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
About SWE

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

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.
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

The Development of SWE’s Literature Reviews Since 2002
SWE’s Literature Review: The Beginning

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.

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

SWE’s Literature Review: Picking Up Steam

Women in Engineering: A Review of the 2002 Literature

In the past year, there has been much interest in understanding the recruitment of women and girls to engineering and the barriers and facilitators that are involved. The American Chemical Society’s Chemistry in the Public Interest (CIP) program provides a good overview of NSF funding related to gender equity in science and engineering.

- 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
SWE’s Literature Review: Looking at the Data

Women in Engineering: A Review of the 2005 Literature

- 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

Overview:
For this year’s literature review, we located 724 articles, dissertations, and technical reports. Of these, 244 included data percentages and of these, 240 added more nuance concerning women’s role in science and engineering. Events Opened and Closed 2005 with an emphasis on Women in Science and Engineering.

Women in engineering: A review of the 2005 literature

SWE’s Literature Review: New Topics of Interest

Women in Engineering: A Review of the 2006 Literature

- 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
SWE’s Literature Review, cont.

Women in Engineering:
A Review of the 2006 Literature


SWE’s Literature Review: Promoting the Research

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
SWE Literature Review, cont.

Women Engineering Deans

Women in Engineering: 2010 Literature Review

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.
SWE Literature Review: A New Home

Women in Engineering: A Review of the 2016 Literature

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

By Peter Nelkin, Ph.D., Cleveland State University
Peggy L'Heureux, Ph.D., Rensselaer Polytechnic Institute
Kathy Bednarski, Ph.D., University of Massachusetts Lowell
Sarah Mattern, Virginia Tech
Michael Khatri, Virginia Tech

The amount of public attention devoted to women’s role in engineering and science is now also on the rise. The National Science Foundation reports a sharp rise in the number of women in science and engineering at the graduate level.

SWE Literature Review: A Retrospective Analysis

THE STATE OF WOMEN IN ENGINEERING: ANALYZING 20 YEARS OF SOCIAL SCIENCE LITERATURE

[Image of a hand with text]
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., keySight professor and chair of organizational behavior, Case Western Reserve University

Trends & Outcomes
# Engineering Degrees Earned by Women Since 1955

**Percent of US Engineering Degrees to Women**

1955 - 2020

**Sources:** Engineering Workforce Commission, ASEE

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# Bachelor's Degrees Earned by Women, by Discipline

- **Aerospace:** 18% (2002), 15% (2020)
- **Biological/Agricultural:** 12% (2002), 10% (2020)
- **Biomedical:** 31% (2002), 40% (2020)
- **Chemical:** 24% (2002), 28% (2020)
- **Civil:** 19% (2002), 19% (2020)
- **Electrical/Computer:** 16% (2002), 19% (2020)
- **Industrial/Manufacturing:** 36% (2002), 33% (2020)
- **Metallurgical/Materials:** 29% (2002), 33% (2020)
- **Mining:** 14% (2002), 21% (2020)
- **Mechanical:** 14% (2002), 17% (2020)
- **Nuclear:** 16% (2002), 19% (2020)
- **Petroleum:** 18% (2002), 17% (2020)

**Sources:** ASEE reports – *Engineering on the Rise* (2003) and *Profiles of Engineering and Engineering Technology* (2021)
Insights of Significance

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
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)

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
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.

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
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.

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
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

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
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.
THANK YOU!

and

Questions?

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