

IMPROVING INNOVATION WITH DIVERSIFYING ENGINEERING CAREER CHOICES

Alice M. Agogino

Professor of Mechanical Engineering

Chair, Development Engineering Graduate Group

University of California at Berkeley



Gender Diversity Improves Products and Business

- **Connects companies with customers:**
Women in the U.S. purchase 50% of computers, 50% of cars and 80% of consumer goods.





Ford Windstar, 1999

Today woman make up 50% of automotive buying decisions, compared to 20% in 1990.

TECHNICAL WOMEN IN SMALL AND MEDIUM BUSINESSES

EMILY BLAKEMORE, ANGIE IM, CHANNING MARTIN, ALBERY MELO, SARA RAJU, AND LIZ SCHUELKE.

THE H. JOHN HEINZ III COLLEGE, CARNEGIE MELLON UNIVERSITY

Women control 80 percent of consumer decisions but design only 10 percent of IT products and services.



Source: Harris, K., and M. Raskino. 2007. *Women and Men in IT: Breaking Sexual Stereotypes*. Stamford, CT: Gartner.

Gender Diversity Improves Products and Business

- **Connects companies with customers:** Women in the U.S. purchase 50% of computers, 50% of cars and 80% of consumer goods.
- **Improves innovation and problem-solving:** Draws on broader diversity of experiences.



Winning Mustang Design: High Gear Designed and Voted by Woman



40 women designers and engineers

Early Air Bags Tested on Male Crash Dummies Exclusively



Gender Diversity Improves Product Design

- improves use rate
- satisfies people's needs and wants and increases the quality of their lives
- doesn't stand alone but is part of an infrastructure
- meshes with the culture
- is sustainable over the product life cycle



Femme Den is here
to save good
women from bad
products

Gender Diversity Improves Products and Business

- **Connects companies with customers:**
Women in the U.S. purchase 50% of computers, 50% of cars and 80% of consumer goods.
- **Improves innovation and problem-solving:**
Draws on broader diversity of experiences.
- **Increases the Bottom Line:** Fortune 500 companies women in leadership have a return on sales increases by at least 42%.



Women in Company Leadership Tied to Stronger Profits



Study of 22,000 publically traded companies in 91 countries, Peterson Institute of International Economics: http://www.nytimes.com/2016/02/10/business/women-in-company-leadership-tied-to-stronger-profits.html?_r=0

NATIONAL ACADEMY OF ENGINEERING AND
NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

CAREER CHOICES OF FEMALE ENGINEERS

SUMMARY OF A WORKSHOP





BACKGROUND

As part of a project to examine the career outcomes of female recipients of bachelor's degree in engineering, the National Research Council Committee on Women in Science, Engineering, and Medicine (CWSEM) held a workshop on April 24, 2013, titled "Career Outcomes of Female Engineering Bachelor's Degree Recipients". The project was supported by the National Science Foundation (Grant No. 1137641).

The workshop was designed to increase (1) understanding of gender differences in the recruitment, retention, and advancement of women at critical transition points and (2) investigate and share the best practices to facilitate career transitions and advancements for all.

A summary of the workshop was published in 2014. This overview highlights some presentations and data from the workshop summary.

The views expressed are those of individual conference participants and do not necessarily represent the views of all conference participants, the planning committee, the National Research Council, or the National Science Foundation.



