STEM Voices

THE EXPERIENCES OF WOMEN AND MINORITIES IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH OCCUPATIONS

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Introduction by Brent Orrell

AEI

AMERICAN ENTERPRISE INSTITUTE

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Foreword

In today's economy, STEM careers are among the most lucrative and in demand. The median salary for STEM workers is more than double the median salary of US workers overall ($85,390 versus $37,690).[1] While still representing a small portion of the overall workforce, jobs in science and engineering have more than doubled since 1980 and now account for approximately 5 percent of all US jobs, employing 7.5 million nationwide.[2]

Because of the centrality of STEM knowledge in an advanced economy, these jobs are far more important than their numbers alone might suggest. In economic terms, careers in STEM are often touted as the new "great equalizer" for those trying to climb the rungs of the socioeconomic ladder.[3] Indeed, the STEM fields appear to offer some of the most promising pathways for US workers to contribute to the creation of a more technologically advanced society while comfortably supporting themselves and their families.

An AEI survey of 1,368 STEM degree holders in July 2020 uncovered a more complex career landscape that for some is fraught with obstructions and pitfalls rather than direct pathways to success.[4] While women make up over half the college-educated workforce, they account for only a third of science and engineering workers.[5] The percentages are similarly disproportional for underrepresented minorities including Black, Hispanic, American Indian, and Alaskan Native workers. Women and racial minorities who pursue STEM careers are more likely to leave their field or regret having entered it in the first place. More than 50 percent of women and non-White STEM workers in AEI's survey said they believe women and minorities encounter more obstacles in STEM than in other industries, a view not shared by those who dominate the field.

These survey results are striking. If STEM jobs provide some of the best opportunities for securing competitive wages and professional growth, what is deterring female and minority participation? Addressing this question is vital to ensuring that US technological innovation

remains globally competitive. Companies and institutions that foster workplace diversity tend to outperform their peers in profitability.[6] For over a decade, increasing diversity in STEM education has been a public policy priority and a private institution endeavor made through an array of scholarships and programs geared toward minorities,[7] but without much success in boosting women's and minorities' participation in STEM fields.[8] Once female or minority students enter STEM professions, they experience lower rates of job retention and promotion, especially for senior management positions.[9]

Anne Kim's report successfully broadens and deepens our understanding of the STEM diversity gap. The findings are based on 25 qualitative interviews with past and present STEM workers conducted between November 15, 2020, and March 23, 2021, 21 of whom were participants in AEI's July 2020 survey. These testimonials give startling personal insight into the career trajectories, barriers, and experiences of diverse individuals in STEM fields. Kim reveals the bottlenecks and blockages in the STEM pipeline, including the initial barriers to entry such as limited access to quality secondary education and the subsequent barriers to career success.

Reasons for reduced participation in STEM can be partially explained by structural barriers to success that exist during the formative stages of life. For instance, high schools in low-income neighborhoods—which disproportionately serve Black and Hispanic students—are much less likely than schools in affluent areas to offer advanced classes in math and science. As a result, low-income students of color in these neighborhoods may often be less prepared than their peers are to pursue STEM majors in college—and less likely to attend college at all.[10]

In addition to structural hurdles, qualitative barriers start from early ages. Because fewer women and minorities are in STEM, these groups are less likely to have role models or mentors. This reduces the likelihood of early exposure to, developing interest in, and investment in the subjects that would eventually lead to STEM careers.

For women and minorities who do pursue STEM education and find employment, cognitive biases or social isolation in the field can act as detrimental barriers to job placement and promotion. Kim's narrative details issues such as exposure to stereotypes, lack of mentors, exclusion from networking opportunities, and pressures to "code-switch" (i.e., to adopt

the language and manner of speaking and relating of the majority to be taken seriously in the workplace). Meanwhile, White male workers experienced the reverse: "ramps" into and upward in STEM—such as mentoring, access to workplace networks, and investment in on-the-job training—that help propel career success.

As a result, women and minorities interviewed consistently felt ill prepared and unsupported. They reported feeling stagnant compared to majority coworkers, noted instances of being passed over for project opportunities, and talked of not seeing a future for themselves in their career field. These narratives resonate with and help explain AEI's previous findings of reduced career persistence and feelings of regret over career choices for women and minorities in the STEM field.

This is a timely report. American society is undergoing rapid demographic shifts that increasingly require greater attention to integrating diverse populations into the workplace while grappling with the challenges posed by an excessive and burdensome "wokeness" that disrupts social cohesion by encouraging division rather than building bridges.

Kim's research is a starting point for a different kind of conversation that encourages readers to walk in the shoes of those who have experienced firsthand the challenges women and minorities face in the employment marketplace. This is an especially important contribution when so much of our public discourse around topics such as implicit bias and systemic discrimination are being reduced to flat, one-dimensional caricatures.

These are the voices of real people—many of whom experienced exclusion, intentional and unintentional, that has limited their personal and professional growth. Some of these stories are inspirational, highlighting perseverance and success against the odds. Others will help readers encounter the great discouragement many women and minorities experience in the American workplace. All of these stories are well worth the time they take to read to help improve our understanding of workplace and social realities.

This report is composed of three major sections. In the first, we detail some of the obstacles that women and non-White minorities face in the STEM workplace, including company culture, hiring tendencies, promotion opportunities, and pay practices. This discussion provides the foundation for understanding the current state of the STEM field as a whole

from an employment perspective and what disparities exist for different workers within it.

The second section builds on this foundation with the personal experiences of real STEM professionals and highlights the myriad qualitative obstacles that gender and racial minorities face, including a lack of pre-career guidance, on-the-job mentoring, and professional network access that help account for disparate workplace outcomes including promotion and wages. This section also discusses the incongruence in the perception of the diversity problem between women and non-Whites compared to the racial and ethnic majorities that make up most of the field. In the third section, we discuss methods to increase STEM on-ramps and retention rates for underrepresented groups, such as placing more minority teachers in STEM classrooms and preserving public-sector and military workplaces as avenues for advancement and mobility in STEM occupations.

Much effort has been made to improve workforce diversity and social mobility in STEM occupations. This report gives us a glimpse of the successes and failures of those initiatives. The reality is that much remains to be done to foster a STEM environment that is more welcoming of those who have not, to date, fully benefited from the wages and advancement opportunities this crucial sector of the economy offers. This report encourages us to leverage our social imaginations in service of creating a STEM working environment that works for all our fellow citizens.

—Brent Orrell

Part I:
The Depth of STEM's Diversity Problem

In a February 2021 analysis, the *New York Times* uncovered a troubling statistic: Out of 417 PhD economists on staff at the Federal Reserve Board in Washington, DC, only two are Black.[11] And among the 12 regional banks that make up the Federal Reserve System, the *Times* found, five did not employ a single Black economist, while Latinos were also severely underrepresented.

According to separate research by the Brookings Institution, just 24 percent of PhD economists working for the federal government are racial minorities, and only 30 percent are women.[12]

These glaring disparities are unfortunately symptomatic of broader inequities in scientific and technical professions. Although the numbers of women and racial minorities entering STEM occupations have grown over the past two decades, these workers remain significantly underrepresented relative to their share of the working-age population. Women and people of color are especially less likely to be employed in better-paid specialties, management and leadership positions, and academia. And as the *New York Times* analysis illustrates, they are all but absent from the highest echelons of their respective fields.

Disparities like these are deeply damaging for both individual workers and the US economy more broadly. They are the result of long-standing structural and qualitative disadvantages handicapping the ability of women and racial minorities to advance in their careers.

According to the National Science Foundation (NSF), the share of women in science and engineering jobs grew just 3 percentage points from 2003 to 2017, from 26 percent to 29 percent,[13] though women now make up 52 percent of the college-educated workforce. The share of workers who are "underrepresented minorities" (Black, Hispanic, American Indian, or Alaska Native) also rose by only 4 percentage points over the same

period, from 9 percent to 13 percent, though they represent 17 percent of college-educated workers.[14] Asians are the one exception to these trends as the only racial minority overrepresented in science and engineering. In 2017, Asians accounted for as much as 20 percent of science and engineering workers (compared to 6 percent of the US population).[15] In contrast, Black and Hispanic Americans accounted for just 5.6 percent and 7.5 percent of workers in STEM fields, respectively (compared to 11.9 percent and 15.6 percent of the US population over age 21).[16]

Regarding elite jobs across tech—CEOs and managers, venture capitalists and entrepreneurs, and university researchers and professors—gaps in representation become chasms.

Among US Fortune 500 companies, there are only four Black CEOs, none of whom are in technology.[17] American tech giants have especially poor track records. Facebook's 2020 diversity report disclosed that just 3.4 percent of its senior leadership is Black (up from 3.1 percent in 2019),[18] while at Google, the share of Black employees in leadership roles in 2020 was an even more dismal 2.6 percent.[19] Amazon reports that, as of December 31, 2020, 10.6 percent[20] of its "managers" were Black—but the company did not hire its first Black executive until 2019.[21]

Women fare somewhat better, with an all-time high of 37 CEOs in the Fortune 500 in 2020.[22] Eight of these women are leading technology-related companies, including[23] heavyweights such as Oracle and Northrup Grumman. But not one of these Fortune 500 CEOs is Black or Latina, and only three are women of color. Among Fortune 500 tech firms, only one CEO is a woman of color—Advanced Micro Devices' Lisa Su.[24]

Why Representation Matters

Lack of diversity in STEM means US firms are missing out on a crucial source of innovative potential and productivity. Studies find that companies with diverse executive teams are generally more profitable than those that are not.[25] Diversity also drives innovation by bringing fresh perspectives and encouraging the generation of new ideas.[26] As rivals such as China fight for global economic dominance, the United States cannot afford to leave any competitive edge on the table. But that is

precisely what the nation is doing by limiting opportunities for a major chunk of its citizenry.

