

# Drawing a More Inclusive Future: Breaking Down Gender Biases in the Workplace

Sarah Eckersley ■ Dow

Solving the gender equity issue in engineering will require deliberate and systematic effort on many fronts.

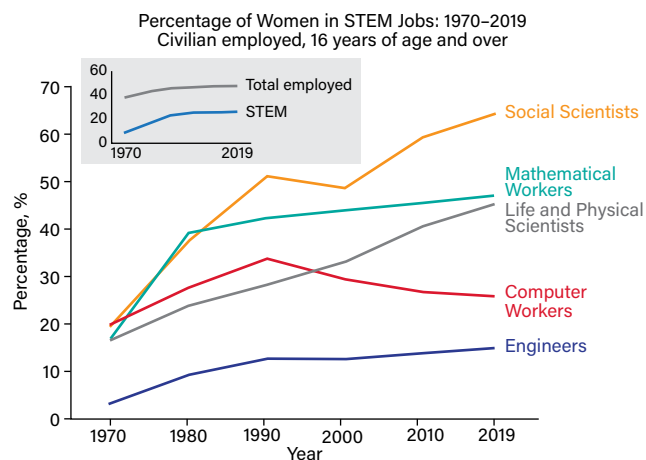
**A**s a society, we have directed significant individual and organizational energies to advancing the cause of diversity (of gender and beyond). In spite of our efforts and intentions, we have made only modest progress toward equity.

In 2021, I was the recipient of AIChE's Lawrence B. Evans Award in Chemical Engineering Practice and the Society of Women Engineers' Global Leader Award. These recognitions came with a heavy dose of humility, gratitude, and self-reflection on the 35 years I have spent as an engineer. My experiences have given me a unique vantage point from which to observe our profession's progress. I am not an academic expert on diversity issues, so while this article references pertinent research, it is not a comprehensive survey. Instead, I share my perspectives on progress related to gender diversity through the dual lenses of data and personal experience.

This article examines the progress of women in engineering over the past decades and considers the future based on recent trends. Action is needed at the individual, enterprise, and ultimately societal level to make meaningful, lasting change. The article offers the concept of allyship as an approach to support inclusion and accelerate the pace of change in the engineering profession.

## By the numbers

Let's start by looking at the journey through tangible measures of progress. Figure 1, which collates data from the U.S. Census Bureau, shows that the number of women employed in science, technology, engineering, and math



▲ **Figure 1.** The participation of women in STEM over the past 50 years has shown a notable increase in some disciplines, but only a moderate increase overall. Source: (1).

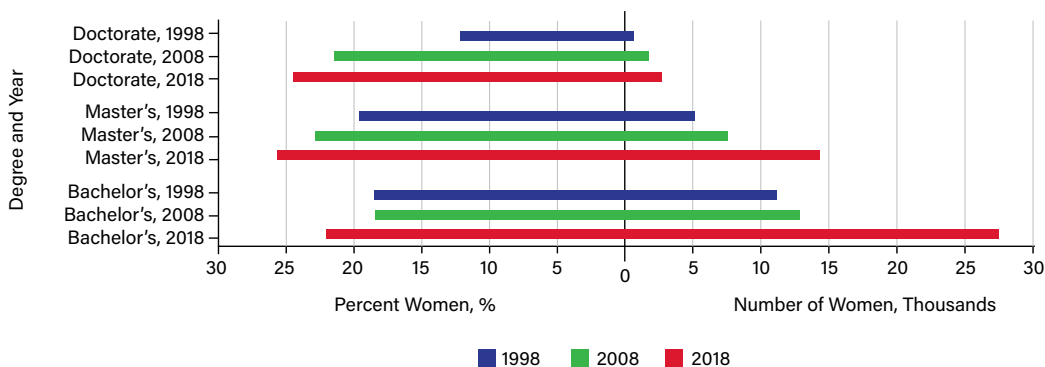
## CRITICAL ISSUES

(STEM) has increased in some disciplines, but has experienced only a moderate increase overall (1). This is reflected by minor gains in engineering and a decline of women in computer fields. Data published by the National Science Foundation (NSF) shows that the number and percentage of engineering degrees awarded to women has increased over the past 20 years (Figure 2) (2). These figures suggest that the major efforts directed toward education and filling the pipeline are having a positive outcome.