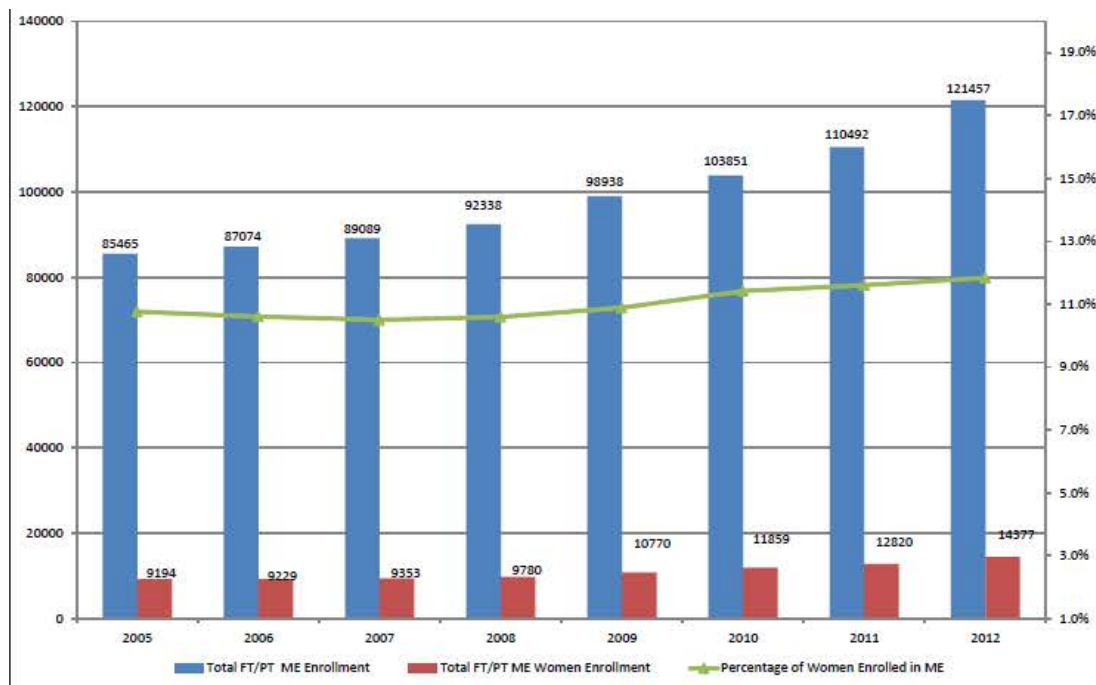
INTRODUCTION

- Despite decades of government, university, and employer efforts to close the gender gap in engineering, **women make up only 11 percent of practicing engineers in the United States.**
- This workshop examined women's career paths and obstacles for women and minority groups.
- The loss of women engineers from technical workplaces has implications for women themselves, the organizations they leave, and society as a whole.
- It is critical to US technological competitiveness and national security to understand the impact of gender diversity in the technical workforce.

Taken from *Career Choices of Female Engineers: A Summary of a Workshop*. The National Academies Press, 2014.

