

Women in Engineering: 20-Year Literature Review

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Agenda

- Overview of the Society of Women Engineers (SWE)
- The Development of SWE’s Literature Reviews Since 2002
- Trends & Outcomes
- Insights of Significance
- Opportunities for Future Research
- Q&A



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About SWE



- Established in 1950
- More than 40,000 members worldwide
- A growing international membership
- Approximately 6,000 SWENext members



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SWE Mission



Empower women to achieve full potential in careers as engineers and leaders, expand the image of the engineering and technology professions as a positive force in improving the quality of life, and demonstrate the value of diversity and inclusion.



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SWE Activities

- 300+ collegiate member sections
- 100+ professional member sections
- More than \$800,000 in scholarships annually
- Awards & Recognitions
 - Outstanding women in engineering and technology
 - Individuals and organizations who are furthering women in engineering and technology
- 100+ Corporate Partnership Council members
- Annual Conference + WE Local Conferences
- Advocacy: Congressional Outreach Day
- Publications: 5 magazine issues per year
- Outreach: SWENext, IIBI



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The Development of SWE's Literature Reviews Since 2002

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SWE's Literature Review: The Beginning

2001 LITERATURE REVIEW

Women in Engineering: A Review of the 2001 Literature

Recognizing the long-standing need to compile research on women in engineering, the SWE Magazine Editorial Board has committed to producing this essential information.

BY CLAIRE THELEN, SWE

The focus of this summary is research on engineering-related to the career choice process. Confidence, satisfaction, and expectations for future success. CWilliam

- Demographics
- Career choice
- Girls' interest in engineering
- Teaching, learning, mentoring
- Persistence & retention in engineering
- Gender differences in the workplace: Management & representation
- Engineering faculty



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SWE's Literature Review: Picking Up Steam

2002 LITERATURE REVIEW

Women in Engineering: A Review of the 2002 Literature

BY LISA M. FRIEHL, PH.D., JAMMIE BENTON-SPEYER, AND PAMELA HUNT

In the past year, there has been much interest in understanding the movement of women and girls into and through the engineering pipeline and their experiences in that pipeline. At least 22 dissertations explored a range of issues about gender and engineering and more than 40 articles appeared in peer-reviewed publications. Large conferences — like the 12th International Conference of Women Engineers and

more family-friendly and that stereotypes and harassment need to be curtailed if academia is to recruit and retain a diverse labor force. Sevo provides a good overview of NSF funding related to gender equity in science and engineering.

The Institutional Transformation program is a bold new initiative aimed at changing the institutions in which gender bias is often subtle and built into work structures rather than overt

for more details about these programs.

Over the past couple of years there have been a few books and articles that address questions about the impact of feminism on science and technology. An excellent edited volume by Creager, Lunbeck, and Schiebinger (2001) as well as a 1999 book by Schiebinger address this very issue and both conclude that feminism has had an interesting impact upon science, technology and medicine — but in different ways in

- Institutional transformation: NSF ADVANCE
- Programmatic efforts to encourage women & girls to pursue engineering
- Factors associated with choosing or not choosing engineering
- Experiences of women and girls in STEM



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SWE's Literature Review: Looking at the Data

2005 LITERATURE REVIEW

Women in Engineering: A Review of the 2005 Literature

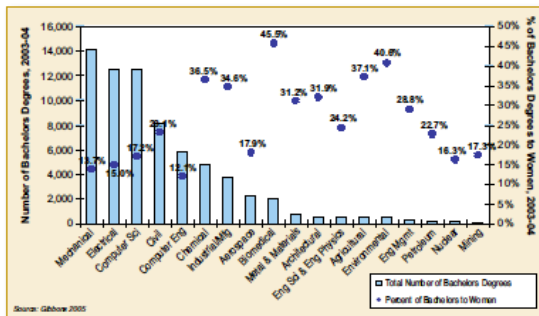
BY LISA FRIEHL, PH.D., ABBY JAVUREK-HUMG, AND CECILY JESER-CANNIALE

For this year's literature review, we located 374 articles, dissertation abstracts, and books, and of these, used 224 to

remarks concerning women's suitability for careers in science and engineering.