Disparities in economic opportunity are also driving widening inequalities in income and wealth among Americans. Job quality and wages translate directly into opportunities for savings, investment, and wealth accumulation such as homeownership. Black families, however, "can expect to earn up to $1 million less than white Americans over their lifetimes," according to a report by the consulting firm McKinsey & Company, because of differences in educational and job opportunities and earnings.[27] One result is the "racial wealth gap"—the vast gulf in wealth between White households and households that are Black or Hispanic. In 2019, according to the Federal Reserve's Survey of Consumer Finances,[28] "The typical White family [had] eight times the wealth of the typical Black family and five times the wealth of the typical Hispanic family" ($188,200 for White families versus just $24,100 for Black families and $36,100 for Hispanic families).

In STEM fields, inequities play out as disparities in representation and the "occupational segregation" of workers into particular fields by race and gender. This sorting implies that many women and minorities hit ceilings in their educational attainment and career advancement or get locked out of certain specialties altogether. As a result, millions of talented professionals are deprived of the opportunity to reach their full potential in achievement and earnings, to the detriment of their individual financial security and contributions to society.

For instance, women make up 48 percent of life scientists and 59 percent of social scientists (including 69 percent of psychologists) but account for only 16 percent of engineers and 31 percent of computer and math scientists.[29] Similarly, Black and Hispanic workers are more likely to work in social sciences, accounting for 8.6 percent and 10.4 percent of the workforce in those occupations, respectively. Yet only 4 percent of employed engineering degree holders are Black, and just 9 percent are Hispanic.[30]

Racial minorities also have a heavier presence in the "skilled technical workforce," where jobs require scientific or technical expertise but less than a bachelor's degree (such as in IT support or advanced manufacturing but excluding health care). Black workers accounted for 10 percent of these positions, while Latinos were even slightly overrepresented, accounting

for 18 percent of workers.[31] These jobs, however, are relatively underpaid compared to other STEM professions. While the average wage for skilled technical workers is much higher than the average wage for all workers without college degrees ($45,000 versus $29,000),[32] college-educated STEM professionals earn nearly twice as much.[33]

Occupational segregation accounts for much of the persistent wage disparity documented between men versus women and White workers versus workers of color. Research by the Stanford University Center on Poverty and Inequality estimates that occupational segregation accounts for about 18 percent of the gender gap in wages and as much as 39 percent to 45 percent of the racial gap in pay between White people and Black and Hispanic people.[34]

Problems in the Pipeline

The underrepresentation of women and racial minorities among STEM professionals is a direct result of underrepresentation in the educational pipeline. For many Americans, the nation's educational system is less a pipeline than a funnel that ultimately allows few to pass through.

Black and Hispanic Americans in particular earn a disproportionately small share of degrees in STEM fields relative to their share of the population, the consequence of long-standing structural disadvantages arrayed against these groups from childhood onward. Black and Hispanic students are more likely to attend lower-resourced elementary and secondary schools, which means they have less access to advanced STEM and college-preparatory classes. They are less likely to be ready for college, enroll in college, and complete a degree. Those who do seek higher education are less likely to major in STEM or its most lucrative specialties.

Black students earned just 7 percent of STEM bachelor's degrees in 2017–18, according to the Pew Research Center, along with 9 percent of master's degrees and 6 percent of research and professional doctorates. Hispanic students, meanwhile, earned 12 percent of STEM bachelor's degrees, 9 percent of master's degrees, 7 percent of research doctorates, and 6 percent of professional doctorates.[35] White students, in contrast,

earned 62 percent of all bachelor's degrees in STEM fields and 67 percent of research doctorates. Asians were similarly overrepresented, earning 11 percent of all STEM bachelor's degrees and 18 percent of all doctorates.[36]

Women, perhaps surprisingly, earned a majority of the STEM bachelor's degrees (53 percent) awarded in 2017–18, according to Pew. This share, however, was still less than women's total share of bachelor's degrees awarded that year (58 percent), and degrees were heavily concentrated in just a few fields. For instance, women earned 85 percent of the bachelor's degrees awarded in health-related fields but only 22 percent of degrees in engineering.[37]

Many Black and Hispanic students never make it to college, a problem that the coronavirus pandemic has only worsened. While multiple barriers, such as lack of affordability and counseling, have long limited college access for Black and Hispanic students,[38] the pandemic has catastrophically affected college enrollment. By the summer of 2020, Black college enrollment had dropped by 8 percent compared to the prior year, according to the National Student Clearinghouse Research Center, with especially sharp declines among Black men.[39] In the spring of 2021, the number of Black men enrolled in postsecondary education was a whopping 9.7 percent lower than in the spring of 2020.[40]

The pandemic has also exacerbated already inequitable opportunities for college readiness, thereby further narrowing the pipeline in years to come. A December 2020 analysis from McKinsey & Company estimated that students of color entering school last fall were, on average, about three to five months behind where they should have been in math proficiency, the consequence of pandemic-related school shutdowns and inadequacies in remote learning.[41]

Academic readiness and achievement are particularly vital for postsecondary success in STEM, where coursework is rigorous and disparities in preparedness tend to compound themselves over time.[42] Deficits begin as early as elementary school due to inequitable access to high-quality early childhood education and preschool. By high school, these deficiencies are potentially insurmountable. A joint report by the ACT and UNCF (formerly the United Negro College Fund) found that just 14 percent of Black high school graduates met the ACT's benchmark for college readiness in math in 2015 and 12 percent met the ACT's standard in science. Overall,

just 6 percent of Black graduates met all four of the ACT's benchmarks in English, reading, science, and math.[43]

Compared to their peers in affluent, suburban school districts, students in lower-income schools—who are disproportionately minorities—are less likely to have highly qualified, experienced teachers.[44] (Black and Hispanic students are two to four times more likely than are White students, for instance, to attend schools where a significant share of teachers are uncertified.[45]) Students in low-income schools are also much less likely to have access to higher-level math and science classes, which can also negatively affect their odds of college readiness and success. In a 2018 report, the US Government Accountability Office (GAO) found that a quarter of "high-poverty" schools (in which 75 percent or more of students are receiving free or reduced-price lunch and where the student body is overwhelmingly Black or Hispanic) offered no Advanced Placement (AP) math classes in 2015–16,[46] and nearly 40 percent of these schools did not offer physics. Nearly 100 percent of affluent schools, however, offered AP math courses, and 70 percent provided students with options for 10 or more AP classes.[47]

Qualitative Barriers

As significant as they are, structural barriers—such as poor-quality K–12 education and lack of access to high-level math and science courses—only partly explain the dearth of women and minorities in STEM professions. Just as determinative are the qualitative experiences individuals have as they pursue their education, apply for jobs, and work to advance in their careers. A hostile work culture, the lack of mentors, and outright discrimination can all serve to derail talented individuals from fulfilling their potential.

These less measurable factors can help explain, for example, why many women with STEM degrees don't hold STEM jobs. Although women earn a majority of the degrees awarded in biological sciences, social sciences, and psychology,[48] as noted above, these specialties also have the highest rates of those working "involuntarily out of field." According to the NSF, 8.5 percent of degree holders in biological sciences and 11 percent of degree holders in social sciences held jobs outside their field in 2017, compared to just 3.6 percent of those with degrees in engineering.[49]

Many other women "choose" to leave. According to a 2019 survey of more than 1,500 women in tech by Accenture and Girls Who Code, "Half of young women who go into tech drop out by the age of 35."[50] Clearly, some set of factors is serving to push women out of STEM fields, despite their qualifications.

Qualitative factors can also help account for the segregation of minorities into less lucrative fields and majors in college, which contributes to occupational segregation. In a December 2020 study, researchers at the Urban Institute found that Black students are overrepresented in majors such as public administration and social services and underrepresented in "high-paying majors in business, health, and STEM fields."[51] What's more, this within-school segregation was more likely to happen at "selective" colleges, where all students are presumably high achievers. Researchers speculated that this segregation could be the result of students "being steered toward a handful of majors" or "being excluded from or disinterested in other majors."[52]

Unfortunately, abundant anecdotal and qualitative evidence supports the view that many STEM industries have a "culture" problem that tolerates the exclusion of women and racial minorities and discourages reform. In the Accenture and Girls Who Code survey, just 21 percent of women said it was "'easy for women to thrive in tech.'" Among women of color, that number was 8 percent.[53] In another 2019 survey of college-age women, Girls Who Code found that half the women they surveyed "either had a negative experience applying for a job in tech, or know a woman who has."[54] Interviewers, for instance, focused on women's "personal attributes rather than their skills," asked biased questions, or made "inappropriate verbal remarks."

