaiian or Other Pacific Islander	29,000	13.8	D	D	D	20.7	20.7	37.9
Multiple race	89,000	18.0	S	2.2	S	16.9	16.9	43.8
Without disability	6,164,000	16.8	1.2	1.6	1.0	16.4	19.5	43.5
With disability	453,000	14.3	0.9	1.8	0.4	17.0	17.0	48.6

* = estimate < 500; D = suppressed for confidentiality; S = suppressed for reliability.
S&E = science and engineering.

NOTES: Scientists and engineers include persons who have ever received a U.S. bachelor's or higher degree in an S&E or S&E-related field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003. See http://sestat.nsf.gov/docs/occ03maj.html for a detailed description of the occupational classification. American Indians or Alaska Natives, Asians, blacks or African Americans, Native Hawaiians or Other Pacific Islanders, whites, and persons reporting more than one race refer to individuals who are not of Hispanic origin. Persons of Hispanic origin may be of any race. Numbers are rounded to the nearest thousand. Detail may not add to total because of rounding.
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System (SESTAT): 2008.

TABLE F-3 Scientists and engineers employed in industry, by sex, race/ethnicity, disability status, and primary/secondary work activity: 2008 (Percent)

Sex, race/ethnicity, and disability status	All work activities (*n*)[a]	Research and development	Management, sales, or administration[b]	Computer applications	Teaching
Both sexes	10,204,000	30.0	68.8	15.2	5.7
White	7,639,000	28.8	71.0	13.5	5.6
Asian	1,311,000	39.7	55.8	27.3	4.0
Black or African American	470,000	24.7	68.5	12.3	10.0
Hispanic	542,000	28.2	69.7	12.4	7.4
American Indian or Alaska Native	36,000	27.8	63.9	8.3	S
Native Hawaiian or Other Pacific Islander	44,000	27.3	70.5	11.4	6.8
Multiple race	161,000	29.8	69.6	13.7	5.6
Without disability	9,561,000	30.1	68.8	15.2	5.7
With disability	643,000	29.1	69.4	14.0	5.4
Female	3,587,000	22.2	66.6	9.9	10.2
White	2,575,000	20.7	68.5	8.6	10.6
Asian	471,000	30.8	56.7	18.9	6.2
Black or African American	232,000	20.3	64.2	8.6	14.2
Hispanic	208,000	23.1	69.2	7.7	10.1
American Indian or Alaska Native	13,000	S	61.5	S	S
Native Hawaiian or Other Pacific Islander	16,000	25.0	62.5	D	D
Multiple race	72,000	22.2	66.7	11.1	6.9
Without disability	3,397,000	22.3	66.7	9.9	10.2
With disability	190,000	19.5	65.8	10.5	8.9
Male	6,617,000	34.3	70.0	18.0	3.2
White	5,063,000	33.0	72.3	16.0	3.0
Asian	840,000	44.8	55.2	31.9	2.6
Black or African American	238,000	29.0	72.7	16.0	6.3
Hispanic	334,000	31.4	70.1	15.3	5.7
American Indian or Alaska Native	23,000	30.4	65.2	8.7	D
Native Hawaiian or Other Pacific Islander	29,000	31.0	72.4	17.2	D
Multiple race	89,000	36.0	71.9	15.7	4.5
Without disability	6,164,000	34.3	69.9	18.2	3.1
With disability	453,000	33.1	70.9	15.5	4.0

D = suppressed for confidentiality; S = suppressed for reliability.
[a] Total includes other work activities (production, operations, or maintenance; professional services; or other) not broken out separately.
[b] Includes respondents who reported the following work activities: accounting, finance or contracts, employee relations, quality or productivity management, sales and marketing, or managing and supervising.

NOTES: Scientists and engineers include persons who have ever received a U.S. bachelor's or higher degree in a science and engineering (S&E) or S&Erelated field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003. See http://sestat.nsf.gov/docs/occ03maj.html for a detailed description of the occupational classification. American Indians or Alaska Natives, Asians, blacks or African Americans, Native Hawaiians or Other Pacific Islanders, whites, and persons reporting more than one race refer to individuals who are not of Hispanic origin. Persons of Hispanic origin may be of any race. Numbers are rounded to the nearest thousand. Detail may not add to total because of rounding and multiple response to work activity. Totals sum to more than 100% because respondents could select both a primary and a secondary work activity.
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System (SESTAT): 2008.

Management

Just over 1 in 10 scientists and engineers working in industry are managers. Men and women and the various racial/ethnic groups differ in their propensity to be managers, partly reflecting differences in age distributions. Among scientists and engineers in the United States, women are younger on average than men, and minorities are younger on average than whites.[7] Among scientists and engineers within industry, men are more likely than women to be managers, both mid-level and top-level managers, executives, and administrators within most racial/ethnic groups and regardless of disability status (Table F-4). Asians, blacks, and persons who reported multiple races are less likely than whites to be managers. Similar proportions of persons with and without disabilities are managers.

[7] National Science Board (NSB). 2010. Science and Engineering Indicators 2010. NSB 10-01. Arlington, VA: National Science Foundation.

TABLE F-4 Scientists and engineers employed in industry, by sex, race/ethnicity, disability status, and management occupation: 2008 (Percent)

Sex, race/ethnicity, and disability status	All occupations (*n*)	All managers (*n*)	Top-level managers, executives, or administrators	Mid-level S&E managers	Mid-level non-S&E managers	Nonmanagers (*n*)
Both sexes	10,204,000	1,108,000	5.8	3.1	2.0	9,095,000
White	7,639,000	900,000	6.4	3.1	2.3	6,738,000
Asian	1,311,000	97,000	3.6	2.9	0.9	1,214,000
Black or African American	470,000	36,000	3.0	3.0	1.7	434,000
Hispanic	542,000	54,000	5.2	3.0	1.8	488,000
American Indian or Alaska Native	36,000	5,000	8.3	5.6	D	32,000
Native Hawaiian or Other Pacific Islander	44,000	5,000	S	D	D	39,000
Multiple race	161,000	10,000	4.3	1.2	0.6	151,000
Without disability	9,561,000	1,044,000	5.8	3.1	2.0	8,517,000
With disability	643,000	64,000	5.0	2.6	2.2	579,000
Female	3,587,000	206,000	2.4	1.8	1.6	3,381,000
White	2,575,000	160,000	2.4	1.9	1.8	2,416,000
Asian	471,000	20,000	2.8	1.1	0.4	451,000
Black or African American	232,000	12,000	1.7	2.2	1.3	221,000
Hispanic	208,000	12,000	2.9	1.0	1.9	196,000
American Indian or Alaska Native	13,000	S	D	D	D	12,000
Native Hawaiian or Other Pacific Islander	16,000	D	D	D	D	15,000
Multiple race	72,000	2,000	D	S	D	70,000
Without disability	3,397,000	196,000	2.5	1.7	1.6	3,201,000
With disability	190,000	10,000	S	2.6	S	180,000
Male	6,617,000	902,000	7.6	3.8	2.3	5,715,000
White	5,063,000	741,000	8.4	3.8	2.5	4,322,000
Asian	840,000	77,000	4.0	3.9	1.3	763,000
Black or African American	238,000	25,000	4.6	3.8	2.1	213,000
Hispanic	334,000	42,000	6.6	4.2	1.8	292,000
American Indian or Alaska Native	23,000	4,000	13.0	D	D	19,000
Native Hawaiian or Other Pacific Islander	29,000	5,000	S	D	D	24,000
Multiple race	89,000	8,000	7.9	1.1	S	81,000
Without disability	6,164,000	848,000	7.7	3.9	2.2	5,316,000
With disability	453,000	54,000	6.4	2.9	2.6	399,000

D = suppressed for confidentiality; S = suppressed for reliability.
S&E = science and engineering.

NOTES: Scientists and engineers include persons who have ever received a U.S. bachelor's or higher degree in an S&E or S&E-related field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003. See http://sestat.nsf.gov/docs/occ03maj.html for a detailed description of the occupational classification. American Indians or Alaska Natives, Asians, blacks or African Americans, Native Hawaiian or Other Pacific Islanders, whites, and persons reporting more than one race refer to individuals who are not of Hispanic origin. Persons of Hispanic origin may be of any race. Numbers are rounded to the nearest thousand. Detail may not add to total because of rounding.
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Scientists and Engineers Statistical Data System (SESTAT): 2008.