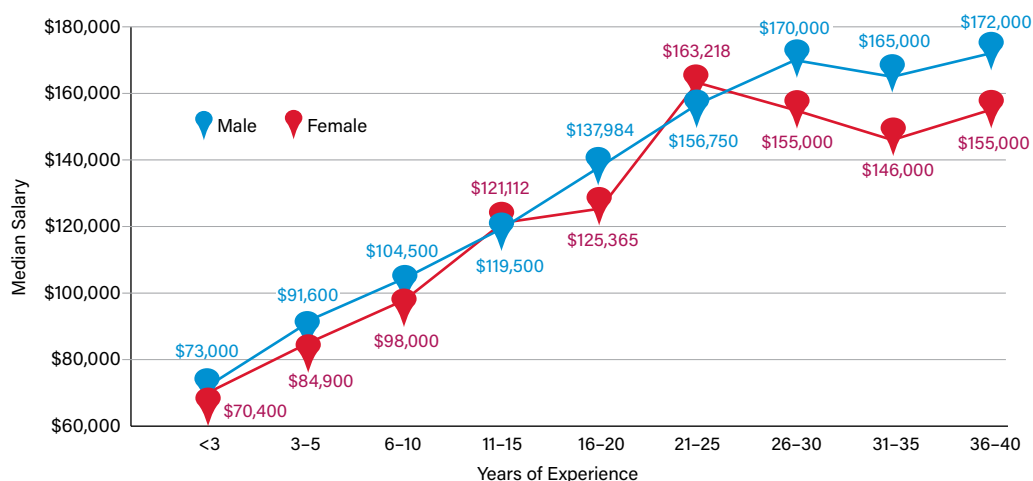
Another measure of progress that is well known to CEP readers is illustrated by AIChE's biennial salary survey. Figure 3 shows salary differentials between men and women as a function of years of experience (3). At the early- to mid-career levels, salaries track rather closely, with women showing a salary disadvantage of \$13,000 at the most. However, at more than 26 years of experience (levels corresponding to senior supervisory leadership), the pay deficit for women is more pronounced. This could indicate a "glass ceiling" — *i.e.*, an unacknowledged barrier to advancement (4). Women are underrepresented in management compared to men, and this is amplified at more senior levels.

*Reviewing 50 years of Draw-a-Scientist.* An interesting measure of the advancement of women in the world of STEM is simply to look at how women are perceived in society through the unfiltered gaze of young children. We have a window into that societal perception of women in STEM thanks to a landmark project that has spanned 50 years and continues today. The Draw-a-Scientist Test, an open-ended study developed by David Wade Chambers in the 1960s, asks grade school children to draw an image of a scientist (5).

When the study was first conducted, the vast majority of students associated the word "scientist" with a man (Figure 4) (6). (Indeed, it's likely that if I had been asked to draw a scientist when I was a girl, that scientist would have been a White man.) The data is stark — of the 5,000 drawings collected between 1966 and 1977, only 28 depicted female scientists, and all 28 were drawn by girls. A recent meta-analysis of data from 80 studies comprising over 20,000 students shows the progress made since then (7). In the 1980s, one-third of girls drew woman scientists (Figure 5). Today, more than half of young girls draw a woman when asked to draw a scientist (Figure 6, Figure 7) (8).



◀ **Figure 2.** The number and percentage of engineering degrees awarded to women has increased over the past 20 years. Source: (2).



◀ **Figure 3.** Salary discrepancies between men and women are the most pronounced among engineers with 25 years of experience or more. Source: (3).