Companies such as Amazon, Facebook, and Google have faced numerous allegations of bias and discrimination, some resulting in lawsuits and claims filed with the Equal Employment Opportunity Commission (EEOC). In April 2021, the *Washington Post* reported that the EEOC had launched a broad investigation into Facebook's hiring, promotion, and pay practices, based on complaints filed by Black job applicants.[55] Recruits said they met all the requirements for advertised jobs but were nonetheless rejected because the "company was looking for people who would fit in culturally." According to a former Facebook recruiter interviewed by the *Post*, the company had

"adopted metrics that prompt recruiters to go through the motions without actually delivering talent."[56] The vague notion of "fit," complainants alleged, essentially gave the company an excuse not to hire minority applicants.

Similar complaints have dogged Amazon and Google. In February 2021, an investigation by Vox Recode concluded that "Black Amazon employees are promoted less frequently and are rated more harshly than non-Black peers."[57] Some Black workers interviewed by Recode said they sought mental health treatment because of their experiences, while others said they accepted transfers and demotions to escape "toxic bosses." At Google, a former diversity recruiter for the company told the *Washington Post* in March 2021 that she had been fired for protesting bias against students from historically Black colleges and universities (HBCUs) in Google's recruiting and hiring practices (despite a stated commitment to prioritizing these schools).[58] In April 2021, a former software engineer wrote a first-person account for the *New York Times* about the repeated sexual harassment she experienced at Google from her supervisor and the indifference of higher-ups and human resources.[59]

A 2020 AEI survey of 1,368 adults with STEM degrees also confirms that women and minorities face greater challenges with job satisfaction and success. For instance, more than a quarter of women (26 percent) say they regret their choice of major, compared to 17 percent of men. Many workers don't feel their employers are committed to their success; 52 percent of non-White respondents believe their "employers would prefer to bring on new talent as opposed to training their current workforce."[60]

Among respondents no longer in STEM, a lack of on-the-job training activities was cited by 35 percent of non-White respondents as a major reason for leaving the field, while 46 percent said they left because "contributions of people like them were undervalued." Fifty-four percent of female respondents also said they believe women face more obstacles to advancement in STEM compared to other fields, while 51 percent of non-White respondents said they felt Black workers faced more barriers. Tellingly, however, most men and White respondents disagreed with these assessments, which hints at one reason STEM's culture problems persist: Some White male workers don't even see a problem.[61]

The next section of this report summarizes key findings from 25 qualitative interviews conducted in the fall and winter of 2020–21 with current

and former STEM workers in various fields. Their experiences show that problems with workplace culture and inclusion are not unique to the biggest and highest-profile companies. Rather, they are endemic to the experience of being a STEM professional. While these interviews provide only a brief window into a small number of individuals' lives, their stories hint at much broader concerns that industry, academics, and policymakers must address if equity in STEM fields is to be achieved.

Part II:
Barriers Versus Ramps

Carla A. and Christian G. are two professionals in their late 40s with similar credentials but radically divergent careers. Carla A., who is Black, was the first in her family to go to college. She earned a bachelor's degree in electrical engineering in 1995, followed by a master's and a master of business administration (MBA). A star student, "All of my math teachers loved me in college because I was setting the curve," she said.[62] As an undergraduate, Carla interned with a major aerospace manufacturer and went on to work for one of the nation's largest computer and IT companies after graduation.

She left engineering after about a decade, prompted by a layoff during the Great Recession. But before then, she said, she had suffered years of frustration at work—the result of unequal pay, no opportunities for advancement, and poor treatment by supervisors and colleagues as one of the few women and non-White employees in her department. She recalled one instance when she was ordered to clean out the office of a White male coworker who had left the company and discovered his discarded pay stubs. "He had one year more of experience than I did, and his salary [was] four times the amount of mine," she said.[63]

> I thought that I would have more opportunities for growth, but what I found was every year having to fight for my pay increase. And I honestly felt like it was because I was a woman. I had probably one other woman on my team at various times, and it just seemed like the men weren't having the same problems we were having. Staff meetings, trying to convey what the clients said, it seems like the management and the other engineers just brushed it off. And I don't know if it was because I was Black or a woman or because I was new, but I felt like at some point they weren't listening to me.[64]

Eventually, she said, she gave up. "I wanted to grow with the company because that's what I saw my mom and dad do . . . that generation before me," she said. "They were putting in 30, 40 years and retiring, and that's what I envisioned myself doing. But it just didn't turn out that way."[65] For the past 13 years, Carla A. has been the human resources officer at a law firm in Atlanta founded by her cousin.

Like Carla A., Christian G. has a degree in engineering and an MBA. He graduated from Ohio State University in the early 1990s at the height of a recession and initially struggled to find work. "It was a difficult job environment," he said. "Friends of mine who had gotten jobs at Caterpillar, Rubbermaid, every big name you can think of . . . were all getting their offers rescinded."[66]

After shorter stints at smaller facilities and a return to school for an MBA, Christian G. ultimately landed at a large advanced manufacturer of precision weighing equipment back home in Ohio, where he has spent the past 10 years. He has since risen into management. "It's been a really good place to work," he said. "My boss and his boss both . . . pushed me and gave me direction. [They] told me things to work on and what I need to do to advance that's been helpful."[67]

Christian G., who is White, says few of his colleagues are female or racial minorities. "It's a very male-dominated field, honestly, where I work," he said. "It's unfortunate I don't have a really good way to describe it other than, it's older White males."[68]

The stories of Carla A. and Christian G. illustrate the starkly disparate career paths that many women and people of color experience in STEM careers compared to their White and male peers.

In-depth interviews with 25 current and former STEM professionals, conducted in the fall of 2020 through early 2021, demonstrate how the difficulties many women and underrepresented racial minorities experience likely contribute to the persistent lack of diversity within STEM fields. (See Appendix A for brief descriptors of interviewees and notes on methodology.) A majority of women and non-White professionals, like Carla, said they faced multiple obstacles at work and school, which they overcame to varying degrees of success. White men, in contrast, reported far fewer barriers to advancement.

These workers' narratives, which represent a broad range of fields and experiences, vividly illustrate how qualitative factors—such as workplace environment, the presence of mentors, and family background—shape an individual's career choices, trajectory, and persistence long before their first paycheck.

Many businesses—especially in science and technology—have made broad public commitments to promoting diversity, equity, and inclusion in their hiring and personnel practices. These efforts have accelerated since the summer of 2020, when George Floyd's brutal murder by Minneapolis police forced a national reckoning on the myriad ways in which systemic racism hinders the lives and liberty of people of color.

But as the narratives in this section show, it is not so simple to shift deeply ingrained attitudes, behaviors, and cultures that stymie many workers' aspirations. This seems particularly true in STEM, where all too often a culture of exclusion appears the default, not the exception.

The Experiences of Women and People of Color Working in STEM: Barriers

The female and minority workers interviewed for this report are an elite group compared to the US population as a whole. Out of 19 interviewees who were women, racial minorities, or both, 11 possessed advanced degrees, including doctorates and professional degrees. Only one had a two-year degree. Many attended selective educational institutions or worked at some of the nation's leading companies in their respective fields.

Nevertheless, a majority of these interviewees reported facing significant obstacles nearly every step of their careers, despite their academic and professional success. None ascended to senior management or executive positions, and five switched careers or left STEM fields.

Many felt socially isolated working in offices dominated by White people or White men and excluded from valuable opportunities for mentorships, networking, and training. Others confronted subtle and not-so-subtle sexism and racism, including inappropriate comments, double standards on performance, the denial of promotions, and unequal pay. Several women indicated their fields were hostile to workers with family obligations, which

also limited their opportunities for advancement. Others said they regretted career and educational decisions made without adequate pre-career guidance. While older workers were more likely to report having experienced blatant episodes of racism or sexism, younger workers also felt racial or gender prejudice was prevalent.

Not all interviewees, of course, experienced difficulties in their careers. Karen L., who is White and recently retired after 20 years as a professor of clinical laboratory science at a West Virginia university, said she landed her teaching job when one of her former professors contacted her as his successor on his retirement. "I guess a lot of times in my career, I either knew the right people, or I was in the right place at the right time, basically," she said.[69]

Leigh H., a PhD agriculture researcher working for the federal government, said that although she is one of only a few Black female scientists at her agency, "So as far as dealing with any discrimination or anything like that, I really haven't."[70] Hector P., a Latino IT worker, said he saw more bias in his native Colombia, where he said connections mattered more than credentials did. "It depends more that . . . you have some people that can help you to get a promotion in the company . . . and that's not fair," he said.[71]

Overall, however, the experiences of these workers illustrate why STEM's diversity problem continues: Many women and people of color face work environments fiercely hostile to their success, including a constellation of barriers to their advancement.

Social Isolation: "The Only One." Overwhelmingly, the most common experience reported by female and non-White workers was that they were "the only" or one of only a few women or racial minorities at their workplace or in their classes. This isolation created not only psychic burdens but hurdles to advancement: Workers felt shut out from potential opportunities and stymied in their ability to build valuable relationships with colleagues and supervisors.