Data Sources and Availability

Data presented here are from the 2008 Scientists and Engineers Statistical Data System (SESTAT), which comprises three large demographic and workforce surveys of individuals conducted by the National Science Foundation: the National Survey of College Graduates, the

National Survey of Recent College Graduates, and the Survey of Doctorate Recipients. The 2008 SESTAT included 100,313 individuals representing a population of about 19 million scientists and engineers, including people trained in S&E or S&E-related fields or working in S&E or S&E-related occupations. The 2008 SESTAT surveys had a reference week of 1 October 2008. All demographic, employment, and education data on scientists and engineers represent the status of these individuals during the reference week. The full set of detailed tables from the SESTAT integrated database will be available in the forthcoming report *Characteristics of Scientists and Engineers in the United States: 2008* at www.nsf.gov/statistics/us-workforce/.

Definitions
Scientists and engineers: Persons who have ever received a U.S. bachelor's or higher degree in an S&E or S&E-related field through 30 June 2007, persons holding a non-S&E bachelor's or higher degree who were employed in an S&E or S&E-related occupation on 1 October 2003, and persons who held a non-U.S. S&E degree and were in the United States on 1 October 2003.

S&E fields: Biological/agricultural/environmental life sciences, computer and information sciences, mathematics and statistics, physical sciences, psychology, social sciences, and engineering. S&E related fields include health, science and mathematics teacher education, technology and technical fields, and other S&E-related fields, such as architecture/ environmental design and actuarial science. See http://sestat.nsf.gov/docs/ed03maj.html for a detailed description of the educational classification.

S&E occupations: Computer and mathematical scientists; biological, agricultural, and other life scientists; physical and related scientists; social and related scientists; and engineers. S&E-related occupations include health-related occupations, S&E managers, S&E precollege teachers, S&E technicians and technologists, and other S&E-related occupations, such as architects and actuaries. See http://sestat.nsf.gov/docs/occ03maj.htmlfor a detailed description of the occupational classification.

Race/ethnicity: All graduates, both U.S. citizens and non-U.S. citizens, are included in the race/ethnicity data presented in this report. American Indians or Alaska Natives, Asians, blacks or African Americans, Native Hawaiians or Other Pacific Islanders, whites, and persons reporting more than one race refer to individuals who are not of Hispanic origin. Persons of Hispanic origin may be of any race.

Disability: The SESTAT surveys ask the degree of difficulty—none, slight, moderate, severe, unable to do—an individual has in seeing (with glasses/contact lenses), hearing (with hearing aid), walking without assistance, or lifting 10 pounds. Respondents who answered "moderate," "severe," or "unable to do" for any activity were classified as having a disability.

Primary and secondary work activities: These activities were self-defined by the respondent in response to the following question: "On which two activities... did you work the most hours during a typical week on this job?" Numbers for work activities sum to more than 100% because of multiple responses.

Appendix G

List of Selected Literature

Prepared by Wei Jing, Victoria Gunderson, and Mahlet Mesfin

Adya, Monica P. 2008. Women at work: Differences in IT career experiences and perceptions between South Asian and American women. *Human Resource Management* 47(3): 601-635.
The number of youth from developing Asian nations in the US IT workforce is increasing, and an examination of the career experiences and perceptions of South Asian women compared to American women shows that social cultural and individual factors impact their career experiences. Most women from South Asia did not identify career "genderization" in the workplace and felt less stereotyping and discrimination than American women. South Asian women felt the same work-life balance concerns as American women, but responded to them differently. There were also differences between the two groups in their perceptions of IT work, mentoring relationships, and coping mechanisms. The authors proposed recommendations for improving diversity integration into the workforce for the future.

Anita Borg Institute for Women and Technology. 2009. The recruitment, retention, and advancement of technical women: Breaking barriers to cultural change in corporations.
This summary of the Anita Borg Institute's 2009 Technical Executive Forum reports discussions of cultural elements that prevent the recruitment, retention, and advancement of women and solutions that can contribute to cultural change.

Aerospace Industries Association. 2008. Launching the 21st century American aerospace workforce. Online (www.aia-aerospace.org/assets/report_workforce_1208.pdf).[1]
The report underscores the aerospace industry's need for technical talent, reviews the actions that individual aerospace companies were already taking, and provides recommendations for the government to partner with the industry.

National Center for Women and Information Technology. 2007. Who invents IT? An analysis of women's participation in IT patenting. Online (www.ncwit.org/sites/default/files/legacy/pdf/PatentReport_wAppendix.pdf).
This report examines women's IT patenting rates and trends over the past 20 years. It shows that the rates were similar across IT industry subcategories, with an exception in the computer software subcategory; however, women's patenting rates differed widely from one organization to another.

[1] All online resources were accessed March 31, 2014.

Auletta, K. 2011. A woman's place: Can Sheryl Sandberg upend Silicon Valley's male-dominated culture? *The New Yorker* 87(20): 54.
This magazine article presents Sheryl Sandberg's career path to becoming chief operating officer of Facebook, with additional comments regarding the role of women in leadership roles at technology companies.

Babe, G. 2010. A national imperative: The nation needs women and minorities to succeed as scientists and engineers. *Pittsburgh Post-Gazette*, April 30, p. B1.
A brief news article that highlights recent Science, Technology, Engineering and Mathematics (STEM) education results from a Bayer Science study. The survey results suggest that the low number of women and minorities in STEM-related fields results from the poor identification and nurturing of women and minorities at a young age to pursue STEM careers in the future.

Baron, R.A., G.D. Markman, and A. Hirsa. 2001. Perceptions of women and men as entrepreneurs: Evidence for differential effects of attributional augmenting. *Journal of Applied Psychology* 86(5): 923-929.
In this study, women and men shown in standard-format photos were described to different groups of raters as being either entrepreneurs or managers. The raters assigned higher scores to women when they were described as entrepreneurs. The results support the authors' hypothesis that perceptions of women entrepreneurs are enhanced by attributional augmenting.

Barsh, J., and L. Yee. 2011. Changing companies' minds about women. McKinsey Quarterly.
This article is based on interviews with senior executives in companies and discussions with 30 diversity experts. The findings suggest that real progress to achieve diversity requires systemwide change driven by a hard-edged approach. The article details the factors that strengthen the approach, including senior leadership commitment, sponsorship, and the rigorous application of data in performance evaluation.

Bayer Corporation. 2006. The Bayer facts of science education XII: CEOs on STEM diversity: The need, the seed, the feed.
Based on the data from a survey of CEOs at STEM companies, this Bayer report describes the current STEM workforce challenges identified by the survey respondents. The survey respondents agreed that a company plays a critical role in ensuring women and minorities' participation and success in science and engineering (S&E) fields. A majority of the respondents agree that more needs to be done to nurture women and minority employees in the workforce.

Bayer Corporation. 2010. Bayer facts of science education XIV: Female and minority chemists and chemical engineers speak about diversity and underrepresentation in STEM survey findings. Online (http://bayerfactsofscience.online-pressroom.com/#a).
This report is the most recent Bayer Facts survey that examines the dual issues of diversity and underrepresentation by women and minorities in STEM. The report highlights as one of its findings that African Americans have the strongest opinions on a variety of social and economic issues, including bias, stereotyping, and the financial burdens of education. The survey focuses on the following aspects: (a) issues of diversity and underrepresentation in the US STEM workforce; b) causes of/contributions to underrepresentation; (c) developing an interest in

science; (d) bias in the classroom; (e) discouragement along the STEM pipeline; (f) respondents' significant precollege barriers and opportunities; (g) respondents' significant college/graduate school barriers and opportunities; (h) important resources, opportunities, and individuals along the way; (i) respondents' workplace challenges and road to success; and (j) recommendations.

Beede, D., T. Julian, B. Khan, R. Lehrman, G. McKittrick, D. Langdon, and M. Doms. 2011. Education supports racial and ethnic equality in STEM. US Department of Commerce.
The authors examined demographic disparities in STEM education and found that educational attainment may affect equality of opportunity in these critical, high-quality jobs of the future.

Beede, D., T. Julian, D. Langdon, G. McKittrick, E. Khan, and M. Doms. 2011. Women in STEM: A gender gap to innovation. US Department of Commerce. Online (www.esa.doc.gov/Reports/women-stem-gender-gap-innovation). This report finds that women are underrepresented in both STEM jobs and STEM undergraduate degrees and have been consistently over the last decade. The relatively few women who receive STEM degrees are concentrated in physical and life sciences, in contrast to men, who are concentrated primarily in engineering. Women who do receive STEM degrees are less likely to work in STEM jobs than their male counterparts. While women working in STEM jobs earn less than their male counterparts, they experience a smaller gender wage gap compared to others in non-STEM occupations.