Events Opened and Closed 2005 with an Emphasis on Women in

Why So Slow? The Advancement of Women, professor of psychology, and head of Hunter College's Gender Equity Project, which includes the National Science Foundation-funded ADVANCE research program.



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- Data on the % of women engineering graduates
- Data & research on the gender pay gap
- The impact of motherhood
- Global comparisons
- Women in academia: Flexibility & research productivity

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SWE's Literature Review: New Topics of Interest

2006 LITERATURE REVIEW

Women in Engineering: A Review of the 2006 Literature

BY LISA M. FRIEHL, PH.D., NICOLE DI FABIO, PEGGY LAYNE, PE, ANE TURNER-JOHNSON, AND SARAH HOOD

Overview

As in past literature reviews, we identified sources via keyword searches of academic and press databases. In order to cast a wider net, we scanned the tables of contents of 70 peer-reviewed journals in disciplines such as engineering, education, psychology, management, sociology, science and technology studies

ing of individuals' experiences. Qualitative studies are often limited to a particular geographic region. Social scientists and educational researchers, therefore, typically search for studies that address the same question using different research methods and different populations. This approach answers these questions more fully while taking into ac-

(CWSE), it appears that mentoring is the magic bullet to enable U.S. institutions to better recruit and advance women students and faculty in science and engineering. The buzz about mentoring is everywhere. For example, the in-flight magazine for a major airline had an article about mentoring. Academic journals feature items about both

- Impact of mentoring on productivity, self-efficacy, self-esteem, job satisfaction. Also on same-gender pairing.
- K-12 education: Math, science, critical thinking skills, stereotypes. Also looked at racial differences.
- Recruitment & persistence in engineering college programs, undergraduate and graduate
- The academic workforce: NSF ADVANCE research
- The culture of engineering and the IT workforce
- Globalization & international studies of women in engineering



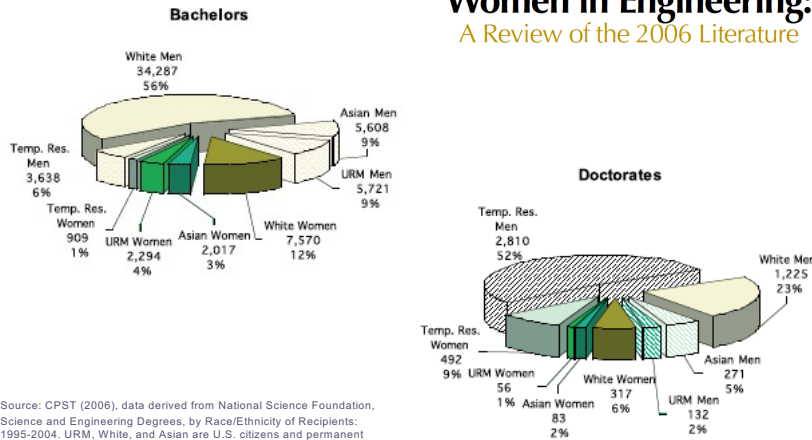
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SWE's Literature Review, cont.

2006 LITERATURE REVIEW

Women in Engineering: A Review of the 2006 Literature



Source: CPST (2006), data derived from National Science Foundation, Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1995-2004. URM, White, and Asian are U.S. citizens and permanent residents. URM = Under Represented Minority and includes African Americans, American Indians, and Hispanics. "Asian" includes Asians and Pacific Islanders. "White" are non-Hispanic whites.



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SWE's Literature Review: Promoting the Research

2007 LITERATURE REVIEW

Q: Where do you turn if you want to know more about leadership trends in industry? Current statistics on engineers in the work force? Research to underpin your next outreach activity or research grant? Ideas on how to improve your parenting?

A: Turn to "Women in Engineering: A Review of the 2007 Literature," on page 109. Each year, *SWE Magazine* publishes this compendium, otherwise known as the literature review.