Of the 19 female and non-White interviewees, 18 said they worked or went to school with mostly men or White people. (The sole exception was Karen L., the professor of clinical laboratory sciences, who also said her field was female dominated—though also largely White.) "I guess I'm the

token Hispanic," said Laura M., a California graduate student in her 20s who is pursuing a master's in data science and is the only woman in her program.[72] Mike K., a software engineer in his 50s, said, "In pretty much four-plus years through my engineering classes, I . . . was the only African American, period."[73]

Terri H., a White woman in her 60s, said she encountered few people of color in her education or career as an environmental engineer and geologist working for typically male-dominated private construction and engineering firms.

> I believe there was only one African American person in school. There were none in geology. There was one in engineering that I remember. . . . We had one Black girl in our department—actually two for awhile; one left. There were very few African Americans at all at the company. There were a lot more Asians, Indian, which I guess you could classify that was Asian. There were a lot of Middle Eastern people. . . . I worked with one lady who was Indian. . . . I don't even remember working with any Latino people, and very few women in upper management.[74]

Similarly, clinical laboratory science professor Karen L. said that few of her students over two decades of teaching were racial minorities.

> We don't have a lot of Black or Hispanic people that live in our state, or that come here to school. Yes, there are some Black people, but not every class of 30 people would have even one person not of White extraction. . . . We've had, in recent years, more foreign students who come here from Korea, but that's a little bit different when they're coming to our country from another country. I never had, I don't think and in all the years that I taught, or that I've worked, I've never worked with a Hispanic person.[75]

Female and non-White workers said they felt discomfort, aloneness, and lack of belonging. "It feels very weird to be in a class surrounded by all guys," said Laura M., the data science master's candidate. "Even if they're

super nice, there's always that weird dynamic." Some interviewees said they felt a heavy burden to over-perform because of their "outsider" status. "Many times I feel like I'm the lone representative of my race and gender, and it's difficult," said Sarah N., a Black female biochemist in her 50s who earned a doctorate at the California Institute of Technology. "I feel the expectation. I feel like I need to be better than everybody else, just to show that I totally deserve to be here."[76]

The isolation women and non-White workers felt could help explain one reason for the lack of diversity in STEM: It is self-perpetuating. Workers who do not feel welcome at work and cannot rely on the camaraderie and support of their colleagues are unlikely to stay. In a February 2021 study,[77] researchers at George Mason University surveyed 325 Black math teachers to understand the persistent shortage of these teachers and why so many were leaving the field. The scholars found that teachers' desire to leave was highly linked to sentiments such as "I have experienced feelings of isolation at my school/district based on my race."

Michelle P., a computer science instructor and the author of several technical books on IT, said:

> If you don't have other women to talk to and . . . be friends with and talk about the things that we want to talk about versus the guys talking about the games that they're playing or whatever, that can be lonely.[78]

Michelle is a White woman in her late 50s. "I've had a couple of females that I spoke with that said they kind of left because there was no female companionship in the job to help," she said.[79] Nicole L., who is an IT auditor who tried and failed four times to land a job in management, said her department has a tight-knit coterie of men she described as "cliquey." "They have a lot of inside jokes and that kind of thing," she said.[80]

Lack of Mentors and Professional Networks. Numerous interviewees reported that they lacked mentors and professional networks that could bolster their advancement—one result of their social isolation. Tiffany C., a doctoral student who also has a degree in information science and design, said she was the only Asian American woman in her 50-student master's

program. "I came out of that program with no friends," she said. "It was so harrowing."[81] Chemist Sarah N. said she is frequently not invited to meetings among her mostly male and White colleagues: "Many times I would find out that, 'Oh, we had a little session about this chemistry problem among the chemists in the group,'" she said. "Why wasn't I included?"[82]

Social isolation damages workers' opportunities for advancement if they are left out of the office grapevine, have no mentors to advocate their promotion, or miss out on job training vital for promotion. The same dynamics apply in school and college, where marginalized students cannot build networks with fellow students who could become valuable future contacts. In a 2019 survey of more than 3,700 professionals by Coqual (formerly the Center for Talent Innovation), 31 percent of Black professionals said they have access to senior leaders, compared to 44 percent of White people (and 49 percent of White men). "No wonder, then, that Black professionals are frustrated with advancement—they don't have the same opportunities to forge relationships with key decision makers," the study concluded.[83]

David B., a retired engineer, said he had difficulty finding mentors who could help him navigate his advancement at the Navy, where he had worked as a civilian. "Frankly, you gravitate to people that look like you, and that's just the way it is," he said. Not having a mentor, he said, meant a dead-end career in the bureaucratic environment where he worked. "There are boxes that you need to check as far as your work experience in order to qualify for a lot of positions, [but] somebody has to tell you that," he said.[84] He continued:

> So you're 10 years into your career and they say, "You haven't [checked] these five boxes." But you haven't been afforded the opportunity to check four of them . . . and then they use that against you as you get older. . . . If you don't have a mentor early on that tells you, "These are the things that you need to focus on," . . . and "You need to look for opportunities like this" and "Press your boss for opportunities like these," then you don't have a shot. . . . You'll get 20 years into your career, and you're done.[85]

LeeAnn C., who has a degree in wildlife conservation and lives in Utah, said she has contemplated earning a master's in her field at the same Utah university where she earned a bachelor's but felt handicapped as a woman.

> I feel like with some of the opportunities, especially for getting a master's degree with some of the professors, I know that if you go golfing with them on the weekends, you're much more likely to get accepted as their grad student than if you don't. And so I feel like there's a little bit of bias, for who you know in the field. . . . It's hard to have a friendly relationship with someone of the opposite sex, if you're a married woman. Or if they're married. . . . But I do know that in the field, networking is really important. Everybody seems to know everybody. And if they don't know you, you cannot find a way in.[86]

Professional societies reinforced the isolation some interviewees felt rather than alleviating it. Chemist Sarah N. said she attended some local meetings organized by the American Chemical Society but "it was mostly older white men and I was like . . . well . . . it just didn't feel like somewhere I wanted to spend a lot of time."[87]

Software engineer Mike K. said he recalls that the few women in his engineering classes had to "go through a lot." There was, he said, "a lot of bullying, you know, to be honest [because of] the male-dominant attitude. Nobody wanted to partner with the females when we did labs."[88]

Further compounding these problems is the lack of women and underrepresented minorities in management and decision-making positions who can advocate for greater diversity. Interviewees uniformly reported that few women or people of color occupied senior-level positions where they worked. "You're not going to walk in and become vice president in six months," said Terri H., the environmental engineer and geologist. "But I think that there was a sort of good old boy attitude too in the upper management."[89]

"In my whole career with different companies, I've never worked with any woman or woman Asian manager," said Lonnie L., an Asian woman in her 50s who worked in IT support for 20 years. "I keep hoping that

somebody will tell me differently, and they worked for like five Asian female managers. But everybody's like, 'No women, no Asians.'"[90]

"It's very hard for women to rise," said IT instructor Michelle P. "And in my case, I never had a female manager. Ever."[91]

Stereotyping: The "Soft Bigotry of Low Expectations." A majority of the women and workers of color interviewed for this report said they experienced some sort of stereotyping, discrimination, or bias because of their race or gender. Of the 19 female and non-White interviewees, only two said they had never personally experienced any discrimination or disparate treatment.

Numerous interviewees reported hurtful comments based on stereotypes about their intelligence or capabilities, which affected their morale, performance, and perceptions about their field. "There is some sort of preconceived notion that Black people don't do well in sciences," said J. S., a Black woman in her 50s who holds a doctorate in veterinary sciences and now works as a research scientist for the federal government.[92] "My sister is a lawyer, and in high school, she was told by the assistant principal that she was not going to amount to anything. . . . I was in vet school and the veterinarian told me that she couldn't see me with a DVM behind my name."[93]

John D., who worked as a computer programmer at one of the nation's largest telecommunications companies, said he overheard colleagues say his firm "had to overlook qualified White people to hire unqualified Black people."[94] (John D. is Black.) At the same time, said J. S., Black Americans are punished for overachieving, putting them in an impossible bind. "If you were a janitor, then they treat you just fine," she said. "They feel benevolent toward you. But when you're at the same level as them, now you have an attitude, and you're 'arrogant' and whatever."[95]

A growing body of research finds that constant uphill battles against stereotyping and bias can take a heavy psychic toll. Seminal research by Columbia University psychology professor Derald Wing Sue and colleagues popularized the term "microaggressions" to describe the "commonplace verbal or behavioral indignities, whether intentional or unintentional, which communicate hostile, derogatory, or negative racial slights and insults"[96] that many people of color endure.

Even if slights are unintended, "The cumulative nature of these innocuous expressions is detrimental to racial minorities because they sap the energy of recipients," as Gerald Wong and colleagues wrote in 2014.[97] Carla A., the electrical engineer who left the field after her layoff, is a self-described "workaholic" who said her work environment nonetheless eventually affected her mental health.