Blake-Beard, S., A. Murrell, and D. Thomas. 2006. Unfinished business: The impact of race on understanding mentoring relationships. *Harvard Business School/Working Knowledge for Business Leaders.* Available at www.hbs.edu/research/pdf/06-060.pdf.
While the overall population is becoming increasingly diverse, the change in diversity among the top levels of the workforce has been stagnant. The nature of interracial dynamics indicates the state of racial affairs within a firm and issues that may be predictive of future problems among majority members of the workforce. This review examines existing literature in the attempt to answer three key questions: (1) How race influences access to mentoring relationships; (2) How race impacts the interactions between mentors and protégés; and, (3) How race influences the outcomes of mentoring relationships. The authors reexamined and revised previous models on cross-race relationships to examine the strategies for managing racial differences and the resultant types of relationships.

Broyles, P., and W. Fenner. 2010. Race, human capital, and wage discrimination in STEM professions in the United States. *International Journal of Sociology and Social Policy* 30(5/6): 251-266.
Data for this study were obtained from the American Chemical Society's 2005 census of its membership, which consisted of 13,855 male chemists working full-time in industry; there were too few minority women to make comparisons. The racial wage gap was decomposed by modeling earnings as an exponential function of race, education, marital status, children, experience, employment disruption, work specialty, work function, industry, size of employer, and region of work. This research shows that there was racial discrimination in STEM professions. The study found that overall minority chemists received lower wages than White chemists. For Asian and black chemists, the wage differential was largely due to discrimination.

The study explains that most of the difference in wages between Hispanics and whites was led by the lower educational attainment and experience of Hispanic chemists. The report states that achieving racial pay equity is one important step toward eliminating racial discrimination in the STEM workforce.

Bunker Whittington, K.C., and L. Smith-Doerr. 2004. Patenting productivity puzzles: Is there a gender gap and what are the effects of academic and commercial science contexts? Paper presented at the annual meeting of the American Sociological Association.
The authors investigated whether the durable gender inequality in science careers is affected by the changing boundaries between university and firm. Using data on patenting activity and examining career characteristics of a sample of life scientists, they were able to quantify and compare gender differences in productivity across small biotechnology firms, large pharmaceutical companies, and life science departments in academia.

Burke, S., and K.M. Collins. 2001. Gender differences in leadership styles and management skills. *Women in Management Review* 16(5): 244-257.
The study suggests that female and male accountants have different leadership styles. Female accountants are more likely to indicate that they use transformational leadership, which is found to be correlated with several management skills associated with success. The study also finds that female accountants may receive more developmental opportunities than their male colleagues.

Burrelli, J., and J. Falkenheim. 2011. Diversity in the federal science and engineering workforce. Arlington, VA: National Science Foundation. Available at www.nsf.gov/statistics/infbrief/nsf11303/nsf11303.pdf.
The federal government employed 235,000 scientists and engineers in the US in 2009. This report breaks down the gender, racial/ethnic, and disability characteristics of federal scientists and engineers by agency, occupation, and level. From 2000 to 2009, women's share of the federal S&E workforce rose from 21 percent to 27 percent and minorities' (Asians, blacks, Hispanics, and American Indians) share rose from 18 percent to 22 percent, with Asians at 9 percent; blacks, 8 percent; Hispanics, 4 percent; and American Indians, 1 percent.

Catalyst. 1999. Women scientists in industry: A winning formula for companies. Online (www.catalyst.org/publication/73/women-scientists-in-industry-a-winning-formula-for-companies).
This study identifies factors in the corporate culture that contribute to or impede the retention, development, and advancement of women scientists in corporations. Based on interviews with 30 women scientists in corporations, the study summarizes organizational barriers that women scientists face. These barriers include lack of female role models, style differences, risk-averse supervisors, and the lack of work-life balance.

Catalyst. 2001. Leadership careers in high tech: Wired for success. Online (www.catalyst.org/publication/79/leadership-careers-in-high-tech-wired-for-success).
This study is intended to provide young women in high tech with a roadmap they can use to shape their own careers. The report finds that mentors and networking are vital to career advancement and mobility for women in the industry. It shows that although many believe the

high-tech world is a strict meritocracy, women say that the higher you go in the industry, the more important it is to get to know the key power players. It indicates that work-life balance is important to both men and women in high tech.

Catalyst. 2003. Bit by bit: Catalyst's guide to advancing women in high tech companies. Online (www.catalyst.org/publication/17/bit-by-bit-catalysts-guide-to-advancing-women-in-high-tech-companies).
This study is based on discussions from five roundtable meetings, a focus group study, and interviews with representatives from companies. It includes barriers to women's advancement identified by the meeting participants. These barriers include: 1) exclusionary corporate culture; 2) difficulty in achieving work-life balance; 3) lack of role models, network, and mentors; and 4) lack of commitment and support from companies.

Catalyst. 2004. Advancing African-American women in the workplace: What managers need to know. Online (www.catalyst.org/publication/20/advancing-african-american-women-in-the-workplace-what-managers-need-to-know).
This report details the reasons companies need to advance the female African-American segment of the workforce. It finds that African-American women felt exclusion from informal networks and conflicted relationships with white women. Many study respondents reported that their diversity programs were ineffective. It shows that 37 percent of African-American women saw their opportunities for advancement to senior management positions in their companies declining over time.

Catalyst. 2004. The bottom line: Connecting corporate performance and gender diversity. Online (www.catalyst.org/publication/82/the-bottom-line-connecting-corporate-performance-and-gender-diversity).
This study was undertaken to explore the linkage between gender diversity and corporate financial performance. The study found that companies with the highest representation of women on their top management teams experienced better financial performance. This finding was true for both financial measures analyzed in this study: Return on Equity (ROE) and Total Return to Shareholders (TRS).

Catalyst. 2008. Women in technology: Maximizing talent, minimizing barriers. Online (www.catalyst.org/publication/36/women-in-technology-maximizing-talent-minimizing-barriers).
Building on previous research by Catalyst on women in the high-tech industry, this report examines issues faced by companies and the overall satisfaction of women in their jobs and companies. It provides data related to women's perception of supervisory relationships, fairness, development and training opportunities, career planning, barriers to career advancement, generational differences among women, equal opportunity, and opportunities within their companies.

Ceci, S.J., and W.M. Williams. 2011. Understanding current causes of women's underrepresentation in science. ***Proceedings of the National Academy of Sciences*** **108(8): 3157-3162. Available at www.pnas.org/content/early/2011/02/02/1014871108.**

To better understand the causes of women's underrepresentation in math-intensive fields, the authors reviewed the past 20 years of data and suggested that some of the claims of discrimination are no longer valid and that widespread acceptance of these claims may delay or prevent understanding of contemporary determinants of women's underrepresentation. The authors found that the differences in career outcomes between males and females result from a difference in resources due to choices, which could be influenced and better informed through education. They believed that society needs to engage in solving the current problems to address meaningful limitations deterring women's participation in STEM careers, which requires focusing on education and policy changes.

Cohoon, J. McGrath, V. Wadhwa, and L. Mitchell. 2010. Are successful women entrepreneurs different from men? Kauffman Foundation.
This study is based on data collected in 2008-2009 from 549 respondents from randomly selected high-tech companies. The survey looks into the backgrounds, experiences, and motivations of men and women entrepreneurs. The findings show that successful women and men entrepreneurs are similar in almost every respect, such as levels of education, interest in entrepreneurial business, desire to build wealth or to capitalize a business idea, and access to funding. It also finds that men and women entrepreneurs agreed on many top issues and challenges that they faced in starting and managing their businesses. The survey data reveal small gender differences among successful entrepreneurs.

Cohoon, J. McGrath. 2011. Summary of recent research on gender & high-tech startups. National Center for Women and Informational Technology. Online (www.ncwit.org/sites/default/files/legacy/pdf/startupsandgender.pdf).
This summary lists and details the five employment models that are frequently used by high-tech startups. It analyzes the characteristics of each model regarding employee attachment, selection, and control.

Coons, R. 2010. Survey: women and minorities discouraged from science careers. *Chemical Week* 172(7): 14.
This article discussed the results from the Bayer Corporation Survey. It shows that about 40 percent of women and underrepresented minority chemists and chemical engineers say that they were discouraged from pursuing a STEM career at some point in their lives. Leading workplace barriers for the female and minority chemists and chemical engineers identified in this study include managerial bias, institutional bias, lack of professional development, limited access to networking opportunities, and a lack of advancement opportunities. Nearly three-quarters of the chemists and chemical engineers say that it is harder for women to succeed in their field than it is for men, while more than two-thirds think it is more difficult for minorities to succeed than it is for nonminorities.