These promising results seem to suggest that we have reached the tipping point where STEM professions like scientists are not solely associated with men. But sadly, this is not the case. As children mature into adolescence, boys and girls alike systematically bias toward the stereotype of the male scientist. Data published in 2018 show that by the time a student is sixteen, there is more than an 85% likelihood that he or she will draw a male scientist (Figure 8) (7).

What conclusion can we draw from these data? My perspective is that we have made only minor progress, despite decades of effort and investment. Looking back on my own undergraduate era, I was in a chemical engineering class that was 25% female. While I don't recall feeling disadvantaged because of my gender, I do recall minor, irritating exceptions, e.g., when the president of the engineering student society asked me whose girlfriend I was at a party for chemical engineers. My daughter, who is currently in college pursuing a chemical engineering degree, experienced casually dismissive comments when she was in high school from STEM teachers and mentors in her STEM-related after-school program. However, she has not received any

such comments in her college experience thus far. Of course, it is hard to draw any conclusions from the unusual college experience caused by the pandemic over the past two years.

Billions of dollars have been directed toward the development of the educational pipeline. The proportion of women in engineering has increased slightly over the past



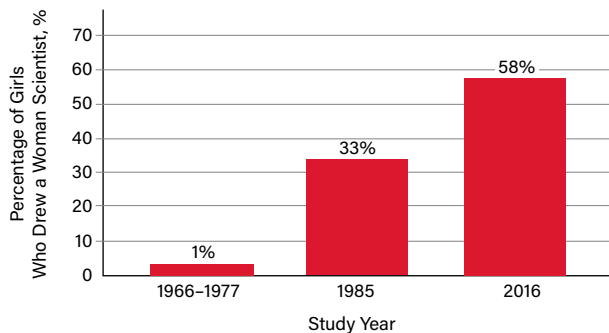
▲ **Figure 4.** When the Draw-a-Scientist study was first conducted in the 1960s, more than 99% of grade-school children drew a male scientist — an example of which is shown here. Source: (6).



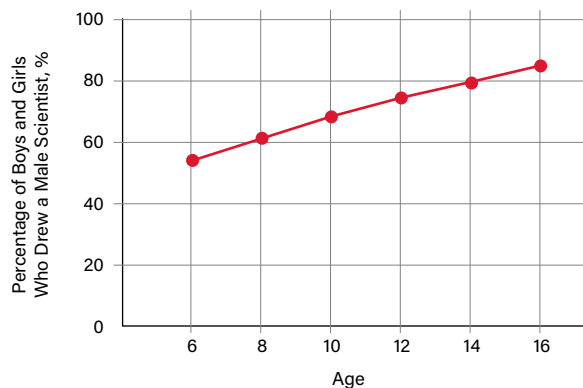
▲ **Figure 6.** In the Draw-a-Scientist studies conducted today, girls are more likely to draw a woman scientist — as shown in this example drawing by a girl. Source: Vasilisa Christidou.



▲ **Figure 7.** Today, more than half of girls draw a woman when asked to draw a scientist. Used with permission of American Association for the Advancement of Science, from Ref. 8; permission conveyed through Copyright Clearance Center, Inc.



▲ **Figure 5.** In the 1960s and 70s, only 1% of girls drew a woman when asked to draw a scientist. In 2016, more than half of girls drew a woman. Source: (7).



▲ **Figure 8.** Boys and girls are more likely to draw a male scientist as they get older. Source: (7).

## ■ CRITICAL ISSUES

decades, but has done little to change the stark reality that only 13% of practicing chemical engineers are women (9). In many ways, we are still at the beginning of a journey to realize gender equity in the engineering workplace.