> My work was always spectacular, but mentally, I had checked out. I didn't care because I was like, well, I don't feel like they care about me. . . . I knew that when that next round of layoffs came, that I probably was going to get laid off. And I didn't care because at that point I had been looking for other jobs for like a year before. . . . [My] boss came down and he was like, "Carla, are you leaving?" And I'm like, "Yes." He's like, "Why?" And I was like, "I'm tired of fighting. I'm tired."[98]

Coqual's survey found that Black, Hispanic, and Asian professionals were much more likely than White professionals were to experience incidents like the following:

> Colleagues have touched my hair without my permission; I have been told I'm "not like others" of my race/ethnicity; I have repeatedly been told that "I'm articulate;" Others have regularly taken credit for my ideas in meetings; I have been excluded from meetings relevant to my job.[99]

Aside from the psychic damage, stereotyping can negatively affect the treatment of female and minority workers and their odds of professional or academic success. Some interviewees, for instance, said they experienced the weight of low expectations because of their race or gender, coupled with double standards for their performance. J. S., now in her 50s, recalled that at one of her first jobs, a White supervisor insisted on micromanaging her work, though she did not do the same for White colleagues with lesser credentials.

> She was constantly telling me how to do [my job]. Constantly, literally, physically standing over my shoulder watching me

> type. . . . I was like, "Why are you doing this?" [She said,] "Well, I need to make sure you're doing it right."
>
> "Well, you're not doing that to Mike and Amy."
>
> "Yeah, but Mike and Amy know what they're doing."
>
> "What do you mean Mike and Amy know what they're doing? They have bachelor's degrees. I have a doctorate degree, same as you. Why are you getting over my shoulder?"[100]

Software engineer Mike K., who attended college in Kentucky in the 1990s, said some of his professors had made assumptions about his background that affected his treatment in the classroom. Things changed when his instructors essentially swapped a negative stereotype for a positive one. "They said, 'Oh, we didn't know you're from Africa,' and things changed," he said.[101]

> My physics professor [was] a Caucasian, and I was asking him a question to explain some things I don't understand [but] he ignored me. He just answered other kids, other students, issues, or questions. I kept asking him, and he ignored me, period. . . . I went to his office hours [and said,] "I really don't appreciate the way you handle our communication." I told him, "I'm not here to bother you. . . . I'm here to learn. So please, next time . . . I would definitely appreciate if you can respond to me."
>
> But then through our communication, [he] can hear [my] accent and he says, "Oh, by the way, where are you from?". . . And then he said, "Oh, I've mistaken you. I thought you were one of those Black kids from the state." I told him, "Well, sir, I don't know where your expectation is. But I just want you to treat me like the rest of your students."[102]

Some interviewees said they felt they needed to over-perform to prove their worth and overcome negative assumptions about their competence. Michelle P., the IT instructor, said this was especially true early in her career, when she was confronted by classes that were invariably 100 percent male.

> When I was teaching in the early 2000s . . . the questions I would get asked were very rough. And I knew they were challenging me, they were trying to see, "Does this lady really know what she's talking about?". . . Later on, it didn't happen. In 2015, 2016, that challenge to my knowledge didn't happen, and I didn't have to go above and beyond to prove myself. . . . And then, yes, if somebody made a mistake, if the guys made a mistake it seemed like, okay, it's all right. But if you made the mistake, it was a little more severe.[103]

Racial and gender stereotypes also manifested themselves in presumably well-meaning paternalism that was nonetheless destructive. Terri H., the environmental engineer and geologist, said many younger women in her office missed out on valuable work experience because of decisions male supervisors made.

> They were babying a lot of the new women, and they weren't babying the men. They wouldn't send them out to jobsites, and [the women] were actually doing a lot more admin-type work than they really should have been doing. . . . These young girls were kind of treated like, okay, well, we can't send her out in the field because she's going to be with these construction workers, or we can't do this, or we can't send her to the plant.[104]

Perhaps the most pernicious impacts of stereotyping, however, might happen long before individuals choose their careers. J. S., the veterinary research scientist, said her children are now seeing the same sort of negative treatment she experienced.

> I have noticed that Black children, right from school age, start getting treated differently because teachers have preconceived notions that the Black kids are not as smart. They don't sound as smart or they don't have the same sort of resources in pre-kindergarten as the other kids do. Teachers treat them a little bit differently.

> My kids went through the same thing. The teachers treat them a little bit differently. And then, of course, the other children who are not Black are seeing this and then they grow up behaving that way as well like, "Okay, they're a little bit different." It goes on and on and on through high school, through college. . . . These little things are very discouraging.[105]

Lois T., who is Black and taught math in Chicago for 40 years before she retired in 2020, said she spent much of her career battling these kinds of stereotypes and low expectations among her students.

> When I was in the classroom teaching, I would share with them, I'd say, "Now look. There are people who don't even care about you." I said, "You got to care about yourself. Let us learn." I'd say, "You got to learn."[106]

David B., who volunteers as a high school math tutor, said he believes the majority of students who "can't" do math are in fact more than capable. "I just think it's a matter of who gets pushed and who gets shown, and who doesn't," he said. "It's just that they've been told or they had poor experiences with one tests or two tests, and nobody pushes them through that."[107]

Discrimination and Disparate Treatment. Compared to their White counterparts, women and non-White interviewees were much more likely to report that they had been denied promotions, raises, and other opportunities for advancement. "I felt like it was . . . a good old boys network," said Carla A., the electrical engineer who now works in human resources.

> Like, "Oh, well, we like him. He's great and he looks the part, [so] we're just going to make him manager" instead of truly looking at the team and seeing maybe there's another person who might be a better fit. . . . I felt like women and minorities might have gotten overlooked.[108]

Surveys find that significant shares of minority and female workers say they've experienced workplace discrimination or prejudice. In a January

2021 Gallup survey, for instance, 24 percent of Black workers and 24 percent of Hispanic workers reported that they had been discriminated at work in the past year.[109] Coqual's 2019 survey found that 58 percent of Black professionals (and 41 percent of Latinos and 38 percent of Asians) say they "have experienced racial prejudice at work" at some point in their careers, compared to 15 percent of White professionals.[110]

More than four in 10 women (42 percent) say they've experienced gender discrimination, according to a 2017 survey by the Pew Research Center, with higher rates of discrimination reported by women in male-dominated offices. Among women working in majority-male offices, "48% say women are treated fairly where they work when it comes to recruitment and hiring, and even fewer (38%) say women are treated fairly in promotions and advancement."[111] In contrast, a majority of women (70 percent) who work in gender-balanced offices say women are treated fairly.[112]

Pew's research also finds that postgraduate women—like the majority of interviewees for this report—are more likely than less-educated women are to report discriminatory treatment. For instance, Pew found that 27 percent of postgraduate women have experienced "repeated small slights at work because of their gender," while 24 percent said "they have received less support from senior leaders than a man" doing the same job, 18 percent said they were passed over for important assignments, and 35 percent said they were paid less than men performing the same work.[113]

Among interviewees for this report, midcareer and older workers were more likely to report egregious instances of discrimination, especially earlier in their careers, although younger workers also reported they were the victims of bias. "I actually did get told by one man that he wouldn't hire me because I was female, which was just idiotic," said environmental engineer and geologist Terri H.[114] David B., the former naval engineer, said "it was a struggle"[115] when he began his career in 1981 as one of only a few Black employees at the naval shipyard in Philadelphia.

> My supervisors at the time were all World War II vets, segregated military kind of thing. And I'll never forget this. One of my first bosses brought me in, and he basically said, "We're lucky we're paying you." He said, "You're lucky." He said, "You

> should be grateful and not even accept pay, because we're teaching you stuff."[116]

Veterinarian J. S., who said she was the only Black student and one of only a handful of women at her veterinary school in the Midwest in the early 1990s, said her advisers demanded she take courses not required of her fellow students.

> When I did my clinics, they insisted that I had to have 10. . . . And part of it was also, I think, because they knew I didn't want to go into the private practice, they knew I wanted to do research. They were like, "You have to take 10 hands-on clinical courses, or you will fail. You must take 10.". . . So I signed up for 10. . . . And then all the other people that were not Black. . . . All these other people were like, "What do you mean you have to take 10, I'm only taking four.". . . And I'm like, "Well, they told me I had to take 10."
>
> And so I actually went to the dean, [who] knew my dad. He said, "They are treating you unfairly. But if I tell them that you don't have to take these 10, they're going to make it very difficult for you. Because it's all subjective at this point. You're in clinic, they can pass you or fail you as they please. I suggest you take those 10 and just keep your nose clean.". . . So I took the 10 classes, and I worked way, way harder than Becky with the good hair. Way harder.[117]

J. S., who grew up in Nigeria, said her experience as an immigrant growing up in a majority environment gave her the capacity to persist. She even turned down an offer to transfer to the historically Black Tuskegee Institute.