Davidson, J. 2011. Latinos in Senior Executive Service (SES) will be "vastly underrepresented" by 2030. *Washington Post*, September 22, p. B4. Online (www.washingtonpost.com/politics/column/feddiary/report-latinos-in-ses-will-be-vastly-underrepresented-by-2030/2011/09/21/gIQA9Fx7lK_story.html).
This newspaper article highlights the diversity problem faced by the government's senior leadership. Besides President Obama's executive order "to Promote Diversity and Inclusion in

the Federal Workforce," it also mentions recent results from the Center for American Progress indicating that Latinos will remain vastly underrepresented in senior executive service roles.

Desvaux, G., S. Devillard-Hoellinger, and M.C. Meaney. September 2008. A business case for women. McKinsey Quarterly.
The article indicates that companies with women in management tend to perform better financially and have a deeper pool of talent. Similarly, companies with three or more women on their governing boards are shown to be more effective in multiple organizational dimensions, including accountability, motivation, innovation, and capability.

Eagly, A.H., M.C. Johannesen-Schmidt, and M.L. van Engen. 2003. Transformational, transactional, and laissez-faire leadership styles: A meta-analysis comparing women and men. *Psychological Bulletin* 129(4): 569-591.
This study finds that female leaders are more transformational than male leaders and engaged in more of the contingent reward behaviors that are a component of transactional leadership. It also reveals that male leaders are more likely to manifest the other aspects of transactional leadership and laissez-faire leadership.

Eddleston, K.A., J.F. Veiga, and G.N. Powell. 2006. Explaining sex differences in managerial career satisfier preferences: The role of gender self-schema. *Journal of Applied Psychology* 91(2): 437-445.
The authors examined whether gender self-schema would explain sex differences in preferences for status-based and socioemotional career satisfiers. The study finds that male managers regard status-based career satisfiers as more important and socioemotional career satisfiers as less important than female managers do.

European Commission. 2009. Guidelines for gender equality programmes in science.
The guidelines are the result of the project "Practicing Gender Equality in Science," which aimed to address women's underrepresentation in leadership positions in scientific and technological research. The guidelines review issues at stake and explore the linkage between diversity and excellence. The report then discusses three main strategies developed under the project (1) to illustrate and create a friendly environment for women; (2) to insert gender dimension in the process of research and innovation design; and (3) to promote and support women's leadership of science in a changing society. Examples of effective programs are included in the guidelines.

Fabio, N.D., C. Brandi, and L.M. Frehill. 2008. Professional women and minorities: A total human resources data compendium. Commission on Professionals in Science and Technology.
This report presents data about women and minorities at various points of the pipeline and career outcome. It is broken down into the following chapters: (1) general population and precollege education; (2) enrollment in higher education; (3) degrees earned in higher education; (4) degrees by discipline; (5) science and engineering employment; and (6) international education and employment.

Fouad, N.A., and R. Singh. 2011. Stemming the tide: Why women leave engineering. University of Wisconsin, Milwaukee.

The report, based on survey results from over 3,700 engineers, shows that workplace climate is a strong factor in women's decisions to leave engineering after college or as mid-career professionals. It shows that people who stay in engineering are usually influenced by key supportive people in the organization as well as a perception of value of their work.

Frehill, L.M., N.M. Fabio, and S.T. Hill. 2008. Confronting the "new" American dilemma: Underrepresented minorities in engineering: A data-based look at diversity. National Action Council for Minorities in Engineering.
Throughout the report the National Action Council for Minorities in Engineering sends a message that "the solution to America's competitiveness problem is to activate the hidden workforce of young men and women who have traditionally been underrepresented in STEM careers—African Americans, American Indians, and Latinos." This report examines the data and data trends of male and female African-Americans, Latinos, and Native Americans in engineering at all levels of higher education and in the workforce. It also identifies barriers that prevent these underrepresented minorities from succeeding and calls various stakeholders to action.

Furlong, Lisa. 2007. Industry and government seek Native Americans for tech jobs. *Diversity/Careers in Engineering & Information Technology,* Winter 2003/Spring 2004.
The American Indian College Fund has stated that more Native Americans seek degrees in education or nursing than in technology fields at tribal colleges. These colleges educate a wide demographic of Native Americans, from older, nontraditional students to students who are fresh out of high school and very tech savvy.

Gandz, J. 2005. A business case for diversity. Ottawa: Canadian Department of Labor.
The report indicates that the business case for diversity is different for enterprises in public sector and private sector organizations, but it is generally agreed that diversity is beneficial to organizations. The report discusses various benefits of diversity and indicates that commitment from leadership and an effective assessment of diversity programs are critical for an organization to fully achieve diversity.

George, Y.S., D.S. Neale, V.V. Horne, and S.M. Malcom. 2001. In pursuit of a diverse science, technology, engineering, and mathematics workforce. Washington: American Association for the Advancement of Science.
This report uses a population projection to highlight the need to diversify the STEM workforce in the future. It identifies and reviews over 150 research studies related to STEM students and faculty diversity, paying special attention to the transition points in academic achievement. It also identifies gaps in existing research on this topic and provides recommendations for improving methodology for research, building community, and exploring new research areas.

Giscombe, K., and M.C. Mattis. 2002. Leveling the playing field for women of color in corporate management: Is the business case enough? *Journal of Business Ethics* 37: 103-119.
The study focuses on examining the experiences of African-American, Hispanic, and Asian-American women in business careers. Based on a survey of professional women of color in 30

companies, the study finds that retention of women of color was positively correlated with supervisors' supportive behaviors.

Gupta, V.K., D.B. Turban, and N.M. Bhawe. 2008. The effect of gender stereotype activation on entrepreneurial intentions. ***Journal of Applied Psychology*** **93(5): 1053-1061.**
The study examines the impact of implicit and explicit gender stereotypes on men's and women's intentions to pursue entrepreneurial careers. By randomly assigning 469 business students to 6 experimental conditions, the authors measured the students' entrepreneurial intentions and test their study hypothesis—"men and women would confirm gender stereotype about entrepreneurship when it was presented implicitly but disconfirm when it was presented explicitly." The results show that men had higher entrepreneurial intention scores when no stereotypical information about entrepreneurship was presented; however, similar intentions were reported when entrepreneurship was presented as gender neutral.

Hambrick, D.C., T.S. Cho, and M.J. Chen. 1996. The influence of top management team heterogeneity on firms' competitive moves. ***Administrative Science Quarterly*** **41: 659-684.**
The paper explores the executive origins of firms' competitive moves by focusing on top management team characteristics, specifically on team heterogeneity. The findings suggest that heterogeneous teams are slower in their actions and responses and less likely than homogeneous teams to respond to competitors' initiatives.

Halford, Bethany. 2007. Chemists of color: It takes more than good intentions to achieve diversity in the chemical workforce. ***C&EN*** **85(13): 46-49.**
African-Americans earn only around 3.5 percent of doctoral degrees in chemistry, while they account for approximately 13 percent of the overall US population. David A. Thomas of Harvard University found that most successful African-Americans in the corporate world had a strong network of mentors to look to for support and guidance, and most of these mentors were Caucasian. Interviews with employees in chemical firms and faculty in academia are included in the article.

Hamilton, B.H., J.A. Nickerson, and H. Owan. 2003. Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation. ***Journal of Political Economy*** **111: 465-497.**
This paper identifies the productivity and participation implications of five potential behavioral responses (free-riding being one) to the adoption of team incentives with heterogeneous workers. The study finds that the more heterogeneous teams are more productive and that high-ability workers appear to have a stronger influence on team productivity than do low-ability workers.

Handelsman, J., N. Cantor, M. Carnes, D. Denton, E. Fine, B. Grosz, V. Hinshaw, C. Marrett, S. Rosser, D. Shalala, and J. Sheridan. 2005. More women in science. ***Science*** **309(5738): 1190-1191.**
In this article, the authors explored reasons for gender disparity: (1) There is a lack of senior women faculty to act as role models; (2) women felt hostility and exclusion in academia; (3) unconscious biases exist, and (4) women bear more responsibilities than men when it comes to caring for a family. The article also discusses exemplary programs and policies in research universities.

Herring, Cedric. 2009. Does diversity pay? Race, gender, and the business case for diversity. *American Sociological Review* 74(2): 208-224.
This article reviews literature that is pertinent to diversity and value in diversity. The author examined the implications of diversity for workplace dynamics and business outcomes by testing eight hypotheses derived from the value-in-diversity thesis using data from the 1996-1997 National Organizations Survey. The results support hypotheses that racial and gender diversity is associated with increased sales revenue, more customers, and greater relative profits. The results also show that racial diversity may lead to greater market share.