### A problem without easy answers

Several studies have sought to understand the drivers of retention in STEM in general, and engineering specifically (10, 11). They probe the intersection between individual drivers of satisfaction and the ability of an occupation to fulfill those needs. If there is a mismatch, retention becomes an issue. The main factors (ranked by importance) that influence the choice to leave a job are comfort (*e.g.*, ability to achieve work-life balance, as well as compensation), fairness (*e.g.*, discrimination, lack of female mentors or role models), achievement (*e.g.*, self-confidence and meaningful assignments), and status (*e.g.*, recognition).

Interestingly, the obligations associated with marriage and motherhood have a far more negative effect on the retention of women in STEM than women in other professions (12). The one notable exception is the case where a woman who works in STEM is married to another STEM professional in the same field. This domestic situation was shown to be important in the retention of women in the STEM field and in the labor force. In contrast, it has no effect on the retention of women in non-STEM fields.

In the workplace, women have been shown to be less self-assured and less willing to advocate for themselves than their male counterparts, even when independent measures show their worthiness (13). The effect of this confidence gap is pernicious; a recent study of undergraduates in the physical sciences showed that even when women were the highest performing students, they were perceived to be lower achieving by all genders (14).

The challenge is undoubtedly complex, and the solution will need to be multidimensional. To advance, we need to drive change at many levels: at the societal level through policy; at the organizational level through human capital management and leadership commitment; at the working group level through actions that influence culture; and at the individual level through professional development.

### Change at the societal level

As a society, we have made great strides in preparing women with educational resources and the freedom to fulfill their ambitions and desires. Of course, this is clearly far from uniform across nations and cultures, and not all playing fields are level. But, once women are in the workforce, many are challenged by the dual expectations of motherhood and career.

The long-term consequences of the COVID-19 pandemic on society and gender equality are yet to be deter-

mined. However, many of the challenges and inequities that existed prior to the pandemic appear to be amplified by it (15). The World Economic Forum defines the gender gap as the number of years required to achieve equity, at the current rate of progress. Prior to the pandemic, the gender gap was estimated to be 99.5 years globally. In 2021, the global gender gap was assessed as having increased by 36 years as a consequence of the pandemic — a number that will likely rise as the pandemic continues (16). In 2021, the gender gap was estimated to be 52.1 years in Western Europe and 61.5 years in North America.

Women contemplate leaving the workforce at four times the rate of men. During the pandemic thus far, 2.3 million women have left the U.S. workforce (17). Within the world of STEM, the COVID impact is disproportionately affecting laboratory-based scientists and mothers of young children, as childcare duties remain associated with women (18). These statistics are sobering, and without intervention this regression may continue.

However, new ways of working that improve social inclusion offer hope. For example, video calling platforms with instant messaging are egalitarian and inclusive, especially when leaders model and encourage participation.

Societal norms and policy are important topics that are beyond our individual control but not beyond our collective ability to influence. In addition to filling the STEM pipeline, we need policies that support women so they remain in STEM fields in college and during caretaking years. Policies/labor laws that support workplace flexibility are key, as well as those that combat harassment and support inclusion (such as the Combatting Sexual Harassment in the Sciences Act and the STEM Opportunities Act).

### Support at the organization level

Nearly all of us working in the chemical engineering profession today are members of organizations, whether corporations or academic institutions. Organizations have an immense role to play in supporting outcomes for diverse talent.

The success of equity, diversity, and inclusion (ED&I) efforts begins and ends with executive leadership and the policies, programs, metrics, and expectations that they drive. Organizations can move the emphasis from intent to action by linking compensation and advancement to certain metrics and structurally trying to avoid bias. Controls that support equity can be applied in a manner that is analogous to controls in a manufacturing environment. For example, hiring practices should be implemented to ensure that candidate pools and interview teams are diverse; organizational leadership should conduct explicit reviews of promotion and assignment opportunities with an eye on gender equity.

It's equally important that leadership provides flex-

ibility and support for the complex navigation of the dual priorities of work and non-work throughout the careers of women and men alike.