> I said no because I'm not going to let these people run me out of [name of school]. I'm going to get my degree here, and I'm going to be successful, and I'm going to put it in their faces. That was my mindset, and that's the way I grew up. If someone tries to put you down, then you will prove to that person

> that you are so much better than what they think you are. And I think that for Black Americans, they've had generations of people telling them that they're not good enough. I mean, it's generations. . . . And so you get to the point where you believe you're not good enough.[118]

Most interviewees agreed that circumstances have improved over the years. "I tell the kids the workforce is a lot kinder and gentler than it used to be, and all around, it is," said David B. "I [don't] see as many, at least openly, racist folks as when I started."[119]

But younger interviewees still said they experienced disparate treatment because of their race and gender. Nicole L., the IT auditor who tried and failed four times to land a job in management, said she was a university lecturer pursuing her doctorate in computer information systems before her current job. The predominantly male faculty, she said, treated her like "a second-class citizen," which is one reason she said she left without her degree. "Even if we taught the same classes and had the same students, I was not their peer," she said. "That job was a little rough."[120]

Chemist Sarah N. said that at several places she worked, "It was very hard to get taken seriously." "I would say something and then . . . a guy would say the exact same thing," she said. "Oh yeah, that sounds great, I just said that five minutes ago."[121]

Interview responses indicate that women of color have a particularly difficult road to advancement. Michelle P., the IT instructor, said she primarily teaches high-level courses for prospective executives and managers. But, she says, "I can say without a doubt I have never taught an African American woman. . . . Like . . . never."[122]

Some interviewees said they received specious evaluations or were simply passed over for opportunities. Tiffany C., the Asian doctoral student, said she was labeled as "difficult to work with" at the engineering design firm in Austin, Texas, where she worked before returning to graduate school and was repeatedly rejected for promotions. "Because I'm Asian . . . they don't see us as being leaders," she said.[123] Carla A. was told that she needed "to smile more."[124]

> No one really complained about my work. Everyone thought I did exceptional work, but comments got back to me like, "Oh, Rick said you'd be nice if you smile more." And I'm like, "What does my smiling have to do with my work?". . . I think I came in very naive and thinking, oh, I'm going to just work really hard like I did in school and I'll eventually rise up in the ranks but never saw that happening.[125]

John D. said he was one of 15 Black programmers hired as part of a minority recruitment push at his company. But "out of those 15 Blacks [hired] 14 years ago, only one—you're speaking to him—has been promoted to programmer analyst," he said. At the same time, he said, "Every White person who's been hired since then has been promoted to programmer analyst."[126] Moreover, he said, his Black colleagues had trained many of the White workers.

Some interviewees said their failure to advance within their firms precipitated their departures. Fred B., a recently retired telecommunications systems engineer in his early 60s, said he was the only Black recruit among a class of 24 trainees recruited by a major telecom company in the late 1970s. But he quit to become a consultant when "I found myself limited for promotion for whatever reason."[127]

> They started promoting people that I had come into training with, and it was just clear that what they were looking for, for promotion, they didn't see in me. And at that point, after two or three years, I realized that maybe I'm not going to get promoted here. . . . I'm not going to tell you whether they were racial issues. But for some reason, it was clear that I wasn't going to get promoted as a [company name] employee.[128]

The irony, some interviewees said, is that companies nevertheless believe they are inclusive when they are in fact badly out of touch with employees' perceptions and job satisfaction. Lonnie L., the IT technician, said, "There's always only one Black, you know, in the team. I guess that's how they want to make things equal, right?"[129]

"[They say] 'We're inclusive and . . . respect minorities,' but their actions clearly state that [they're] more comfortable with people like [them]," said Sarah N.[130]

> I also think it's kind of strange when in popular media they're suddenly concerned about levels of minorities at different companies, and all of a sudden, you know, HR reaches out. "Can you go to this job fair for us and tell them how great it is to work here?" Well, I've never heard of you. You've never contacted me. . . . I am not your token person to go out and represent your company when it's convenient for you.[131]

Pressure to Code-Switch and Develop Defensive Strategies. Several interviewees said they modified their behavior, communications styles, and other aspects of their personalities to cope with their work environments and avoid reinforcing negative stereotypes. Among Black Americans, these kinds of adjustments are known as "code-switching," which researchers Courtney L. McCluney and colleagues say "has long been a strategy for black people to successfully navigate interracial interactions." As defined by McCluney, code-switching means "adjusting one's style of speech, appearance, behavior, and expression in ways that will optimize the comfort of others in exchange for fair treatment, quality service, and employment opportunities." The problem with code-switching, McCluney and colleagues write, is that it comes "at great psychological cost."[132]

> Seeking to avoid stereotypes is hard work, and can deplete cognitive resources and hinder performance. Feigning commonality with coworkers also reduces authentic self-expression and contributes to burnout. . . . Black employees who feel pressure to code-switch may perceive that they are being devalued, which in turn may reduce their commitment to the company and desire to contribute their unique insights.[133]

Some interviewees went far beyond code-switching in their efforts to accommodate White colleagues and survive difficult work environments.

Naval engineer David B., for instance, relied on a strategy he called "talking backwards," especially early in his career. To make his supervisors and colleagues comfortable, he said he minimized his credentials and worked hard to find common cultural ground.

> "Talk backwards" means you need to know the person, the person needs to like you, the person needs to give you access, and the person needs to trust you, in that order. . . . At my first job, that was one of the things I had to understand. . . . To be "liftable," as they say, I had to be likable. And to be likable, I had to push down a lot of the brashness that I had.
>
> I had to downplay the fact that I went to a good engineering school. As a matter of fact, I had to downplay that I even had an engineering degree and I was going for a master's degree. I couldn't go and tell those folks that because that wouldn't allow me to be likable, and then therefore, I wouldn't have access, and they would never trust me, right?
>
> To be likable, again, if your manager's a golfer and can talk golf, or maybe he likes rock, he likes Aerosmith, and you're a minority and you don't. . . . And you're talking about R&B, and he's talking about hard rock, AC/DC, then you're not going to be too likable to him. So I actually had to go out and learn rock, and I learned all that stuff.
>
> But it's part of what you have to do. And it's not a bad thing. I mean, you're learning. I was cool with it, but I knew, this dude likes X, and I have to understand X, at least. . . . And this is what people don't understand. He doesn't have to know anything about what I know. He doesn't have to know anything about R&B. He's the boss.
>
> So if he doesn't like what I'm saying, he's like, "Get out.". . . And again, that's part of getting rid of the brashness. I initially went in, "Hey, I'm smarter than this dude. I'm smarter than these guys. I can perform better, so I don't have to learn rock. I don't have to do that." Well, you do. . . . I mean, it's just the way it is. You do.[134]

Some female interviewees also said they modified their behavior at work, to avoid both stereotyping and potential sexual harassment. IT instructor Michelle P., for instance, said she is "careful how I approached things and kind of voicing my opinion as much as maybe the guys did."[135]

> I hate to say this, but sometimes we judge women and we say, "Well, she's very vocal. She's kind of bitchy." I hate to say that word . . . so it was more me not wanting to be looked at that way. So I was very careful in how I made my arguments, if you want to call it that, or my recommendations. I tried not to be as pushy, even though I don't agree with that particular way of doing it, but I felt like that was how I needed to be.[136]

Michelle P. also said she worked proactively to head off unwanted attention from colleagues.

> One of the things . . . I kind of learned early on to . . . negate harassment . . . was to really make clear that . . . I was happily married and not looking for anything. So, I was very careful. . . . I never wanted to portray myself as somebody who was open to having an affair or flirt. I really had to set those boundaries and I learned early on to be very careful of how you say things and what you say as a woman. . . . I kind of stuck to that and . . . I never, knock on wood, never was harassed or anything like that in my career. So, I was very lucky.[137]

On the other hand, Michelle P. acknowledged she may have hampered her career by distancing herself in this way from her male colleagues. "I never personally wanted to play that game with corporate and try to finagle my way into moving up and that sort of thing," she said.[138]

> It just turns me off personally. I don't know how other women may feel about the political game, I like to call it, that you need to play to move up. . . . In our company, the only way you could do that is if you kind of inserted yourself into a problem that you could try to solve or contacting managers and saying, "I'm

> interested in moving up." And then they want to go have more conversations or they want you to do something. I personally wasn't interested, but sometimes playing that political game can be tough when you're a woman. Usually it's the guys. Right? They go out and have a drink or they go out to dinner or something like that, and I just didn't want to do that.[139]

Other women who also said their strategy was to keep to themselves to avoid trouble said they likely sacrificed their advancement. "I try to stay out of politics as much as I can," said state IT auditor Nicole L. "That could be something that has hindered me over the course of my career because I'm not really great with networking."[140]

"As an Asian woman, I'm more on the quiet side," said Lonnie L., the IT support technician. "My daughter said I'm too passive, like I don't speak up."[141]

Chemist Sarah N. said she believes many women face inherent disadvantages that are not so easy to fix with subtle shifts in communications style. "I really do feel like it's the boys' club at the top, and it's very, very hard to break in—to earn your seat at the table," she said.[142]

> Usually the people who manage to get in are the women who are extremely aggressive. And I don't think that's a common trait in women. And so until it's more accepting of other personality types, it's going to be very difficult for women to get ahead. I think I personally am not very aggressive at all. And so it's very hard to kind of play that game.[143]

Work-Life Challenges. Several female interviewees said that problems with work-life balance hampered their career aspirations. Some said the fields they chose were not family friendly, and two interviewees reported dropping out of the workforce (temporarily in one instance and permanently in the other) because of family and child-rearing obligations.

LeeAnn C., who earned a bachelor's in wildlife conservation, left the workforce after her first daughter was born. She said she had aspired to be a zookeeper but discovered the difficulties of the job during a summer internship.