RETAINING TECHNICAL TALENT: A DISCUSSION ON DATA NEEDS, CRITICAL TRANSITIONS, AND CAREER PATHWAYS

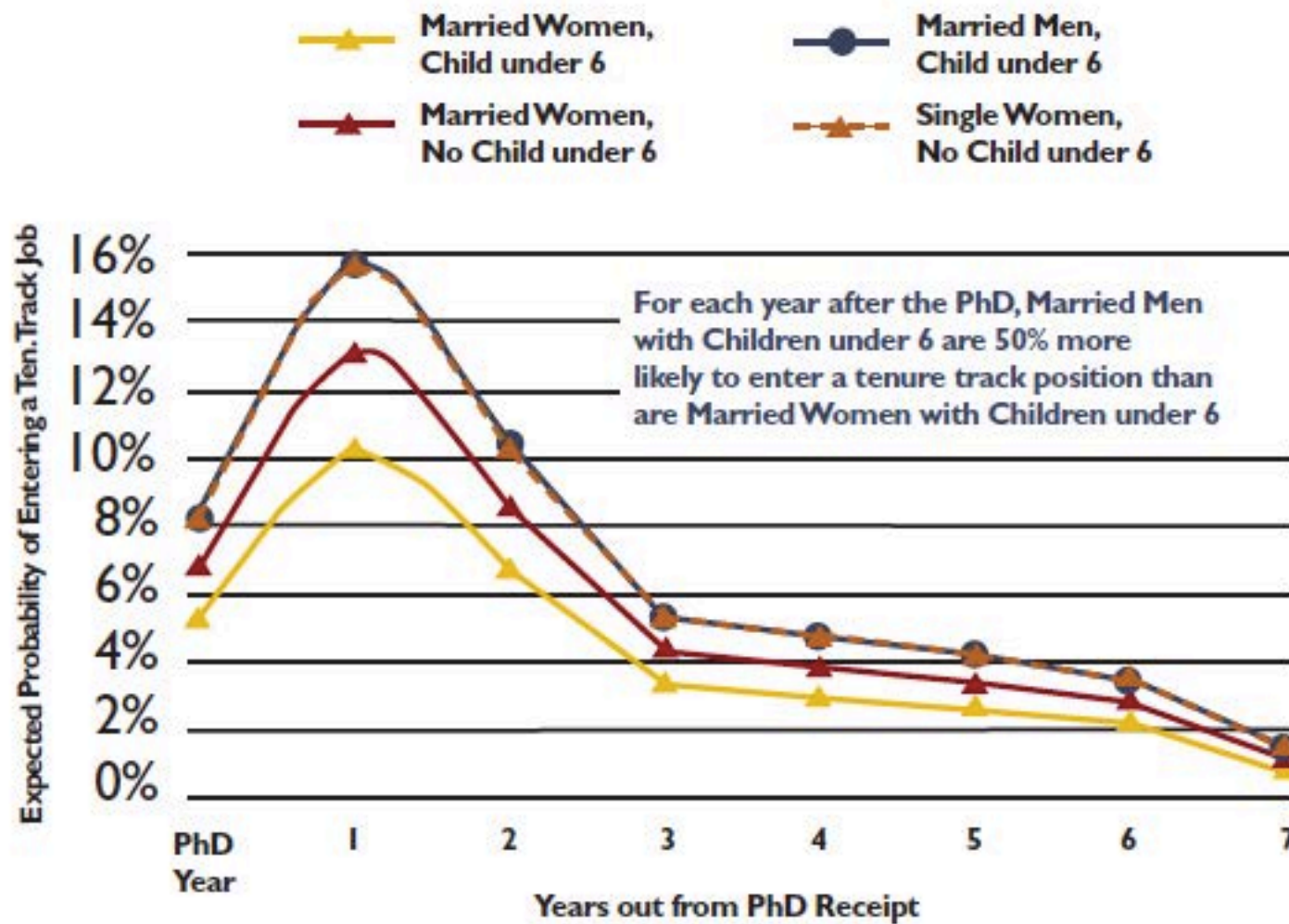
Total full-time/part-time enrollment in US undergraduate mechanical engineering programs, 2005-2012



Source: ASEE Data Mining Site, www.asee.org

The figure shows that despite seven years of continual enrollment growth in mechanical engineering, the enrollment of women remained stuck at 11-12 percent.

Leaks in the Pipeline: PhD to Tenure Track Faculty Position



CAREER OUTCOMES OF WOMEN ENGINEERING BACHELOR'S DEGREE RECIPIENTS

GAIL GREENFIELD

Greenfield examined two key career outcomes: (1) the percentage of graduates in the labor force (**“labor force participation”**) and (2) the percentage of employed graduates working in the field of their major (**“retention”**)

Overall, Greenfield found:

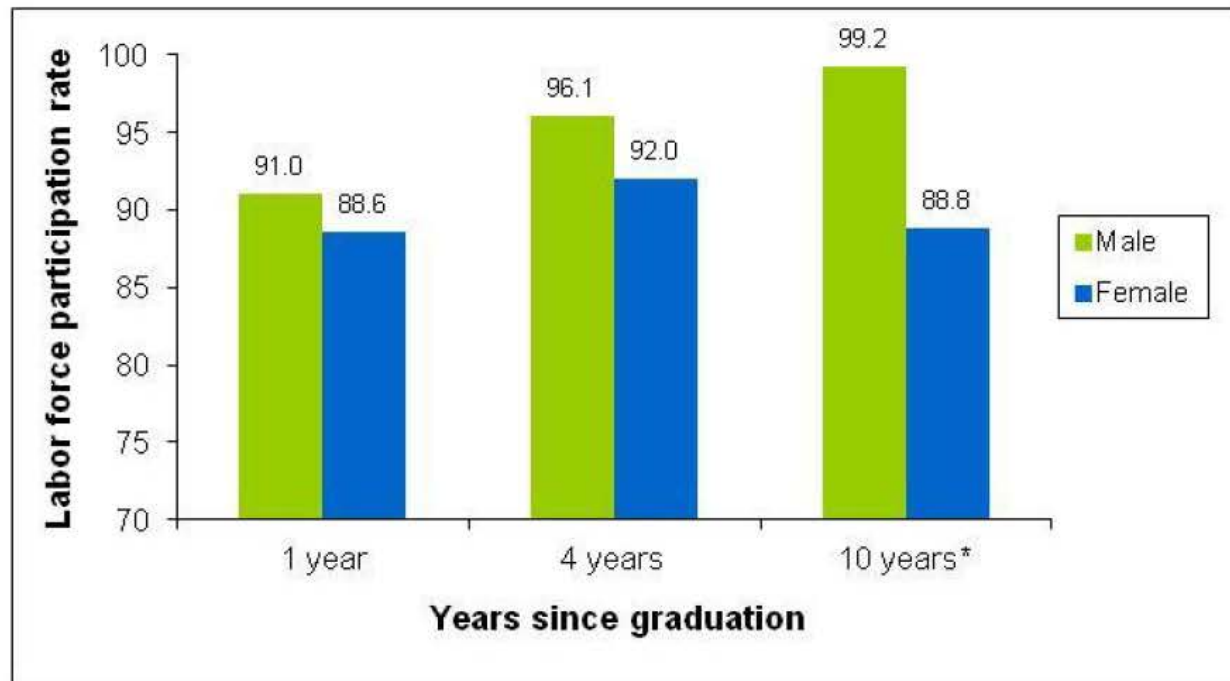
“participation in the labor force is not a concern: women are participating in the labor force at high rates. It is retention in engineering that appears to be a challenge for both men and women: ten years after graduation.”