### Diversity and inclusion at the group level

It is important that organizations drive action that aligns with intentions and that those intentions are visible at the highest levels of leadership. However, this is not enough to accelerate the pace of change and move toward gender equity.

We know that sustained cultural change requires fundamental shifts in the way that leaders lead and employees behave as individuals and in teams. Culture resides in the collective behaviors of a group, and change within a work community is not always easy. All human beings experience the generalizations that are known as implicit bias. Work groups should strive to cultivate a work climate and practices that move beyond the inevitability of biases to create an inclusive workplace that allows diverse talent to thrive. We cannot eliminate all bias, so we need to transcend the effects of bias.

Think of your own work groups. Have you deliberately made the effort to understand the constraints of all team members, and adjusted accordingly? For example, if a team's social events always take place during daycare pick-up time, then they may be unintentionally excluding a teammate from attending. Diversifying the variety and timing of the social events could help all teammates feel included — an easy way to shift the culture.

Moving the conversation away from an emphasis on diversity toward the more-encompassing topic of inclusion is an important shift. Experience tells me that more inclusive workplaces are a necessary requirement to positively accelerate the pace of change in the engineering profession. What's more, social science supports that idea.

The business case for corporate diversity has been frequently highlighted in the popular media and literature. In 2012, Ely *et al.* studied the effects of both diversity and inclusion on the financial productivity of the retail branches of a financial services company (19). Their study focused on racial diversity, but the findings can plausibly be extended to gender diversity. They studied the effect of the learning environment (supportive vs. unsupportive) and team diversity on revenue performance (Figure 9). The study showed that diversity without a supportive environment is value-destroying, whereas diversity with a supportive environment is value-creating.

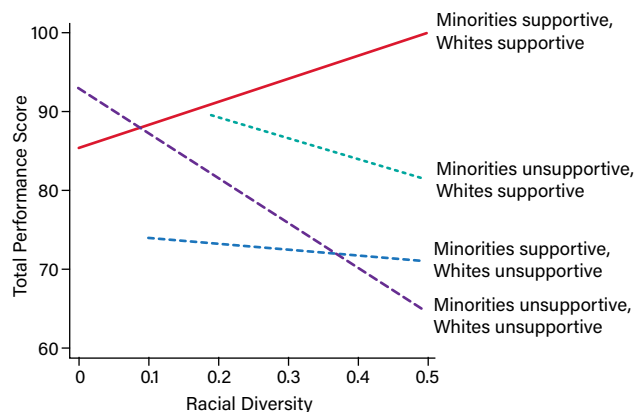
Similarly, Cyr *et al.* studied the effect of social exclusion of STEM professionals in the workplace at nine North American organizations (20). The authors studied teams' social networks and workplace outcomes (work engagement, efficacy, social fit, social identity threat, and workplace sup-

port), which ultimately relate to workplace inclusion. The study reached several notable conclusions. To paraphrase the authors, men who held stronger “think STEM, think MEN” stereotypes socialized with fewer female team members and the women with fewer social ties to men experienced more negative workplace outcomes. Additionally, women who experienced more social inclusion by their male colleagues reported greater engagement, support, and self-efficacy. The authors examined both respect and social inclusion, finding them unrelated (*i.e.*, respect did not result in inclusion). The authors concluded that, because systemic stereotypes are resistant to change, and the majority groups are often unaware of the costs of subtle exclusion, deliberate interventions are needed to raise awareness and foster change.

In the McKinsey special report, “Women in the Workplace,” Burns *et al.* speak to the experience of being in the minority in the workplace — an intrinsic state for women in engineering today (4). People who are “onlys” — meaning, they are often one of the only people of their race or gender in the room at work — have especially difficult day-to-day experiences. Onlys stand out, and because of that they tend to be more heavily scrutinized. Their successes and failures are often put under a microscope, and they are more likely to encounter comments and behavior that attempt to reduce them to stereotypes.