> The new keepers had very low pay, and their schedules were working seven days on, three days off rotating. And so you never had consistent days off. . . . Once I did that internship, I did love working with the animals, but I also saw that being a zookeeper was not going to be really conducive to having a family. And [there was] not really a sustainable amount of money without being married to someone else who is earning money.[144]

Terri H., the environmental engineer and geologist, said she took a five-year hiatus when her children were small but that many of her female colleagues left the workforce altogether. "A lot of women came in and worked for five years, got married, had children, and left," she said. One problem, she said, is that engineers in her field must travel extensively. "I guess you could argue it would be better if companies made it easier for women to work part-time or made it easier for women to work as mothers," she said. "[But] you have to go to the jobsites."[145]

Work-life balance, said IT instructor Michelle P., is also "very difficult" in the IT field.[146]

> That's kind of why, to be honest, I stayed in teaching, because when I finished my class, I was done. When you're a network engineer, that network goes down at 2 o'clock in the morning, you've got to fix it. You've got to wake up and you've got to deal with that, and that can be very tough. Unfortunately, doesn't matter what you have, whether it's a server, a website, a router or switch, the phone system, all of those things go out and they usually go down at the most inopportune time.[147]

Lonnie L., the longtime IT tech support worker, said she believes family obligations are one reason women in her field are less likely to advance. "We don't stay late, like doing overtime, because that will [take] out time from our family," she said. "Men work late . . . so that's how they get promoted faster than women. Women are more like, 'No, we gotta go home and cook.'"[148]

Exacerbating these challenges, some women said, was the lack of sympathy from male colleagues, along with the lack of paid leave. Engineer

Terri H. said she began her career "back when you didn't even have paid time off or time off for having a baby."[149]

> So you're having to use your vacation time and whatever sick leave you happen to have in order to be pregnant and have a child. And then you go into no pay for however long afterwards, and then you go back to work, you have no vacation left, you have no sick time left. So you're having to juggle a baby.
>
> Things have changed a lot since then. But a lot of the women I knew, it was just, you were kind of being treated like [a] second-class citizen. And I had some guy ask me, "Well, what do women want?" And it was like, something more than what I got, maybe. I mean, we're not going to have people on this earth if women don't have children. What can I say?[150]

Even when workplaces became somewhat more flexible, Terri H. said, they were not fully supportive of working parents.

> There was a certain amount of ambivalence on the part of some of your coworkers over the fact that you have these kids at home that you really need to go home to. Or that have to be fed, that have to go to the doctor. There was a certain amount of, "Well, the men don't have to do that." But it wasn't too bad. I worked at a good place, comparatively speaking. A lot of people I know are sent out to jobsites with no regard whatsoever to their family or anything for months, and that's tough.[151]

J. S., the veterinary research scientist, said that in addition to the extra coursework she was required to take in vet school, professors made no allowances for the fact that she had a young daughter.

> My child was in elementary school, so if it was closed, I would just take her to school with me. I sat all the way in the back of this lecture hall and she would sit either next to me . . . or she would sit on the floor, all the way in the back corner. She was totally quiet; she's such a good girl. People would see that she's

> there, because they could see her, but she was completely silent. . . . She'd either be reading a book or just being quiet or even listening to the lecture at the time. . . .
>
> The assistant dean of the college came to class once and he saw her. . . . At the end of class, he completely berated me for bringing her and told me that maybe I should leave and come back to vet school when I can get my priorities straight.[152]

J. S. said her daughter eventually earned a master's in education and is now an elementary school principal.

Lack of Pre-Career Guidance. For some interviewees, particularly those who indicated they were first-generation college graduates or the children of immigrant parents, inadequate pre-career guidance and lack of access to work experience opportunities such as internships have stymied their careers. Some interviewees said they would have chosen a different field had they known of the limited job options available after graduation.

Artie S., a Latino man in his 20s, holds bachelor's degrees in biology and botany but is now a stay-at-home dad after a disappointing start to his career. While he had hoped to find a job in field research, he ended up as a technician processing urine samples for a commercial laboratory. "I was basically a specimen opener and also a processor," he said. "Honestly, it was an entry-level position. . . . I knew a lot of people that only graduated high school and ended up getting the same position as me and didn't really have a background in science."[153]

One thing that hampered his career, he said, was that he couldn't take advantage of internships that would have bolstered his research credentials in his field of interest, mycology. "I had an opportunity to go to Ghana. . . . I just did not have the finances for it," he said.[154]

> So if I had gone back and changed something, I would have done more than I could to try to get on that trip. You put that on your resume saying that you helped discover new fungal species, the fact that I would have gone to a different country and have the experience to actually go somewhere else and study. . . . That would have been huge.[155]

Artie S. said his parents did not have the resources, financial or otherwise, to help him with his career decisions. "My mom is a social worker in San Diego, and my dad is retiring from the Air Force reserves this year," he said. "They never really worked in the science fields . . . kind of just the jobs that they could get, and they stayed there for a long time."[156]

He also did not get much guidance at the California state school where he earned his degrees. "So, I didn't get a lot of counseling as far as what jobs I can do. And it could have been also I wasn't asking the right questions, maybe," he said.[157]

Laura M., the Latina graduate student in data science, said she also regrets not taking advantage of internships during her undergraduate years.

> You definitely need an internship, at least. And I didn't know that we were supposed to do this. I mean, it sounds dumb now, but I didn't realize that we had to be doing those things during college. So when I was doing my master's, I saw so many opportunities that were just for undergrads, and I was like, "I can't believe I didn't know about this."[158]

Laura M., whose parents emigrated from Colombia, graduated in 2015 with a double major in biology and psychology. But because of her lack of experience, she said, her first job out of college was a contract position working for the US Department of Agriculture. "It was just basically doing outreach," she said. "I don't really think you needed a degree, but I did that. . . . We would go to livestock sales and stuff and talk to people there."[159]

After this position ended, she—like Artie S.—found a job processing wastewater samples at a lab in Atlanta. "Sometimes we would get these samples that we would have to open doors and turn fans on just to try to get the smell out, it was so bad," she said.[160] The hours were long, she said, and the pay was low.

After quitting that position, she worked at an ice cream store while researching options for graduate school. Like Artie S., she did not get career counseling from the large state university she attended.

> I wish the counseling had been a little more proactive. But, I mean, it's just hard. It is a public school, and it's a big school, so it is kind of hard to give everyone attention. But at least they could have been like, "Here are websites that you can visit to see internships," or stuff like that.[161]

She said she now regrets her choice of majors. "I think if I could go back, I'm not sure I would do either of those, psychology or biology," she said, and she wishes her college had provided more guidance.[162]

> I love psychology, because it's such an interesting field. But it's just, I'm not really sure what you can do with that after. . . . I mean, I get that they want people in all their majors. But they should definitely have career expectations, or just be a little clearer. It serves them to have a good percentage of their graduates getting decent jobs, right?[163]

Ramps: The Experiences of White Male Workers in STEM

In sharp contrast to most of the female and non-White workers whose career experiences are described above, White male interviewees reported relatively few barriers to achieving their career aspirations. These workers did not report experiencing negative treatment because of their race or gender; rather, the setbacks they experienced were the consequence of broader economic conditions resulting in layoffs or job loss or personal choices. Most interviewees reported strong relationships with mentors and colleagues and ample opportunities for training and advancement. Three of six White male interviewees possessed advanced degrees (compared to 11 of 19 female and non-White respondents). Four of the six held or are working in senior management positions.

Like the female and non-White interviewees, a majority of White male interviewees—four of six—reported that they worked with few women or people of color. (These experiences roughly track AEI's 2020 survey of STEM workers, which found that 59 percent of workers—and 65 percent

of White workers—say that "all or most of the colleagues they regularly interact with are white.")[164] Engineer Bob C., for instance, said "there was maybe 2 percent African American out of the whole freshman engineering class" when he attended college in upstate New York in the early 1990s. "Maybe that had to do with the geography of where I went to school, which is kind of in the boondocks," he said. "I don't know if inner-city engineering colleges might be the other way around."[165]

While all the workers recognized that lack of diversity is a phenomenon in STEM fields, many—unlike their female and non-White counterparts—either did not believe race or gender discrimination to be a problem today or had never witnessed it. Jack H., a retired analytical chemist for the Army, said:

> There are Black engineering societies, scientific societies. . . . I'm just not sure why, if it's an interest thing, or . . . I can't believe they wouldn't have the opportunities if that's the field they wanted to go into.[166]

Some interviewees did, however, say they witnessed disparate treatment of women and racial minorities.

This difference in perceptions could point to one reason the lack of diversity in STEM fields persists: The workers who hold the greatest number of STEM jobs and are the most likely to hold decision-making authority may not be acknowledging the severity of the problem—or that it even exists.

The Road to Advancement. For Todd B., a pocketknife was all it took to land his first job as a hunter education instructor with the state wildlife agency where he would make his career.