CASES FOR EACH COHORT AND SURVEY

Cohort	Survey Year	All	Male	Female
1	1994	640	550	90
1	1997	625	535	90
1	2003	575	490	85
1	All	520	440	80
2	2001	580	480	100
3	2009	930	750	180

Greenfield, G. (2014). The Career Outcomes of Female Engineering Bachelor's Degree Recipients: a study using the Baccalaureate & Beyond (B&B) Longitudinal Study. Taken from *Career Choices of Female Engineers: A Summary of a Workshop*. The National Academies Press, 2014.

LABOR FORCE PARTICIPATION RATE BY GENDER FOR ENGINEERING BACHELOR'S DEGREE RECIPIENTS IN THE 1992-1993 ACADEMIC YEAR



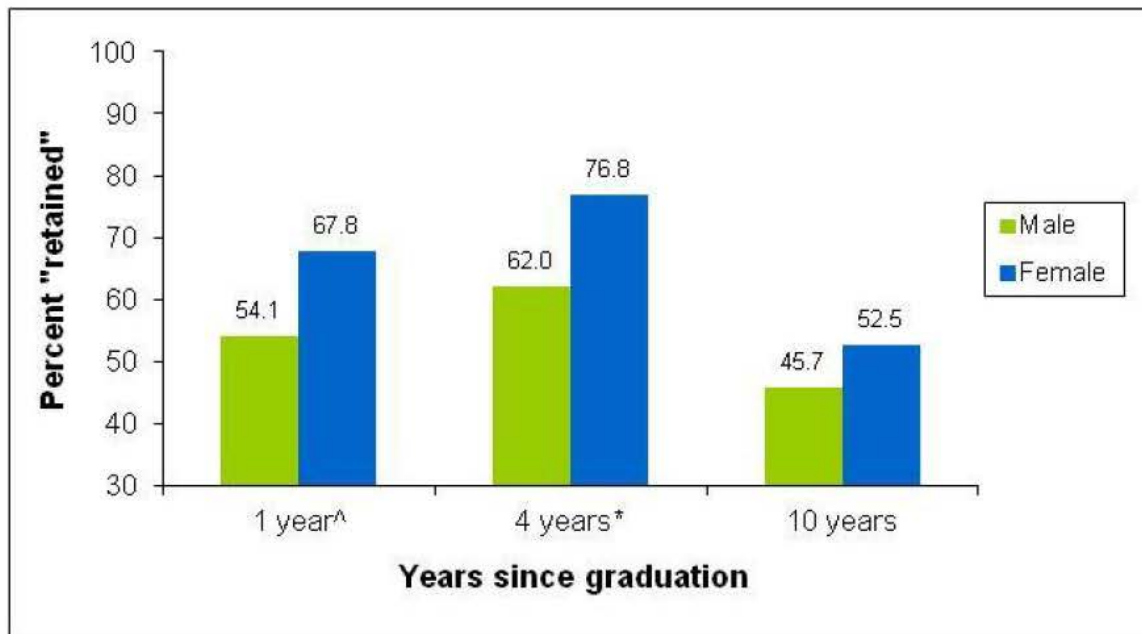
Key findings

- Male participation increases with time, female participation does not.
- While female participation 10 years after graduation remains high, it is still 10% lower than males.