The concept of allyship is rapidly entering the workplace dialogue, but may not be broadly understood. Allyship in the workplace means recognizing the privilege that members of majority groups have in a professional context, and using that privilege to aid in the dismantling of systems and processes that prevent colleagues from having equal opportunities. This could mean understanding and adapting to the things that constrain people and finding ways to stop these things from being limiting (adapting to the schedule of single parents, for example).

Allyship involves deliberately examining the status quo



▲ **Figure 9.** In workplaces where teams had high racial diversity and a supportive learning environment, revenues were higher. Source: (19).

and taking action to achieve equity. This will involve an effort on the part of male allies to raise their own awareness, adapt their behavior, and deliberately work to overcome inequity. For example, 20 years ago when my daughter was born, my husband and I sequentially took family leave. To this day, I know less than five men who have taken leave after the birth of their child. I want you to ponder the reception in your work groups to a man stepping out for several months to take care of a child or parent. We are more likely to question the career commitment of a man who steps away for family than a woman. If women *and* men are not supported equally in their family goals, it creates a trap for both genders. True gender equity equally supports the family obligations of men and women alike.

### Individual development

The gender equity problem cannot be solved by organizations or allies alone, women will also need to develop themselves as individuals and be willing to advocate for equality. Throughout my career, I have kept a journal of

stories and reflections that have shaped me as a leader. Here are a few of those reflections, with some advice that focuses on gender and inclusion that can apply to everyone.

*Be open to mentoring.* Senior mentors are important guides early in your career. Early on, they help with technical problem-solving and organizational navigation. They also help connect your individual talent to opportunities that make sense for you and the organization. As your career advances, your mentoring needs change and peer mentoring becomes increasingly important.

I have benefited from several classical mentors over my career, but peer mentoring is the nature of all my mentoring relationships now. I have a self-assembled group of women who span several functions in my company. We help each other interpret what is happening in the organization and give one another advice.

*Abandon guilt and perfectionism.* As you advance in your career, it gets increasingly difficult to do everything well. It may become difficult to live up to your own standards of excellence. To keep thriving, a few adjustments