Hewlett, S.A., and C.B. Luce. 2005. Off-ramps and on-ramps: Keeping talented women on the road to success. Boston: Harvard Business School Press.
Early in 2004 the Center for Work-Life Policy formed a private sector, multiyear task force entitled "The Hidden Brain Drain: Women and Minorities as Unrealized Assets" to determine various aspects of the "off-ramps" of women's careers, as much evidence shows that women leave their professional careers at a high rate. The results of the task force's survey of over 2,700 women at three companies (Ernst & Young, Goldman Sachs, and Lehman Brothers) show many factors leading to women's professional off-ramps. They are *pulled away* from careers to care for their children and parents. In the business sector they are generally *pushed away* from their careers by factors such as low satisfaction, as they are in other fields such as medicine. Men often take off-ramps in their careers in order to strategically reposition their careers, unlike women's reasons for leaving their professions. Many women (93 percent) who have left their careers would like to reenter for financial or overall life satisfaction reasons, though many women experience significant penalties for leaving their careers and none in the business sector want to return to their prior companies. Work-life balance initiatives such as flexible hours and part-time options are important to women, as 64 percent of the women surveyed cite flexible work arrangements as being either extremely or very important to them. The report cites examples of successful work-life balance programs at Johnson and Johnson, Pfizer, Booz Allen Hamilton, and Ernst & Young.

Hewlett, S.A., C.B. Luce, L.J. Servon, L. Sherbin, P. Shiller, E. Sosnovich, and K. Sumberg. 2008. The Athena factor: Reversing the brain drain in science, engineering, and technology. Boston: Harvard Business School Press.
The Athena Factor research project studied the career trajectories of women with science, engineering, and technology (SET) credentials in the private sector and found five powerful "antigens" in corporate cultures. The study features 13 company initiatives that address female brain drain that are likely to be "game changers." These initiatives were expected to be scaled up to allow many more women to overcome the barriers and to stay on track in SET careers.

Holmes, Anna. 2011. Technically, science will be less lonely for women when girls are spurred early. *Washington Post*, September 23, p. C1. Online (www.washingtonpost.com/lifestyle/style/technically-science-will-be-less-lonely-for-women-when-girls-are-spurred-early/2011/09/21/gIQARGztoK_story.html).
This newspaper article indicates that the gender disparities in the US STEM workforce have not changed in the last 6 years. The author notes that although girls have achieved parity with boys

in test scores and college degrees in math and science, they are also being sent the wrong message that embracing these subjects is anathema to what it means to be female.

Hudis, P.M. 2009. Crafting a solution: Beyond the Dream National Roundtable. National Action Council of Minorities in Engineering.
This report underscores the critical role that community colleges play in building the engineering workforce and maintaining the nation's economic competitiveness. It presents engineering-focused, project-based applications for developmental mathematics were created by the National Action Council of Minorities National Roundtable participants. It also outlines the next steps for the National Roundtable to move this effort forward.

Information Technology Association of America. 2005. Untapped talent: Diversity, competition, and America's high tech future.
The Information Technology Association of America compiled data from the Bureau of Labor Statistics (BLS) Current Population Surveys to document the percentages of women and minorities in BLS occupational classifications that comprise the IT workforce in 2004, and compares them to previous years to determine the progression and regression of diversity. The report shows that the percentage of women in the IT workforce declined from a high of 41 percent in 1996 to 32.4 percent in 2004. Women who leave the IT workforce are also far less likely to return to it, at least not as quickly as men. Women are often hired into administrative jobs, yet represent only 25 percent of the people in professional or management ranks. African-Americans and Hispanic workers are underrepresented in the workforce, while Asian-Americans are overrepresented by about 200 percent. The rate of underrepresentation of African-Americans is increasing over time, while the rate for Hispanics is decreasing.

Jackson, S.A. 2001. The quiet crisis: Falling short in producing American scientific and technical talent. Building Engineering and Science Talent. Online (www.rpi.edu/homepage/quietcrisis/Quiet_Crisis.pdf).
The author identifies challenges to the US STEM workforce and lists priority actions for the federal government, education, industry, and nonprofit organizations.

Jeste, D.V., E.W. Twamley, V. Cardenas, B. Lebowitz, and C.F. Reynolds III. 2010. A call for training the trainers: Focus on mentoring to enhance diversity in mental health research. *American Journal of Public Health* 99(S1): S31-S37.
This study finds a widening disparity between the proportion of minority Americans in the population and the number of researchers from these minority groups, largely because of a lack of mentoring. The authors examined the current academic setting and noted that it is not optimal for developing and sustaining mentoring. The authors also noted that mentoring skills should be evaluated and enhanced.

Kohli, J., J. Gans, and J. Hairston. 2011. A better, more diverse senior executive service in 2050. Center for American Progress. Online (www.americanprogress.org/wp-content/uploads/issues/2011/09/pdf/ses_paper.pdf).
By 2050, the US Census Bureau predicts a nation with no clear racial or ethnic majority with 54 percent of the population being people of color. This study looks at the racial, ethnic, and gender diversity of the federal government's most senior officials. The study finds that projected ethnic,

racial, and gender makeup of the Senior Executive Service will not reflect that of the American workforce in 2030 and beyond.

Kray, Laura J., L. Thompson, and A. Galinsky. 2001. Battle of the sexes: Gender stereotype confirmation and reactance in negotiations. *Journal of Personality and Social Psychology* 80(6): 942-958.
This study on how gender stereotypes affect negotiation performancefound that men and women confirm gender stereotypes when they are activated implicitly. In addition, the authors examined the cognitive processes involved in stereotype reactance and the conditions under which cooperative behaviors between men and women can be promoted at the bargaining table.

Langdon, D., G. McKittrick, D. Beede, B. Khan, and M. Doms. 2011. STEM: Good jobs now and for the future. US Department of Commerce.
The report emphasizes that the STEM workforce has an outsized impact on the country's competitiveness, economic growth, and overall standard of living. An analysis of data from the US Census Bureau's American Community Survey and Current Population Survey shows that (1) STEM occupations are projected to grow by 17 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations; (2) STEM workers are earning 26 percent more than their non-STEM counterparts; (3) STEM workers have higher education attainment than non-STEM workers; and (4) STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations.

Level Playing Field Institute. 2011. The tilted playing field: Hidden bias in information technology workplaces.
This study examined anonymous survey data from engineers and managers at large IT companies and small start-ups. It found that: (1) IT workplace experiences vary by race, gender, and company size; (2) negative workplace experiences lead to increased turnover in IT roles; and (3) diversity is not a priority for gatekeepers. Based on these findings, the study also proposed recommendations to address the issue of underrepresentation.

Lewis, Ricki. 1995. Industry becomes more hospitable to the scientist as new mother. *The Scientist* 9(1): 21.
This article suggests that the challenge of successfully combining the demands of family and career may be easing for women scientists in industry, as many firms have revamped maternity leave policies to better accommodate new parenthood and the transition back to work.

London Business School. 2007. Innovative potential: Men and women in teams.
This study explores individuals' impact on a team's decision making and the interaction among team members. The research collects and analyzes the individual experiences of both men and women in teams. It then looks into how to unlock men's and women's innovative potential at an individual level and at a team level,

Lyness, K.S., and M.K. Judiesch. 2008. Can a manager have a life and a career? International and multisource perspectives on work-life balance and career advancement potential. *Journal of Applied Psychology* 93(4): 789-805.

The authors examine the relationship between work-life balance and career advancement potential using self, peer, and supervisor ratings of 9,627 managers in 33 countries. The study finds that managers with a higher rating in work-life balance are rated higher in career advancement potential; in addition, work-life balance ratings are positively related to advancement potential ratings for women in highly egalitarian cultures and men in low-gender-egalitarian cultures.

Malcom, S., A.H. Teich, J.K. Jesse, L.A. Campbell, E.L. Babco, and N.E. Bell. 2005. Preparing women and minorities for the IT workforce: The role of nontraditional educational pathways. American Association for the Advancement of Science and Commission on Professionals in Science and Technology.
This study examines the role of nontraditional educational pathways in preparing women and underrepresented minorities for the IT workforce. It reviews the traditional and nontraditional pathways into the IT workforce and concludes that the current system of preparation of “line” information technology/computer science (IT/CS) professionals (line managers) appears to be structured to accommodate 18-year-olds who come to colleges or universities directly out of high school. The presumption that their attendance is supported by parents or/and student loans is narrow and outmoded, especially for women and minorities who pursue IT/CS degrees.

Martin, L., and G. Ferraro. 2000. Reaping the bottom line benefits of diversity. ASAE Center.
In this article, two women politicians share their views about the value of diversity. discuss how to deal with diversity and how to use training and leadership to ensure organizational success in a changing labor environment.