*Difference between men's and women's rates is statistically significant at the 5 percent level.

Source: National Center for Education Statistics.

EMPLOYED ENGINEERING BACHELOR'S DEGREE RECIPIENTS FROM THE 1992-1993 ACADEMIC YEAR IN AN ENGINEERING/ARCHITECTURE OCCUPATION



^Difference between numbers for women and men is statistically significant at the 10 percent level. *Difference between numbers for women and men is statistically significant at the 5 percent level. The decline in the percent retained from four to ten years after graduation is statistically significant at the 5 percent level for both men and women.

Source: National Center for Education Statistics.

Key findings

- The retention rate for both men and women drops ten years after graduation.
- The retention rate at each year for engineering bachelor's degree recipients is higher for females than male.

STEMMING THE TIDE: WHY WOMEN ENGINEERS STAY IN, OR LEAVE, THE ENGINEERING PROFESSION

NADYA FOUAD AND ROMILA SINGH, UNIVERSITY OF WISCONSIN

Comparison of the women who leave with those who stay in engineering revealed:

- No difference in self-confidence in performing tasks, navigating work politics, or managing non-work roles
- No difference in terms of interests

STEMMING THE TIDE: WHY WOMEN ENGINEERS STAY IN, OR LEAVE, THE ENGINEERING PROFESSION

NADYA FOUAD AND ROMILA SINGH, UNIVERSITY OF WISCONSIN

Workplace climate is the biggest differentiator. Women currently working in the engineering field:

- Experienced a supportive workplace
 - Supportive workplace: family friendly work culture characterized by recognition of the importance of work-life balance and availability of work-life benefits
- Worked with empathic and understanding supervisors and coworkers
- Experienced fewer barriers at work in the form of **incivility and undermining behaviors** compared to women who left the technical field

RETAINING TECHNICAL TALENT: A DISCUSSION ON DATA NEEDS, CRITICAL TRANSITIONS, AND CAREER PATHWAYS

	2005	2012	Change in number	Percent increase
Female ME undergraduate education	9,194	14,377	5,183	56.40%
Male ME undergraduate education	76,271	107,080	30,809	40.40%

	2007	2012	Change in number	Percent increase
Female ME undergraduate education	9,353	14,377	5,183	53.70%
Male ME undergraduate education	79,736	107,080	27,344	34.30%

Upon closer examination, the data from the previous figure reveals that since 2005 the number of undergraduate women studying mechanical engineering has risen more than 10 percent faster than the number of men—an increase in women of over 55 percent, compared to a 40 percent increase in men.

Source: ASEE Data Mining Site, www.asee.org



TECHNICAL WOMEN IN SMALL AND MEDIUM BUSINESSES

EMILY BLAKEMORE, ANGIE IM, CHANNING MARTIN, ALBERY MELO, SARA RAJU, AND LIZ SCHUELKE.

THE H. JOHN HEINZ III COLLEGE, CARNEGIE MELLON UNIVERSITY

Barriers to recruitment of women in IT:

- Subtle job posting bias deter women.
- Stereotypical environments (e.g. Star Trek posters, video games, etc.) marginally reduce women's identification with the computer science field.

Barriers to retention of women in IT:

- The IT field lacks a culture of collaboration and hands-on learning, causing women to feel isolated.
- The stereotypical perception of women as less technologically capable than men perpetuates the underrepresentation of women in the IT field.

Explicit Discrimination

- Nobel Prize winner Tim Hunt was roundly criticized when he detailed his thoughts about the "trouble with girls" at a conference of science journalists.
- "Three things happen when they are in the lab," he said, "you fall in love with them, they fall in love with you, and when you criticize them they cry."