### Literature Cited

- Martinez, A., and C. Christnacht,** "Women Are Nearly Half of U.S. Workforce But Only 27% of STEM Workers," U.S. Census Bureau, <https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html> (Jan. 26, 2021).
- National Center for Science and Engineering Statistics,** "Women, Minorities, and Persons with Disabilities in Science and Engineering: 2021," Special Report NSF 21-321, National Science Foundation, Alexandria, VA, <https://nces.nsf.gov/wmpd> (April 29, 2021).
- "2021 AIChE Salary Survey," Figure 8, *Chemical Engineering Progress*, **117** (6), pp. 27–37 (June 2021).
- Burns, T., et al.,** "Women in the Workplace 2021," McKinsey & Co., <https://www.mckinsey.com/featured-insights/diversity-and-inclusion/women-in-the-workplace> (Sept. 27, 2021).
- Chambers, D. W.,** "Stereotypic Images of the Scientist: The Draw-A-Scientist Test," *Science Education*, **67** (2), pp. 255–265 (1983).
- "Drawing from Original DAST Study," [https://upload.wikimedia.org/wikipedia/commons/3/35/Drawing\\_from\\_original\\_DAST\\_study.jpg](https://upload.wikimedia.org/wikipedia/commons/3/35/Drawing_from_original_DAST_study.jpg), Creative Commons Attribution-Share Alike 3.0 Unported License (CC BY-SA 3.0) (July 21, 2005).
- Miller, D. I., et al.,** "The Development of Children's Gender-Science Stereotypes: A Meta-Analysis of 5 Decades of U.S. Draw-A-Scientist Studies," *Child Development*, **89** (6), pp. 1943–1955 (2018).
- Langin, K.,** "What Does a Scientist Look Like? Children Are Drawing Women More Than Ever Before," *Science*, image by Leon Walls, doi: 10.1126/science.aat6337 (Mar. 20, 2018).
- U.S. Bureau of Labor Statistics,** "Labor Force Statistics from the Current Population Survey," <https://www.bls.gov/cps/cpsaat11.htm> (accessed Jan. 24, 2022).
- Fouad, N. A., et al.,** "Women's Reasons for Leaving the Engineering Field," *Frontiers in Psychology*, **8**, doi: 10.3389/fpsyg.2017.00875 (June 2017).
- Glass, J. L., et al.,** "What's So Special about STEM? A Comparison of Women's Retention in STEM and Professional Occupations," *Social Forces*, **92** (2), pp. 723–756 (2013).
- Stansbury, A.,** "Women and STEM Occupations: Retention Rates and Reasons for Leaving," *The Journalist's Resource*, <https://journalistsresource.org/economics/women-stem-occupations-retention-rates> (Oct. 18, 2013).
- Exley, C. L., and J. B. Kessler,** "The Gender Gap in Self-Promotion," National Bureau of Economic Research, <https://www.nber.org/papers/w26345> (Oct. 2019, revised May 2021).
- Bloodhart, B., et al.,** "Outperforming Yet Undervalued: Undergraduate Women in STEM," *PLOS ONE*, doi: 10.1371/journal.pone.0234685 (June 2020).
- Torres, I., et al.,** "COVID Has Laid Bare the Inequities that Face Mothers in STEM," *Scientific American*, <https://www.scientificamerican.com/article/covid-has-laid-bare-the-inequities-that-face-mothers-in-stem> (Dec. 2020).
- World Economic Forum,** "Global Gender Gap Report 2021," <https://www.weforum.org/reports/global-gender-gap-report-2021/in-full> (Mar. 30, 2021).
- Jablonska, J., ed.,** "Seven Charts That Show COVID-19's Impact on Women's Employment," McKinsey & Co., <https://www.mckinsey.com/featured-insights/diversity-and-inclusion/seven-charts-that-show-covid-19s-impact-on-womens-employment> (Mar. 8, 2021).
- Myers, K. R., et al.,** "Unequal Effects of the COVID-19 Pandemic On Scientists," *Nature Human Behaviour*, **4**, pp. 880–883 (2020).
- Ely, R. J., et al.,** "Racial Diversity, Racial Asymmetries, and Team Learning Environment: Effects on Performance," *Organization Studies*, **33** (3), pp. 341–362 (2012).
- Cyr, E. N., et al.,** "Mapping Social Exclusion in STEM to Men's Implicit Bias and Women's Career Costs," *Proceedings of the National Academy of Sciences*, **118** (40), e2026308118 (Oct. 5, 2021).

need to be made. First, you need to think through what is most important to deliver. Then, you need to focus your energy on those things that need to be done to the highest standards and then recognize those tasks that can be done to a “good enough” standard. You need to learn to delegate to others — if you’re in a position to do so — so that they can develop in turn and thereby increase the overall capacity of the organization and yourself. Delegation means taking some risk and allowing others to do things slightly differently than you might. Most importantly, you need to decide not to feel guilty about doing these things.

This advice can even extend to parenting, and it can be the most difficult adjustment to make. It is okay for one parent to be the primary nurturer; if that is your spouse, then you need to recognize and support them in this. For me, it meant ceding that role to my husband and getting out of his way. This also meant that I had to come to terms with my own gender identity and the expectations of motherhood. I also had to accept that the notion of “doing it all” was a myth, and that work-life choices were needed. Our male allies have an important role to play in supporting their partners.