Q: But wait, isn't the SWE literature review for researchers?

A: Yes. And every other SWE stakeholder. You'll be amazed at what you can find in this annual box of goodies.

- Access practical information
- Find parenting tips
- Keep up on the most recent literature
- Support workplace discussions on diversity
- Make sense of your work environment
- Create effective outreach programs
- Support grant proposals



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SWE Literature Review, cont.

2007 LITERATURE REVIEW

Women Engineering Deans or equivalent

Deirdre Meldrum, Ph.D.	Arizona State University
Cheryl B. Schrader, Ph.D.	Boise State University
Esin Gulari, Ph.D.	Clemson University
Sandra Woods, Ph.D.	Colorado State University
Eleanor Baum, Ph.D.*	Cooper Union
Beverly K. Hartline, Ph.D.	Delaware State University
Susan M. Blanchard, Ph.D.	Florida Gulf Coast University
Maria Vaz, Ph.D.	Lawrence Technological University
Catherine M. Murphy, Ph.D.	Purdue University, Calumet (Eng.)
Leah H. Jamleson, Ph.D.	Purdue University, West Lafayette
Sallie Keller-McNulty, Ph.D.	Rice University
Dianne Dorland, Ph.D.	Rowan University
Belle Wei, Ph.D.	San Jose State University
Linda E. Jones, Ph.D.	Smith College
Pamela A. Elbeck, Ph.D.	Texas Tech University
Linda Abriola, Ph.D.	Tufts University
Cherrice Traver, Ph.D.	Union College
Linda C. Lucas, Ph.D.	University of Alabama, Birmingham
Mary L. Good, Ph.D.	University of Arkansas, Little Rock
Acha A. Elshabini, Ph.D.	University of Idaho, Moscow
Kathleen A. Kramer, Ph.D.	University of San Diego
Zulma Toro-Ramos, Ph.D.	Wichita State University
T. Kyle Vanderlick, Ph.D.	Yale University

* The first woman engineering dean in the United States, Dr. Baum was inducted into the National Women's Hall of Fame in Oct. 2007. See *SWE Magazine* Spring 2008 issue.
Compiled from data provided by American Society for Engineering Education, 2008



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SWE Literature Review: New Authors

2010 LITERATURE REVIEW

Women in Engineering: 2010 Literature Review

By Peter Melkiss, Ph.D., Cleveland State University; Peggy Layne, P.E., F.SWE, Virginia Tech; and Molly R. Hall, Virginia Tech

Research on women in engineering continued apace in 2010. For this literature review, we identified more than 120 resources, many of which were substantial contributions to the literature. Researchers made continued use of existing data sets (e.g., those collected by the National

concentrated on students. There were numerous studies that attempted to identify factors that either encouraged or discouraged young women from pursuing an engineering degree. Others examined the role of various kinds of educational institutions such as community colleges, historically

not being matched by an increase in the numbers of women in engineering and scientific careers. One would expect, then, that future research would expand the amount of attention being devoted to areas such as the nature of engineering labor markets, retention, and career satisfaction.

- Heavy research focus on education:
 - What encourages/discourages young women from pursuing an engineering degree
 - Role of the various kinds of educational institution in training women engineers
 - Factors influencing women's persistence in engineering programs
 - Women engineers working in the academic sector (NSF ADVANCE)
- A paradox: Literature notes that supply may not be the primary reason why women remain underrepresented in the engineering workforce
- Unlike in prior years, less research on issues affecting women engineers in non-academic workplaces.



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SWE Literature Review: A New Home

2016 LITERATURE REVIEW

Women in Engineering: A Review of the 2016 Literature

SWE's assessment of the most significant research found in the past year's social science literature on women engineers and women in STEM disciplines, plus recommendations for future analysis and study.