Female scientists post 'distractingly sexy' photos





TECHNICAL WOMEN IN SMALL AND MEDIUM BUSINESSES


EMILY BLAKEMORE, ANGIE IM, CHANNING MARTIN, ALBERY MELO, SARA RAJU, AND LIZ SCHUELKE.

THE H. JOHN HEINZ III COLLEGE, CARNEGIE MELLON UNIVERSITY

Small businesses have more flexibility to propose and implement interventions rapidly.

Opportunities for small businesses:

- Adapt organizational environment to accommodate diverse populations, including women
- Encourage recruitment and implement mentoring programs for women in IT
- Provide access to professional technical societies that can be alternatives to internal mentoring program



RETAINING TECHNICAL TALENT: A DISCUSSION ON DATA NEEDS, CRITICAL TRANSITIONS, AND CAREER PATHWAYS

How to leverage the right resources to get the data we need

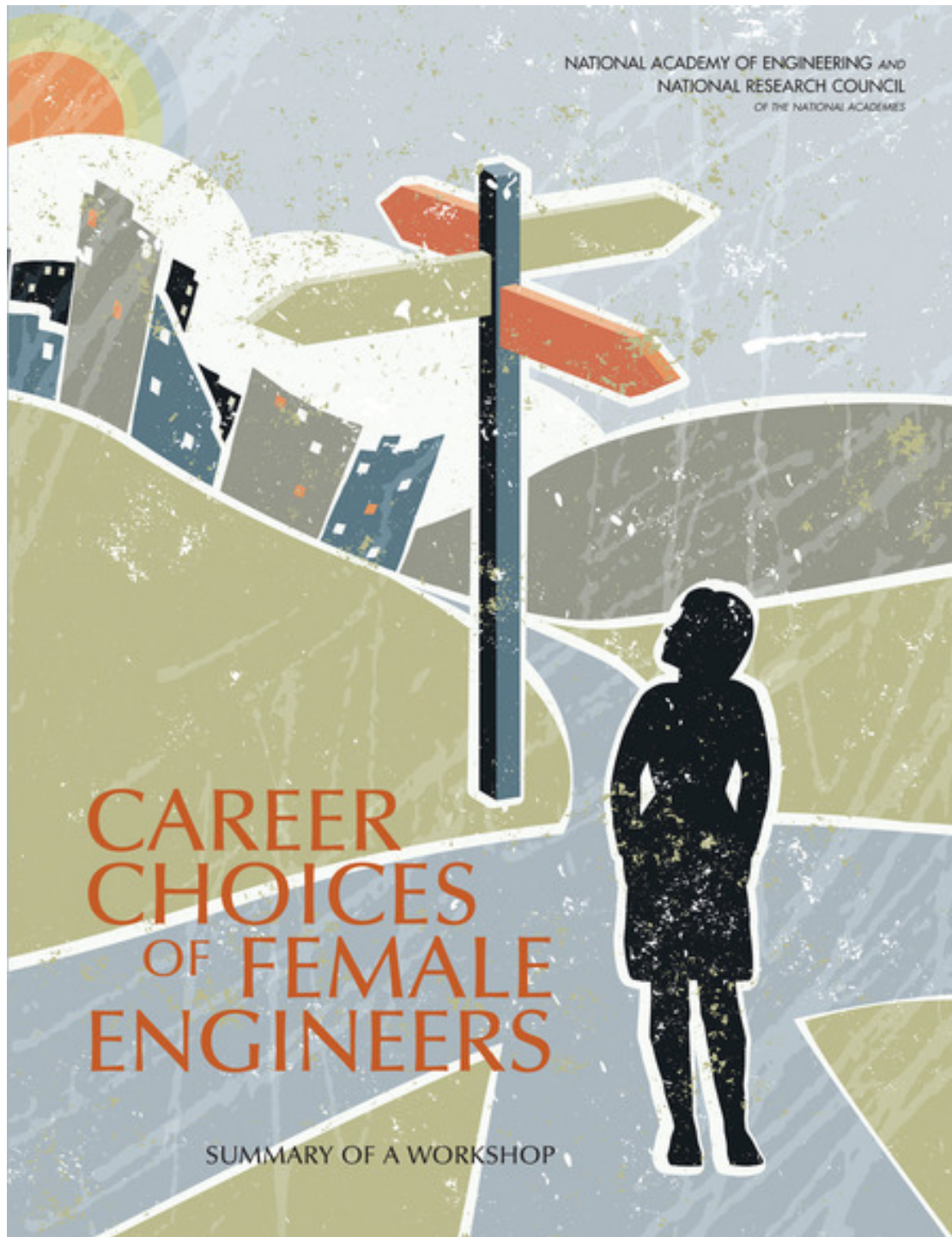
- Promote collaboration among engineering societies
- Make data publicly accessible while protecting confidentiality
- Engaging a diverse range of societies to ensure the inclusion of populations that aren't well represented in national datasets
- Benchmark datasets and conduct comparisons with other cultures , disciplines, and professions
- Encourage researchers to take a broader, interdisciplinary perspective in conducting their research