*Be resilient to failure.* When a career is summarized, it often appears to be a unidirectional progression of increasing accomplishment. The setbacks that have the potential to derail a career are often obscured. For example, in the middle of my career, I was asked to interview for my dream job. However, my progress was blocked by a senior leader who had other plans. When I was informed, I expressed my dismay clearly. In private, I was disappointed and confused. But I moved on and continued in my job with apparent enthusiasm and commitment. My professionalism and resilience

## Acknowledgments

I want to thank Professor Heather Hofmeister of Johann Wolfgang Goethe Univ. for several excellent conversations about how to stimulate action, and specifically for alerting me to the Draw-a-Scientist studies. And I would like to thank Dr. Bindu Krishnan and Dr. Scott Matteucci for their reflections on various academic articles cited here.


**SARAH ECKERSLEY, PhD**, is the Vice President of R&D, Industrial Intermediates & Infrastructure at Dow. She is responsible for the development and delivery of technology aligned to business strategy. Eckersley is also an executive member of the R&D leadership team for Dow, which is accountable for all dimensions of organizational and technology strategy. She previously held global R&D director positions for Coatings, Monomers and Plastic Additives, Pharma and Food Solutions, and Performance Packaging in Performance Plastics. She joined Dow on the Research Assignments program in 1993. Eckersley is a member of the Technical Advisory Board for the Dept. of Chemistry, Univ. of Wisconsin-Madison. She earned chemical engineering degrees from the Univ. of Ottawa and the Univ. of Waterloo, completed a Young Executives Residency from the Univ. of North Carolina’s Kenan Flagler Business School, and the Women on Corporate Boards Program at Harvard Business School. In 2021, she was recognized with the Lawrence B. Evans Award in Chemical Engineering Practice from the AIChE and a Global Leader Award from the Society of Women Engineers. She is co-author of 25 peer-reviewed publications and inventor on six issued U.S. patents.

impressed those around me and paid many dividends later.

Everybody has setbacks. You will receive news or a piece of feedback that you don’t like — some of it fair, some of it unfair. You need to be able to take a long view and keep moving forward. This doesn’t mean that you must be passive and play the victim. Indeed, sometimes you must fight for yourself, and such times can be the most difficult in a career. In most cases, when things don’t go exactly as you wish, you need to be mature and persevere through adversity.

*Learn how to have tough conversations.* Recently, I had been working closely with a colleague on a project, and he presented our work at a meeting using the pronoun ‘I’ throughout. After the meeting, I told him what I had observed, how disappointed I was, and that it raised doubts about my trust in our working relationship. I also told him how much I valued our collaboration. He said he had no idea that he had done this and that he was grateful that I had chosen to tell him. He epitomized good ally behavior with his response. Although this was a difficult conversation to have, it needed to happen to maintain trust in the working relationship and continue the effectiveness of our project work. The payback of the difficult conversation — *i.e.*, an acknowledgment of the problem and an assurance that my colleague would not take sole credit for the project again — taught me that it was worth the risk.

## Where do we go from here?

I would love to have shared a tidy formula or simple equation in this article for making progress on the gender equity issue in engineering. Unfortunately, there are no easy answers. Real change will require deliberate and systematic effort on many fronts, from policy to individual action in the classroom, boardroom, and workplace. We need awareness, advocacy, and allyship at the grassroots level from parents, educators, and engineers in the workforce. With concerted efforts, I believe that we can draw a brighter future. 

## Additional Reading

**Silbey, S.**, “Why Do So Many Women Who Study Engineering Leave the Field?” *Harvard Business Review*, <https://hbr.org/2016/08/why-do-so-many-women-who-study-engineering-leave-the-field> (Aug. 23, 2016).

**Rincon, R.**, “SWE Research Update: Women in Engineering by the Numbers (Nov. 2019),” Society of Women Engineers, <https://alltogether.swe.org/2019/11/swe-research-update-women-in-engineering-by-the-numbers-nov-2019> (Nov. 1, 2019).

“The Impact of Covid-19 on Job Loss,” *Catalyst*, <https://www.catalyst.org/research/covid-19-job-loss> (July 22, 2020).

**Fry, R., et al.**, “STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity,” Pew Research Center, <https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity> (April 1, 2021).