By Peter Meeksins, Ph.D., Cleveland State University
Peggy Layne, P.E., F.SWE, Virginia Tech
Kacey Beddoes, Ph.D., University of Massachusetts Lowell
Sarah Masters, Virginia Tech
Micah Roediger, Virginia Tech
Yashna Shah, Virginia Tech

The amount of public attention devoted in 2016 to the role of women in engineering and sci- 2016 also saw the nomination for the National Book Critics Circle Award of a memoir by



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SWE Literature Review: A Retrospective Analysis

THE STATE OF WOMEN IN ENGINEERING: ANALYZING

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OF SOCIAL SCIENCE LITERATURE



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Profiles and Perspectives from Behind the Research



“

We need a cultural mindset shift to become more inclusive. We need to recognize what that takes, how we get there, and what does that look like in a granular way — and put policies in place so the right information is there when decisions like hiring and promotions are made.”

— Diana Bilimoria, Ph.D., KeyBank professor and chair of organizational behavior, Case Western Reserve University

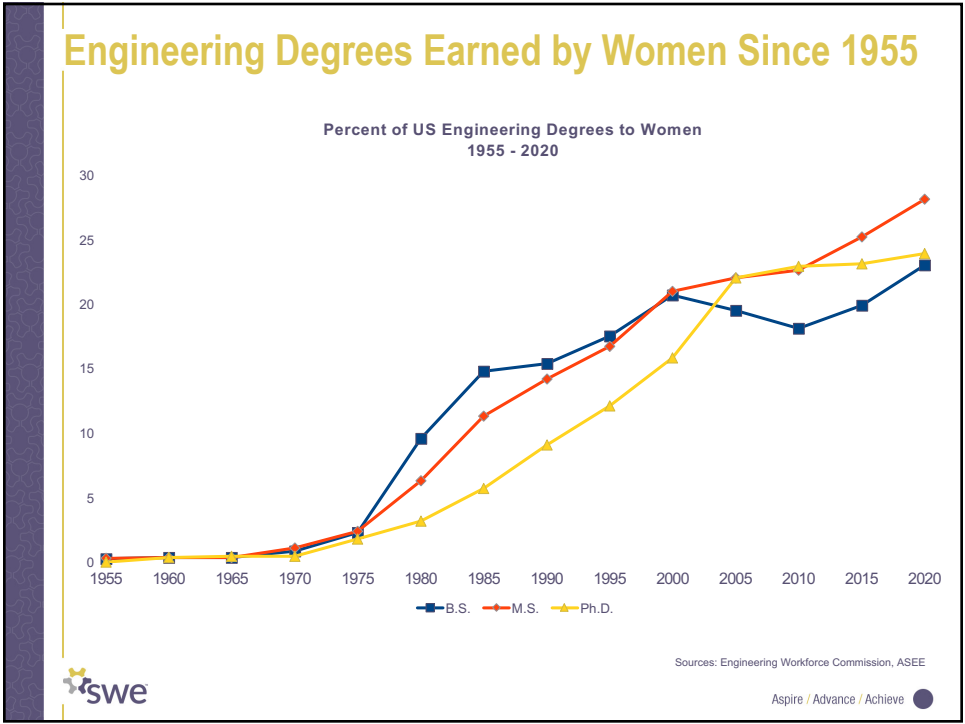


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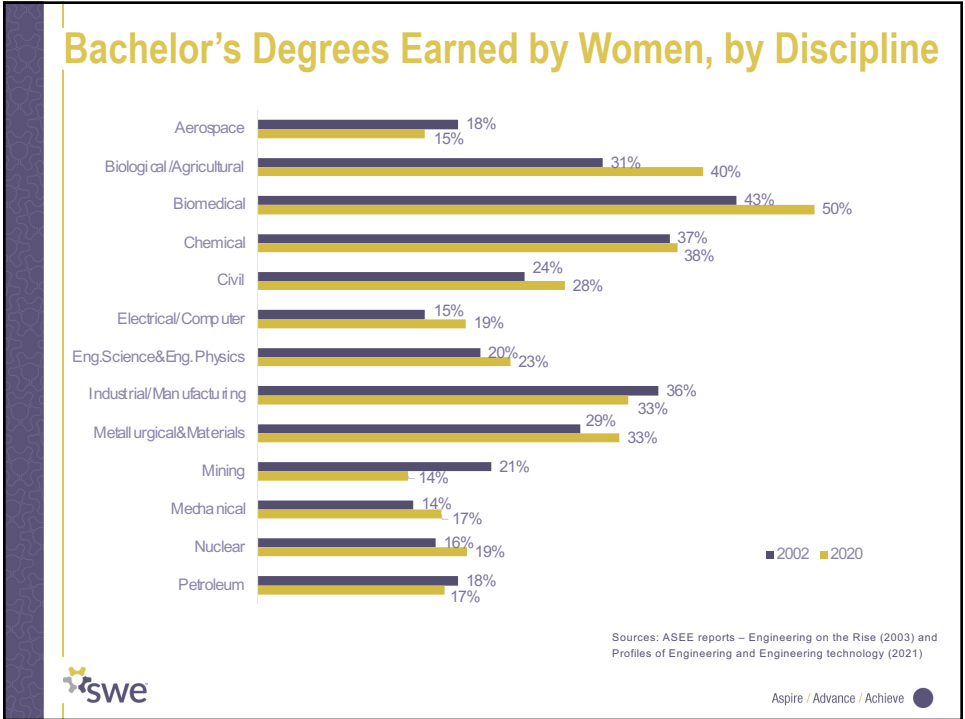
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Trends & Outcomes

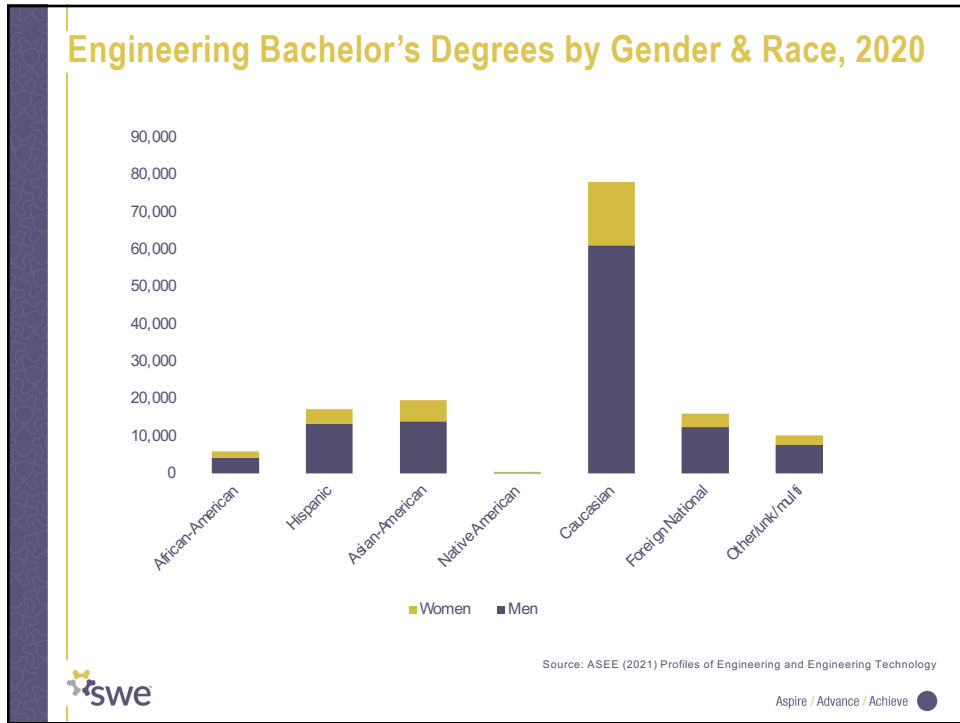
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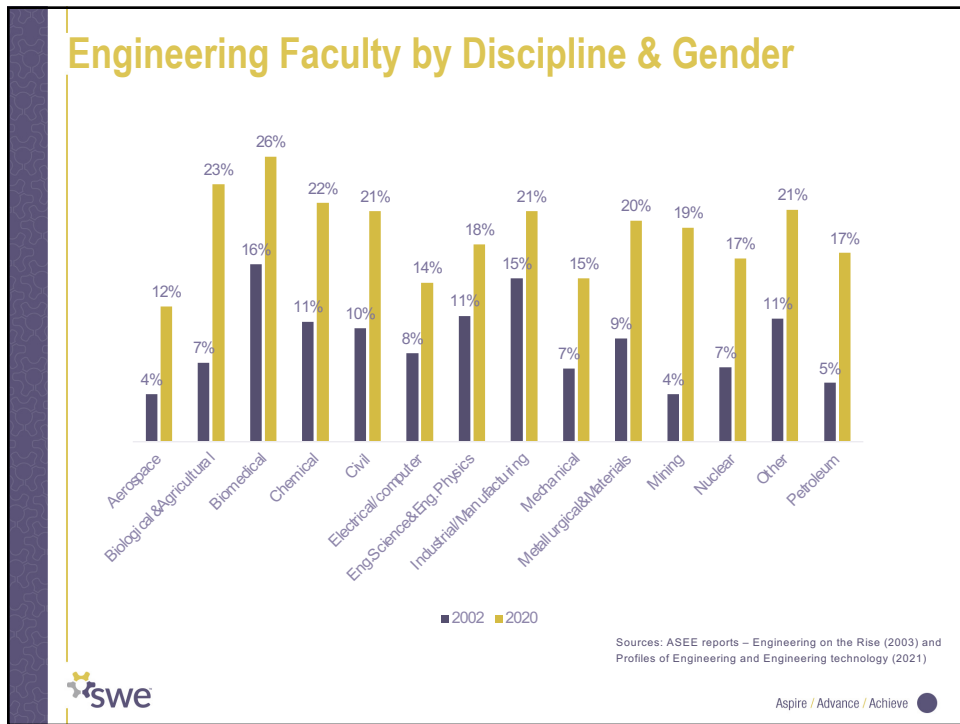
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Engineering Faculty by Rank & Gender