CLOSING DISCUSSION

What is needed to create environments where *all* people feel comfortable, rather than just one group?

- An understanding that diversity & inclusion brings value to every field.
- A change in paradigm, from gender neutrality, which often means the environment favors men, to a paradigm of inclusion.
- Action taken by leadership to define success by taking gender into consideration.



To access or
download or
read the report
online

Full Report:

[http://www.nap.edu/
openbook.php?
record_id=18810](http://www.nap.edu/openbook.php?record_id=18810)

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES



The Making of a 'Lifetime Mentor Award' Winner, Cathy Cockrell

<https://newscenter.berkeley.edu/2013/01/28/alice-agogino-wins-aaas-lifetime-mentor-award/>



“ In 1992 Mattel actually included the line “Math is Hard” with one of its first talking Barbies. Some clever hackers set up a website telling members how to hack into the Barbie and GI Joe voice boxes in a project called “Operation NewSpeak.”

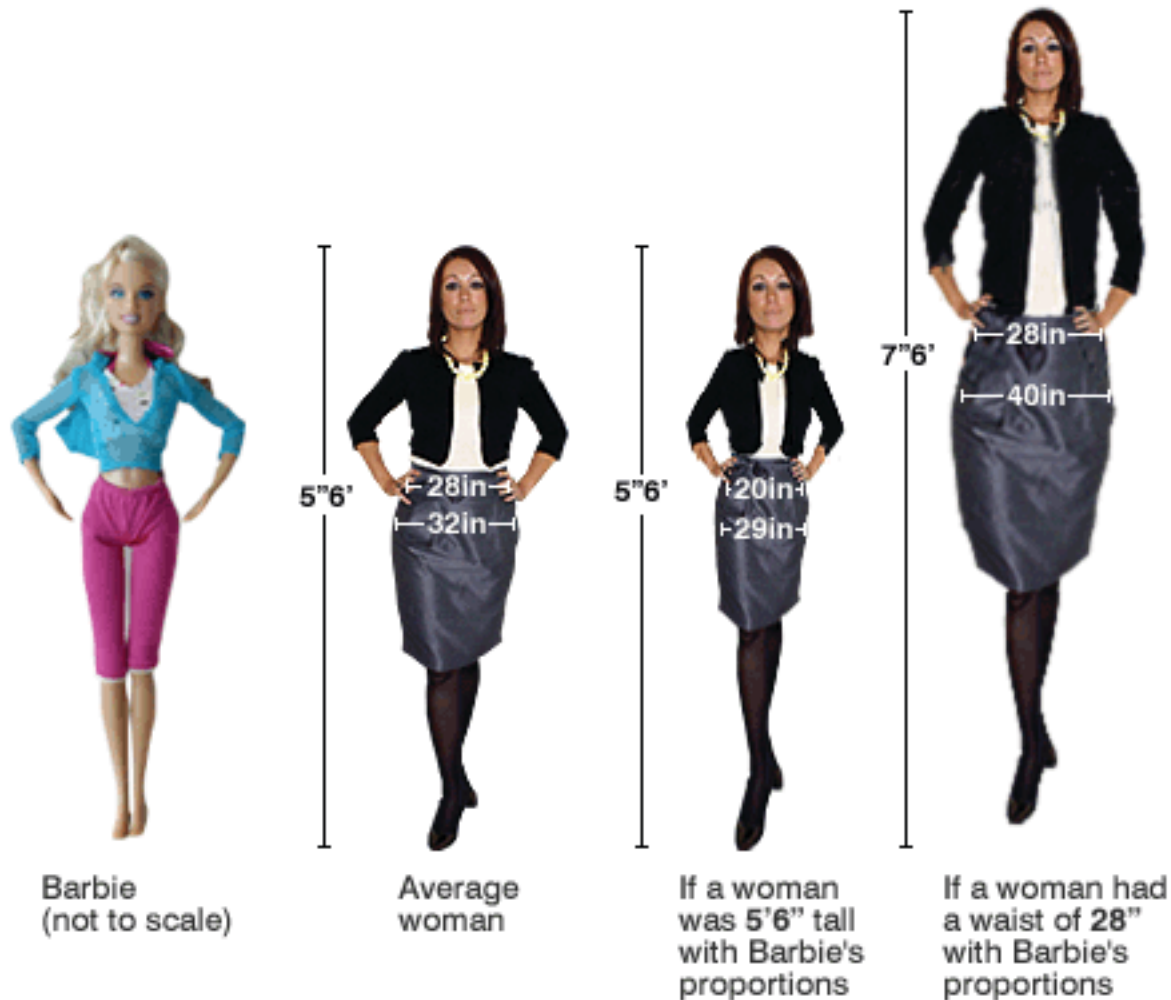
...As a response to criticism Mattel introduced changes: ...Barbie's breasts were reduced to better represent the shape of actual young women. Different multicultural Barbie's were also been introduced, along with career-oriented Barbies in the “I can be ...” series.