Mattis, M., and J. Allyn. 1999. Women scientists in industry. *Annals of the New York Academy of Sciences* 869: 143-174.
This report reviews the barriers for women scientists from previous research and focuses on women scientists who are employed in industry. The findings show that barriers for women scientists in industry persist, though they have experienced progress. Differences were observed across companies in industries employing women scientists. Some companies were viewed as more informed and proactive in improving the work environment and career opportunities for women scientists. Examples of effective corporate initiatives to enhance the retention, recruitment, and advancement of women scientists were gathered in this study.

McKinsey & Company. 2010. Women at the top of corporations: Making it happen.
This report indicates that the majority of leaders agreed on women leaders’ contribution to a company’s performance. However, promoting diversity was not one of the top priorities on the company’s strategic agenda. The report then reviews corporate programs that aim to promote diversity, and indicates that leadership commitment and women’s individual development programs are the most effective among various measures.

McKinsey & Company. 2011. Unlocking the full potential of women in the US economy. McKinsey Quarterly. Online (www.mckinsey.com/client_service/organization/latest_thinking/unlocking_the_full_potential).

In this report, McKinsey & Company examines the following: (1) how women contribute to the US economy; (2) how women's work benefits individual corporations; (3) what prevents women from making greater contributions to their companies; and (4) what approaches can help companies unlock the full potential of women. Their findings underscore the need for systemic and organizational change.

McKinsey & Company. 2012. Women matter 2012: Making the breakthrough. McKinsey Quarterly. Online (www.mckinsey.com/features/women_matter).
This report presents the results from research into the gender diversity practices of 235 European companies, of which the vast majority were devoting significant resources to redressing the gender imbalance. Many made progress with training programs established to open the organizations' eyes to the value of diversity. But despite the progress, many companies expressed their frustration at the absence of more concrete results. Some companies admitted that their initiatives were not always gaining traction, particularly with managers lower down in the organization.

McQuaid, J., L. Smith-Doerr, and D.J. Monti, Jr. 2008. Expanding entrepreneurship: Female and foreign-born founders of New England biotechnology firms. Paper presented at the annual meeting of the American Sociological Association Annual Meeting. Sheraton Boston and the Boston Marriott Copley Place, July 31.
This article examines the role of women and immigrants in founding science-based biotechnology firms, using the data from a survey of 261 biotechnology firms in New England in 2006. The results show that 42 percent of the firms have at least one foreign-born founder, and 21 percent of the firms have at least one female founder. Interviews are included in the study to supplement the data and to show some barriers and opportunities for foreign-born entrepreneurs.

Mitchell, L. 2011. Overcoming the gender gap: Women entrepreneurs as economic drivers. Kauffman Foundation. Online (www.kauffman.org/~/media/kauffman_org/research%20reports%20and%20covers/2011/09/growing_the_economy_women_entrepreneurs.pdf).
This report examines the intersection between the need for US economic recovery and the status of women's entrepreneurship. It shows that women were behind men in measures of start-up activity and growth of their firms, which represented an untapped economic resource. This report documents the current gender gap, debunks common myths and misconceptions about women entrepreneurs, and explores ways to cultivate high-growth start-ups among women.

Moris, F. 2004. Industrial R&D employment in the United States and in US multinational corporations. Arlington, VA: National Science Foundation. Available at www.nsf.gov/statistics/infbrief/nsf05302/nsf05302.pdf.
This InfoBrief examines employment data for industrial scientists and engineers in research and development (R&D) during 1994-2001. The data show that industrial R&D employment has grown at a faster rate than overall industrial employment in the United States. The US manufacturing sector employed the most R&D workers in 2001, followed by the computer and electronic product industry, information industry, and professional, scientific, and technical services. Germany, the United Kingdom, Switzerland, France, and Japan accounted for about 70 percent of R&D expenditures and R&D employment in 2001 by US affiliates of foreign

companies, and most of the R&D employment and expenditures by foreign affiliates of US multinational corporations was concentrated in three manufacturing industries: chemicals (including pharmaceuticals and medicines), computer and electronic products, and transportation equipment.

Murray, F., and L. Graham. 2007. Buying science and selling science: Gender differences in the market for commercial science. *Industrial and Corporate Change* 16(4): 657-689.
Using interviews with life science faculty, the authors examined mechanisms that instituted, reinforced, and reduced the gender gap in commercial science between 1975 and 2005. Gender differences were found on both the demand and supply sides, and the differences remained significant among junior faculty. However, the authors found that advisor mentoring and the presence of institutional support contribute to the decline of the gender differences.

National Research Council. 1991. Women in science and engineering: Increasing their numbers in the 1990s: A statement on policy and strategy. Washington: National Academies Press.
This report explores the underparticipation of women in these fields and presents a strategic plan of action: (1) strengthen the S&E infrastructure; (2) examine the effectiveness of intervention programs; (3) explore career patterns for women in S&E employment; and (4) examine the adequacy of high-quality data.

National Research Council. 1994. Balancing the scales of opportunity: Ensuring racial and ethnic diversity in the health professions. Washington: National Academies Press.
This report looks at the historical significance of racial and ethnic underrepresentation in the health professions, presents data on the problem, and identifies underlying factors that contribute to the failure to achieve fairness in opportunity. The report also examines effective efforts that have decreased underrepresentation and recommends actions and a research agenda to increase numbers of minorities in the health professions.

National Research Council. 1994. Women scientists and engineers employed in industry: Why so few? Washington: National Academies Press.
This report, based on a conference, examines quantitative and qualitative evidence regarding the low employment of women scientists and engineers in the US industrial workforce. It includes corporate responses to this underparticipation and assesses issues related to the working environment and attrition of women professionals in industry.

National Research Council. 1997. Building a diverse workforce: Scientists and engineers in the Office of Naval Research. Washington: National Academies Press.
In late 1994 the Office of Naval Research asked the National Research Council to provide advice on how to ensure diversity in its future science and engineering workforce in order to meet the needs of anticipated naval science and engineering specialties. Responding to this request, the study examined the characteristics of the Office of Naval Research science and engineering workforce and its recruitment practices. The second part of the study reviewed the Office of Naval Research's educational programs and provided recommendations to improve their effectiveness.

National Research Council. 2000. Women in the chemical workforce: A workshop report to the Chemical Sciences Roundtable. Washington: National Academies Press.
This report compiled individually authored papers from participants at the Chemical Sciences Roundtable to examine issues pertinent to the chemical and chemical engineering workforce, with an emphasis on the advancement of women in chemistry.

National Research Council. 2001. From scarcity to visibility: Gender differences in the careers of doctoral scientists and engineers. Washington: National Academies Press.
This study looked into factors that lead to gender gaps in the careers of doctoral scientists and engineers. It examined the employment of doctoral scientists and engineers by gender as well as disparities between men and women in those fields. It then explored factors that contribute to the disparities. The report indicates that the gender gap is most closely related to conditions that slow or interrupt careers, especially in academia.

National Research Council. 2001. The right thing to do, the smart thing to do: Enhancing diversity in health professions. Summary of the symposium on diversity in health professions in honor of Herbert W. Nickens, M.D. Washington: National Academies Press.
The report captures the presentations and discussions at the Symposium on Diversity in the Health Professions, which was convened in 2001 to address challenges to the health professions workforce. The report is composed of 13 individually authored papers.

National Research Council. 2002. Diversity in engineering: Managing the workforce of the future. Washington: National Academies Press.
This is a summary report for the National Academy of Engineering's 2001 workshop on "Best Practices in Managing Diversity." The report contains 15 presentations from the workshop on successful corporate programs that have effectively recruited, retained, and advanced women and underrepresented minorities in engineering careers. It also captures the discussion on developing metrics to better evaluate diversity programs.

National Research Council. 2003. Minorities in the chemical workforce: Diversity models that work—A workshop report to the Chemical Sciences Roundtable. Washington: National Academies Press.
This report is a collection of contributed papers on success stories for increasing diversity. Along with background information on the value of diversity in the undergraduate environment, the stories address both undergraduate and graduate chemistry programs as well as chemical industry.

National Research Council. 2003. Envisioning a 21st century science and engineering workforce for the United States: Tasks for university, industry, and government. Washington: National Academies Press.
This report responds to a request from the National Academies' Government-University-Industry Roundtable regarding views of 21st century challenges for the science and engineering workforce. The report identifies factors that lead to a declining S&E workforce, describes the risks and consequences of this decline, and suggests tasks for government, university, and industry to strengthen the workforce.