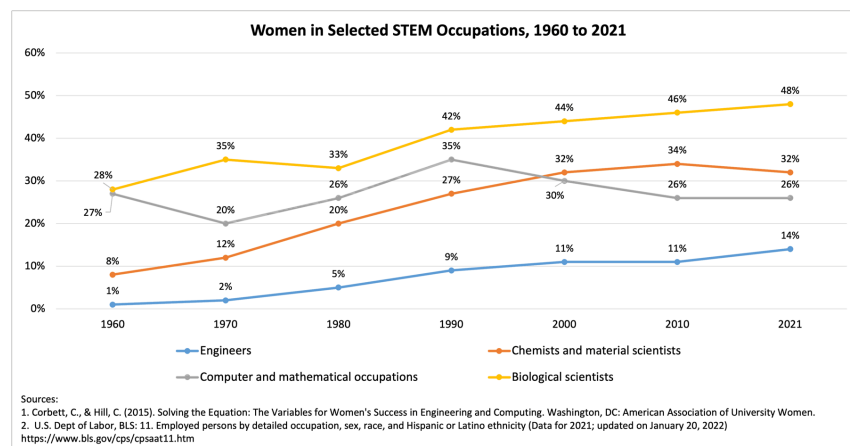
Sources: ASEE reports – Engineering on the Rise (2003) and Profiles of Engineering and Engineering technology (2021)



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Representation of Women in the Engineering Workforce



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Insights of Significance

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Achievement Gaps

Decreased emphasis on the role of math achievement in limiting the numbers of women in engineering.

- 2001: Math & science achievement gaps are a factor
- 2005: Harvard president Laurence Summers controversial remarks about the low representation of women in science.
- By 2020:
 - Advanced math classes are no longer dominated by boys
 - Girls consistently earn higher grades than boys
- Research still shows that high achieving boys are more likely to enter engineering than high achieving girls

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Math Confidence

Researchers continue to focus on whether girls are less confident in math than boys

- Girls at similar achievement levels tend to evaluate themselves lower than boys
- Less clear on the relationship between lower self-reported confidence and not choosing engineering
 - 2021: Research found that girls who believe that girls are better at math than boys are not more likely to major in engineering (but are more likely to major in biology)



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Girls Interest in Engineering

Girls need to be recruited to engineering, while boys do not.