I must admit that I very much enjoyed my Barbies as a young girl. I think she inspired me to think about fashion and design. I designed my own clothes as a teenager and I used a sewing machine to make them. I do think the sewing machines and design patterns (perhaps in CAD today) are important tools in a design engineer's tool box.

Barbie Liberation Organization,
Shopgiving

– Alice Agogino, on Engineering Pathway's
‘Today in History’ blog

How Would a Real Woman Look with Barbie's Proportions?



Entrepreneur Barbie



Computer Engineer Barbie



Playing with Barbie dolls could limit girls' career choices, study shows

- Girls ages 4 to 7 were randomly assigned to play with one of three dolls:
- a fashion Barbie with dress and high-heeled shoes;
- a career Barbie with a doctor's coat and stethoscope;
- or a Mrs. Potato Head with accessories such as purses and shoes.



“Playing with Barbie has an effect on girls’ ideas about their place in the world,” said Aurora M. Sherman, an associate professor in the School of Psychological Science at OSU.

Playing with Barbie dolls could limit girls' career choices, study shows

- After a few minutes of play, the girls were asked if they could do any of 10 occupations when they grew up. They were also asked if boys could do those jobs. Half of the careers were traditionally male-dominated and half were female-dominated.
- Girls who played with Barbie thought they could do fewer jobs than boys could do.
- But girls who played with Mrs. Potato Head reported nearly the same number of possible careers for themselves and for boys.

Bungee Barbie



Bungee Barbie



Rubber band length	Distance of Fall <i>cm</i>
0	28.5 (Barbie's height)
1	35.8
2	43.1
3	
4	
5	
6	

Elasticity, Linear Regression, Physics, Design



GoldieBlox: construction toy starring kid inventor Goldie, who loves to build



Target age range: 5-9





Synaptic Motion: Tensegrity-Inspired Dance (Colin Ho & Jodi Lomask)



Diversifying Engineering



Paper Mechatronics Workshop



Sherry Hsi, Concord Consortium

How do we broaden participation so all kids can learn engineering (robotics & mechatronics)?

Scholarship of Learning; Scholarship of Diversity

Other Resources

Kahneman, Daniel. *Thinking, Fast and Slow*. Farrar, Strauss and Giroux, New York, 2011

Steele, Claude M. *Whistling Vivaldi: How Stereotypes Affect Us and What We Can Do*. WW Norton & Company, New York, 2010 (Issues of Our Times, series editor Henry Louis Gates, Jr.)

Banaji, Mahzarin R. and Greenwald, Anthony G. *Blindspot: Hidden Biases of Good People*. Delecorate Press, New York, 2013

Sandberg, Sheryl. *Lean In: Women, Work, and the Will to Lead*. Alfred A. Knopf, New York, 2013

Thank You!