National Research Council. 2004. In the nation's compelling interest: Ensuring diversity in the health care workforce. Washington: National Academies Press.
This report assesses the potential benefit of having greater racial and ethnic diversity in the health profession. It examines institutional and policy-level strategies that health professions schools, their associations and accreditation bodies, health care systems/organizations, and state and federal governments can pursue to increase diversity among health professionals.

National Research Council. 2005. Engineering research and America's future: Meeting the challenges of a global economy. Washington: National Academies Press.
This book highlights the trends that adversely affect US competitiveness and the nation's capacity for innovation. It provides nine recommendations to various stakeholders to help strengthen US engineering research, underscoring its critical role in maintaining US technological leadership.

National Research Council. 2005. Rising above the gathering storm: Energizing and employing America for a brighter economic future. Washington: National Academies Press.
This report is based on a congressionally mandated consensus study that identified two key challenges tightly coupled to scientific and engineering prowess: (1) creating high-quality job; and (2) responding to the nation's need for clean, affordable, and reliable energy. The committee then came up with four recommendations that focus on actions in K-12 education, research, higher education, and economic policy, along with 20 implementation actions that federal policy-makers should take to create high-quality jobs and focus new science and technology efforts on meeting the nation's needs.

National Research Council. 2006. Opportunities to address clinical research workforce diversity needs for 2010. Washington: National Academies Press.
This report summarizes a 2003 workshop that explored opportunities to address clinical research workforce diversity needs for 2010. The report reviews programs and policies in public and private sectors and highlights exemplary programs that help recruit and retain women and underrepresented minorities in clinical research.

National Research Council. 2006. Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering. Washington: National Academies Press.
This report reviews challenges and barriers faced by women in academic science and engineering. It explains that eliminating gender bias in academia requires immediate overarching reform, including decisive action by university administrators, professional societies, federal funding agencies and foundations, government agencies, and Congress. It recommends actions that would help improve workplace environments for all employees while strengthening the foundations of America's competitiveness, and says that these actions need to be implemented and coordinated across public, private, and government sectors.

National Research Council. 2007. Understanding interventions that encourage minorities to pursue research careers: Summary of a workshop. Washington: National Academies Press.
This report summarizes a workshop that was convened in 2007 to understand the factors that contribute to the success of intervention programs that encourage minorities to pursue careers in research. Three major topics were discussed at the workshop: (1) examples of previous research,

such as social cognitive career theory and research into existing interventions at different levels of the pipeline; (2) elements of effective research; and (3) developing a research agenda.

National Research Council. 2011. Rising above the gathering storm, revisited: Rapidly approaching category 5. Washington: National Academies Press.
This report, which evaluates changes in America's competitiveness since the original *Gathering Storm* report was published in 2005, finds that "our nation's outlook has worsened." It finds that the overall public school system has shown little sign of improvement, particularly in mathematics and science. In the meantime, many other nations have been markedly progressing, thereby affecting America's relative ability to compete effectively for new factories, research laboratories, administrative centers, and jobs. The report concludes that in spite of efforts by government and the private sector, the outlook for America to compete for quality jobs deteriorated over the past five years.

National Research Council. 2011. Expanding underrepresented minority participation: America's science and technology talent at the crossroads. Washington: National Academies Press.
This report examines the role of diversity in the science, technology, engineering, and mathematics (STEM) workforce and its value in keeping American competitive. It analyzes the rate of change and the challenges the nation faces in developing a strong and diverse workforce. Although minorities are the fastest growing segment of the population, they remain underrepresented in the fields of science and engineering. The study suggests that the federal government, industry, and postsecondary institutions work collaboratively with K-12 schools and school systems to increase minority access to and demand for postsecondary STEM education and technical training.

National Science Board. 2012. Science and engineering labor workforce. *Science and Engineering Indicators 2012*. Arlington, VA: National Science Foundation.
From 1993 to 2008, the percentage of women workers in S&E fields and occupations gradually increased, though women are concentrated in different fields (social sciences, biological and medical sciences) than men (engineering, computer science). It shows that only 9 percent of the S&E workforce in 2008 was Hispanic, black, or Native American, although their percentage in the population is roughly 26 percent, in contrast to Asian Americans, who make up 5 percent of the US population but 17 percent of the workers in S&E occupations.

Nosek, B.A., F.L. Smyth, N. Sriram, N.M. Lindner, T. Devos, A. Ayala, Y. Bar-Anan, R. Bergh, H. Cai, K. Gonsalkorale, S. Kesebir, N. Maliszewski, F. Neto, E. Olli, J. Park, K. Schnabel, K. Shiomura, B.T. Tulbure, R.W. Wiers, M. Somogyi, N. Akrami, B. Ekehammar, M. Vianello, M.R. Banaji, and A.G. Greewald. 2009. National differences in gender–science stereotypes predict national sex differences in science and math achievement. *PNAS* 106(26): 10593–10597.
Using results from more than half a million Implicit Association Tests completed by citizens of 34 countries, this study reveals that about 70 percent of people held implicit stereotypes associating science with males more than with females. Nation-level implicit stereotypes predicted nation-level sex differences in 8th grade science and mathematics achievement, while self-reported stereotypes did not provide additional predictive validity of the achievement gap.

The authors suggest that implicit stereotypes and sex differences in science participation and performance are mutually reinforcing, contributing to the persistent gender gap in science engagement.

Obiomon, P.H., V.C. Tickles, A.H. Wowo, and S. Holland-Hunt. 2007. Advancement of women of color in science, technology, engineering and math (STEM) disciplines. Faculty Resource Network.
This paper identifies unique barriers faced by women of color in STEM in faculty positions as well as positions of leadership in the STEM industry. Stereotyping, bicultural stress, and tokenism are barriers that ultimately affect the extent to which women of color advance to tenure, receive research funding, obtain leadership positions, and remain in long-term faculty and leadership positions. Solutions to overcoming these barriers lie primarily in awareness, understanding, and training of women of color and the administrators, faculty, and STEM management involved in advancing their status.

Ong, M.M. 2011. The status of women of color in computer science. *Communications of the Association for Computing Machinery* 54(7): 32-34.
Using findings from the National Science Foundation (NSF)-funded project "Inside the Double Bind: A Synthesis of Empirical Literature on Women of Color," the paper shows that the underrepresentation of women of color in STEM can be linked to the digital divide, unique social challenges for women of color in school, family, and social balance, and the increased number of women of color obtaining their degrees in nontraditional manners.

Page, Scott. 2009. The difference: How the power of diversity creates better groups, firms, schools, and societies. Princeton, NJ: Princeton University Press.
This book discusses how people think in groups, how collective wisdom exceeds the sum of its parts, and why teams of people find better solutions. The author notes that progress and innovation may depend less on lone thinkers with high IQs than on diverse people working together. It shows that groups that display a range of perspectives outperform groups of like-minded experts. The author moves beyond the politics that influence standard debates about diversity and explains why difference beats homogeneity.

Pelled, L.H., K.M. Eisenhardt, and K.R. Xin. 1999. Exploring the black box: An analysis of work group diversity, conflict, and performance. *Administrative Science Quarterly* 44(1): 1-28.
This paper presents and tests an integrative model of the relationships among diversity, conflict, and performance. The results show that diversity shapes conflict and that conflict, in turn, shapes performance, although the linkages have subtleties. It also shows that functional background diversity drives task conflict, but multiple types of diversity drive emotional conflict. Race and tenure diversity are positively associated with such conflict, and task routineness and group longevity moderate these relationships.

Simard, C. 2007. Barriers to the advancement of technical women. Palo Alto: Anita Borg Institute for Women and Technology.
This report reviews research and literature on technical women, the barriers they encounter in their careers, and effective recruitment and retention practices.

Simard, C. 2009. Obstacles and solutions for underrepresented minorities in technology. Palo Alto: Anita Borg Institute for Women and Technology. Online (www.cssia.org/pdf/20000280-ObstaclesandSolutionsforUnderrepresentedMinoritiesinTechnology.pdf).
This report is based on analysis a survey with a sample of 1,795 respondents from seven high-technology companies working in technical positions. It describes the representation of men and women of color in high-technology companies, as well as their work values and self-perceptions. Another part of the study focused on exploring practices that are considered most important to underrepresented groups' retention and advancement.

Simard, C. 2009. Retaining a diverse technical pipeline during and after a recession. Palo Alto: Anita Borg Institute for Women and Technology. Online (http://anitaborginstitute.org/files/diverse-technical-pipeline.pdf).
An unprecedented economic downturn has hurt employee engagement and further jeopardized the focus on practices important to technical women. As a recovery occurs, companies are at risk of further losing female technical talent. The report shows that an ongoing focus on practices that impact retention and advancement, such as a culture of employee development and flexibility, will give companies a competitive advantage in the recovery by enhancing the retention of a diverse technical workforce as well as position them for renewed recruitment.