- Research shows that STEM interest develops early
- Researchers often note that girls know little about what an engineer is or does
 - Lack of role models
 - Toys for girls often do not encourage engineering skill development
 - Engineering not seen as a people-oriented field
- Engineering perceived as “masculine”
 - Draw an engineer
 - 2020: Researchers found that boys are strong defenders of gender norms



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Recommendations to Increase Girls Interest

The effectiveness of some efforts remains unclear.

- Increase role models for girls = more likely to aspire to engineering careers and persist
- Mentoring as a way to retain interested students
- Strengthen girls' engineering identity
- Changing the Conversation: Change our messaging to make engineering more appealing to girls.



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Not All Women are the Same

Growing attention to the ways in which a woman's race/ethnicity, sexual orientation, disability status affect their experiences in engineering

- Earlier research emphasized the need to tailor recruitment efforts to the different experiences and situations of students of color
- More research is now being conducted on LGBTQ+ engineers



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Retention in College Engineering Programs

No clear consensus on the role that attrition from college programs has on the gender gap in engineering

- 2010: Literature review authors clearly state that women do not leave at higher rates than men.
- 2016: Cited meta-analysis by Cheryan et al. concluded that recruitment, not retention, was the reason for the gender gap.
- 2021: Researchers note evidence that women switch out of STEM majors more frequently than men.



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Retention in the Engineering Workforce

Little disagreement that attrition is a cause for the gender gap, but why women leave is still being debated.

- Early research notes the impact of work-life balance/conflict on women's retention
- Later research highlighted the obstacles that women experience as the work towards their organizational and career goals
- Continued focus in later research on the role that culture plays in women's decisions to continue in engineering



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Fix the System, Not the Women

Evidence exists that engineering can be unwelcoming to women, but researchers continue to determine the cause.

- Studies tend to focus on two areas:
 - Bias in hiring and promotion decisions
 - A “chilly climate” in the engineering workplace
- Strategies to address systemic issues are complicated, particularly when engineers and leaders do not acknowledge that structural problems exist.
 - 2017: Britton interview of 100 women STEM faculty found while they reported unfair treatment, they were inclined to treat incidents as isolated cases of individual misbehavior.
 - 2018, 2019: Focus on “STEMinism” – strengthen individual women’s skills in a field that is largely gender-blind



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NSF ADVANCE

- Early project assessments noted the importance of departmental climate
 - 2006: Bilimoria et al. find that a “toxic climate” has a stronger negative impact on women than on men.
- 2010: Noted issues with the techniques used in faculty searches
- Assessments of individual and multiple ADVANCE projects show that they have had a significant impact on the institutions where they were implemented.
 - 2021 article argued that the concept of “implicit bias” is now largely known in the corporate sector because of the work done under ADVANCE
 - ADVANCE demonstrates the impact that research coupled with strong internal support (and grant funding) can have on transforming institutions



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Opportunities for Future Research

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Opportunities for Future Research

- Increasing girls' interest in engineering
 - Understanding the effectiveness of interventions
 - Determining the type of mentoring programs that are most effective
- Retention in college programs
 - Some researchers focus on attrition in engineering college programs, but do not include men in their analysis
 - Unclear how much of a factor attrition is to the gender gap
- Retention in the workplace
 - Women's experiences in non-academic workplaces
 - Understanding why women stay/leave the engineering profession
- Various pathways into engineering
- What interventions have a lasting impact?
- What could cross-disciplinary research offer?
 - Sociology, organizational behavior, psychology, STEM Education, etc.

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THANK YOU!
and
Questions?

SWE Website: www.swe.org

SWE Research Website: <https://swe.org/research/>

SWE Magazine Website: <https://magazine.swe.org/>

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