Simard, C., A.D. Henderson, S.K. Gilmartin, L. Schiebinger, and T. Whitney. 2009. Climbing the technical ladder: Obstacles and solutions for mid-level women in technology. Palo Alto: Anita Borg Institute for Women and Technology.
This study pursues answers to three key questions: (1) Who are mid-level technical women? (2) What are the barriers to retain and advance mid-level women? and (3) How can companies secure their investments by ensuring that female technical talent advance to leadership positions? Based on the analysis of the survey results, five recommendations are discussed in the report: (1) invest in professional development, (2) foster a positive work culture, (3) offer flexible working schedules, (4) train and reward managers and executives, and (5) diversify leadership.

Simard, C., and S. K. Gilmartin. 2010. Senior technical women: A profile for success. Palo Alto: Anita Borg Institute for Women and Technology.
This report offers a snapshot of a rarity in technology: senior technical women working at prominent Silicon Valley technology companies. By examining senior women's profiles, the authors wish to provide companies and individuals with insights on the paths to success in existing organizational structures and hope the experiences can be used to leverage a greater number of senior technical women.

Simard, C., and D.L. Gammal. 2012. Solutions to recruit technical women. Palo Alto: Anita Borg Institute for Women and Technology.
This report presents data-driven results in both academic research and corporate practice that have improved the representation of technical women. It includes examples that show how high-profile companies such as IBM have implemented solutions that ultimately allow for greater returns on their search for and investment in top technical talent. The strategies are broken down

into four areas: recruitment avenues, recruitment practices, the hiring process, and overarching considerations.

Sztein, A.E. 2005. Women in science: Assessing progress, promoting action. Conference Report. Washington: Association of Women in Science.
This report is a conference summary of the National Conference for Women in Science, Technology, Engineering, and Mathematics Disciplines in 2005. It mainly reviews the progress that has been made to date on the status of women in science and engineering.

Thacker, P.D. 2007. Progress over the long term. Online (www.insidehighered.com/news/2007/01/09/science).
This article reviews a 2007 report from the Commission on Professionals in Science and Technology, *Professional Women and Minorities*, which describes the increased representation of women in professional STEM fields that outpaced the increase in representation of minorities in the same fields.

Thom, M. 2001. Balancing the equation: Where are women and girls in science, engineering and technology? New York: National Council for Research on Women.
This report presents strategies for ensuring full participation and achievement in the sciences by women and girls, calling upon all adults to support the interest and persistence of females in science, engineering, and technology.

Thomas, D.A. 2004. IBM finds profit in diversity. Harvard Business School Working Knowledge. Online (http://hbswk.hbs.edu/item/4389.html).
The article highlights four factors that are considered critical by IBM's diversity task forces: (1) demonstrate leadership support, (2) engage employees as partners, (3) integrate diversity with management practices, and (4) link diversity goals to business goals.

Touchton, Judy. 2009. Beyond the degree: Where are women scientists, and how are they doing? *On Campus with Women* 37(2). Online (www.aacu.org/ocww/volume37_2/data.cfm).
The article examines women's employment in government, academia, and industry using National Science Foundation data. It explores where women scientists are employed, how successfully they are able to advance, and how well they are compensated. Specifically, the author looks into the differential impact of marriage and family for women scientists'.

Tullo, Alexander H. 2001. Still few women at the top. *C&EN* 79(27): 18-19.
The article highlights the low representation of women in chemical industry. It indicates that women are poorly represented in managerial positions.

Tullo, Alexander H. 2005. Women in industry. *C&EN* 83(24): 14-15.
The article gives an overview of women's representation on chemical company boards. The lack of female representation shows that the chemical industry is still largely a man's world. Change has been slow regarding the advancement of women into the upper corporate ranks of chemical companies. As evidenced by C&EN's annual survey of women serving as company executives and directors, male dominance of the industry continues.

Tullo, Alexander H. 2008. Women in industry: In the boardroom and executive suite, women's participation is still minuscule. *C&EN* 85(31): 38-39.
C&EN's recent annual survey of women in publicly traded chemical companies finds that of 416 individuals on boards of directors for 42 chemical companies, only 12 percent were women. It indicates an increase from the 2006 data; however, the progress is still slow.

Tullo, Alexander H. 2010. Women in industry. *C&EN* 85(32): 16-17.
This article discusses women's slow but steady progress in the US chemical industry. Ellen J. Kullman became the first female CEO of a publicly traded firm dedicated to chemicals when she took over the top job at DuPont at the beginning of 2009. C&EN's 2010 survey shows that women have made advances by all measures. The survey finds that 13.4 percent of the 396 directors at chemical companies are women. Women made sharper gains in the executive suite as some 9.6 percent of the 418 executive officers at the chemical firms in the survey are women. An emerging barrier to women attaining the kinds of positions that would put them on the surveys compiled by C&EN and Catalyst is the level of satisfaction they feel with their employers.

Tuna, C. 2008. Initiative moves women up corporate ladder. *Wall Street Journal*. Online (http://online.wsj.com/article/SB122446435886248933.html).
This article follows LeasePlan USA's efforts to transform its corporate culture and help move women up the corporate ladder. The company believes that those efforts appear to have led to increasing job satisfaction and engagement among LeasePlan's women employees over time.

Urquhart, Kirstie. 2000. Women in science: Academia or industry? Science Careers.
This article conveys that women are not well represented or advanced in science by presenting the scissors diagram. Interviews with women scientists who are employed in academia and industry highlight a few of the barriers. Women scientists working in industry tend to find better work-life balance than those in academia, the article says.

US Commission on Civil Rights. 2010. Encouraging minority students to pursue science, technology, engineering and math careers. A briefing before the United States Commission on Civil Rights in Washington, DC.
The commission examined why minority college students entered college with the intention to major in STEM fields, yet left those disciplines before graduation at greater rates from those students. The Commission focused on the idea of the "mismatch hypothesis," where students with academic credentials that are different (either positive or negative) than the other students in the class may learn less than if they were matched with students with the same credentials. The experts on the panel, who represented various institutions of secondary or higher education, did not agree on whether affirmative action decisions can lead to negative mismatches for underrepresented minorities. This report includes other findings and recommendations from this panel of experts.

Vedantam, S. 2008. Most diversity training ineffective, study finds. *The Washington Post,* January 20.
The author raised the concern that many diversity training efforts at American companies are ineffective. A review of 830 mid-to-large size companies over more than 30 years found that the number of women in management actually decreased by 7.5 percent, with African American

women decreasing 10 percent and African American men decreasing 12 percent. Statistics for Hispanics and Asian Americans were not given, but the article states that they saw similar decreases.

White House Project. 2009. Benchmarking women's leadership.
This report seeks to address gender equality and offer recommendations that involve specific accountability measures to track progress as well as creative suggestions for solutions. The recommendations cover ten employment sectors (academia, business, film and television, journalism, law, military, nonprofit, politics, religion, and sports) with the hope of achieving transformation and propelling a critical mass of diverse women into leadership alongside men.

Whittington, K.B., and L. Smith-Doerr. 2008. Women inventors in context: Disparities in patenting across academia and industry. *Gender & Society* 22(2): 194-218.
The authors examined the effects that different work settings (academy and industry) have on sex disparities in scientists' careers and commercial productivity (measured by patenting in this study). Using data from academic and industrial scientists working in the US, the authors conducted multivariate regression analysis and found that women are less likely to patent than men. However, in flatter, more flexible network-based organizational structures, female scientists are more likely to patent than in more hierarchically arranged organizations.

Wu, L.S., and W. Jing. 2011. Asian women in STEM careers: An invisible minority in a double bind. *Issues in Science and Technology* 28: 82-87.
This study examines Asian women's representation and advancement in three employment sectors: academia, industry, and the federal government. Based on National Science Foundation data, the authors found that overall, Asian women were well represented in terms of educational attainment. However, the percentage of Asian women decreases as they move up within their institution. The study also found that Asian women rank among the lowest percentage of managers in S&E positions. The authors suggest that Asian women face a double bind caused by their gender and ethnicity.

Zhao, H., S.E. Seibert, and G.E. Hills. 2005. The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology* 90(6): 1265-1272.
Based on structural equation modeling with a sample of 265 MBA students, the authors found that entrepreneurial self-efficacy can mediate the effects of perceived learning from entrepreneurship-related courses, previous entrepreneurial experience, and risk propensity on entrepreneurial intentions. However, gender was not mediated by self-efficacy.