> They wanted somebody who has some experience hunting. They wanted some experience with firearms. They wanted some experience with running boats, and four-wheelers, and all of that kind of stuff. I grew up as a kid doing all those things, and I was hired by what I call the "old-school people."
>
> I remember the job interview. The guy who was actually doing the hiring took me outside. He said, "Let me see your

> pocketknife." And I thought that was kind of weird. I showed him a pocketknife, and he said, "Good and sharp." He said, "You got all the intelligence I need. I can train you to do the rest." He said, "As far as I'm concerned, you're hired." And we had to go back in and we had the HR person sitting there and all of these upper administration types that had to finish their interview, but the guy had already decided he was going to hire me.[167]

Todd B.'s experience illustrates two elements common to the narratives of workers successful in their careers: the presence of a mentor and access to on-the-job training. "I have just about every kind of certification anybody in my line of work would want to have," said Todd B. "I've never been restricted as far as, 'Hey, look, I want to go take this class or I want to get this certification.'"[168]

The kinds of serendipitous opportunities Todd B. experienced were reported by other White men (and some of the White women) interviewed for this report. Kurt E., who began his career as an entry-level operations technician at one of the major airlines, said he "was handpicked by the chief operating officer to be part of his little personal SWAT team of data scientists and software engineers" after writing some software applications on the side to improve the airline's efficiency. "That's when my managers and the managers above them and eventually the COO, it came to their attention that they had this person in the ranks who maybe was misplaced," he said. "Very competent as an operations manager, but maybe we can get better use putting him in a more STEM kind of position."[169]

Ultimately, Kurt E. ascended to the position of hub operations manager for Chicago's O'Hare Airport ("I had 75 gates, 500 flights a day," he said) and was tapped to devise analytical software for other hubs across the country. After his airline's bankruptcy left him unexpectedly unemployed in 2009, he landed a job two weeks later with a defense contracting company specializing in aviation, where he still works.

Jack H., the analytical chemist, retired as a civilian employee for the Army after serving as its director of health risk management. He was deployed around the world, became one of the Army's foremost experts on environmental hazards to US troops, and won a prestigious national

award for his contributions to public health. Training opportunities, he said, were plentiful. "You could get technical training to advance your career; you could get management training if you wanted it,"[170] he said.

He also had managers who supported his advancement. "When I went to the organization, it was very military oriented [with] very few civilian scientists in management positions, even low-level management positions," he said. "I was lucky that I got backing from enough high-level military people that I was able to move up."[171] He said he also looked for opportunities to bolster his experience.

> Some people are afraid to fail. They didn't want to take a chance, they didn't want to do that. So in a lot of cases, when something big came up, I got asked to do it. Whether it was to go to Kuwait and Saudi Arabia for the oil well fires, or when the chemical demilitarization program was shut down at a number of major installations, because they found PCBs in these rocket shipping and firing tubes that they were demilitarizing. So, "Oh, Jack, you can put together a team and go take care of it. Resolve the problem, get the program running again.". . . So I sort of looked for those projects, and got chosen for those projects, and always looked for the next big thing that was coming.[172]

Several of the interviewees attributed their own interests and success in STEM fields to strong family support and backgrounds in science. Christian G., the engineer who works in advanced manufacturing, said his father was a metals engineer who specialized in aluminum and was director of quality at several manufacturing facilities. "I always saw him bringing samples and analyzing things," he said.[173]

Aviation-focused computer scientist Kurt E., who said he learned how to program at age 9, described his father as "brilliant with anything scientific and engineering." "Maybe there's some DNA that came from my dad," he said. "I just had a knack for math and science, and any kind of engineering just came to me naturally."[174] His mother, he said, was the chief financial officer for a local chain of home improvement stores and also encouraged his interest in computer science.

> They were doing everything on paper in the early '80s. As a 10-year-old, I remember I prepared a sales pitch for my mom saying, these are all the advantages of going from paper to a computerized accounting system. My mom was totally sold on the idea, and she said, "Well, could you write some applications that would help me with my accounts payable, accounts receivable, and end-of-month reports?"
>
> And so at age 10, I started writing some applications for her. . . . She jokingly referred to me as her chief technology officer. . . . For a period of 10 years, from age 10 until age 20, I actually acted in that capacity helping out my mom's company with all of their accounting-related computer applications.[175]

Perceptions of Diversity in STEM. While some interviewees acknowledged the existence of "boys' clubs" and the relatively smoother glide path they enjoyed in their careers, the six White men interviewed for this report harbored complex—and sometimes self-contradictory—views on how race and gender affected the workplace.

Wildlife biologist Todd B., for instance, recognized that he had an advantage over other candidates when he applied for the hunter education job that was his entry point to his career. "We White males and at this point, White females, we grew up out in the woods hunting and fishing, and we love the stuff," he said. "I don't think minorities do as much. I think most of them are going to be in more urban-type environments and just don't have the exposure to the outdoors." He is also the adoptive father of two Black teenage boys, which he said was initially controversial in the small Louisiana town where he lives. "The rumors that went around, we would just come home at night and just sit down and start laughing," he said.[176]

At the same time, Todd B. said he believes concerns about racism have been overblown.

> When you have a fire and you let the fire burn down to nothing but an ember, when you start blowing on that ember, it's going to break out into a flame again. My opinion is if we stopped focusing on all the racism . . . if we just let it die down it would

> eventually go away. We are in America, we're in the greatest land in the nation, as far as opportunity. Results are not guaranteed to anyone, but the opportunity is. . . . I think we're headed in that direction. We just keep blowing on that ember. . . .
>
> I tell people all the time, "Look, you want to get rid of racism, turn the news off." I've got Black neighbors, I have some Black coworkers . . . and we have Black families in our church. We all get along great because we don't know that we're supposed to hate each other. We learned to hate each other from watching the news.[177]

Todd B. said he is especially skeptical of employer-mandated diversity training, which he said is unlikely to achieve its intended goals.

> We have certain online classes that we have to take on a yearly basis . . . and then we have to take sexual harassment training. . . . And it's like when we go through it, we all laugh about it, "Yeah, I passed. I'm good at sexual harassment now." And even the females I work with, it's the same way, we all look at this going, "Who comes up with this stuff? It's not realistic."
>
> It's very stereotypical. . . . The woman's always the secretary, and the boss is always the man. And he comes in and rubs her shoulder . . . that kind of stuff. It's like, "Good grief. We're all equal. We're all biologists."
>
> Look, I've been out in the woods with the ladies before, and they got to go pee . . . I know what to do. Walk over there somewhere and turn my back. That's the real world we live in, but those are not things that's covered on these training videos. . . . You don't have the White guy with a picture of a rebel flag in his office. . . . It's just like, "Come on guys. We don't do that stuff." It's like it was pulled out of the '70s and brought into 2020 to train us how to not be that way.[178]

The subtext of confusion and even resentment apparent from Todd B.'s comments was reflected in other interviews as well. Although on the one hand, interviewees recognized the lack of diversity in STEM fields (and in

their own offices), they largely denied that bias, discrimination, or prejudice were responsible for these outcomes. Ron L., who said "there were just a few Blacks and very few women" when he went to electronics school in the Navy several decades ago, said he saw no evidence of biased treatment.

"I don't think I have ever really been a person who would deny anybody any chance because of their race or color, creed, or sex," he said. "And I didn't think I really saw a lot of that. I didn't notice a lot of that while I was in the service."[179]

"I didn't see people, females, and the few minorities that were there held back," said chemist Jack H. "If you have the ability and the drive, people will see that."[180]

Computer scientist Kurt E., who worked in the airline industry, acknowledged that occupational segregation was a rampant phenomenon in the industry, at least in the past. "They definitely had a gender culture," he said.[181]

> If you were a man, you were either a baggage handler or a pilot. If you were a woman, you were a ticket agent or a flight attendant. . . . If you were a Black man, you would be a baggage handler, and if you decided you wanted to be a pilot, you would be a very small demographic.[182]

Nevertheless, he said he believed lack of education was a bigger barrier for some employees than race or gender.

> I definitely did witness people with diversity that were very capable but did not have the college degree. . . . I think a lot of times they would be bypassed because they didn't have the degree and there would be other candidates that did.[183]

He also said he believed the industry's diversity problems have largely been solved. "By the time I left [name of airline] in 2009, the number of African American pilots had gone up very significantly, the number of female pilots went up significantly,"[184] he said. (The Bureau of Labor Statistics reports that, in 2020, 3.4 percent of "aircraft pilots and flight engineers" were Black and 5.6 percent were female.[185])

Most interviewees said they would likely have achieved the same level of success had they not been White men. Engineer Christian G., who said there is only one female manager at his facility, said his industry's environment "is pretty macho . . . as far as the culture of manufacturing goes." Nevertheless, he said, "If my gender were different, I think I would have had the same opportunities."[186]

The sole exception was engineer Bob C., who said he doubted he would have his current job if he were female or Black.

> If I was a woman, I don't know that I would have been attracted to the field that I was, and I don't know that I would've even applied to an engineering school in the first place. In fact, I probably wouldn't have. . . . It just seems like it's not something that females are inclined to want to do.
>
> If I was a person of color, it would depend. . . . If it was purely just the color of my skin, but I still grew up in the same town, still had the same financial situation, I probably would have been just fine where I am. As a matter of fact, I probably would have been a preferred hire. . . . But, having said that, I don't think you can strictly just change color and leave everything else the same. There's culture differences. There's all kinds of changes that go on. Again, I don't think I would've wound up in the career path that I did. It probably would've been a much more blue-collar job, to be perfectly honest.[187]

Bob C. also said he saw a significant amount of sexism at the first company where he worked, though he also said he believes these problems have largely disappeared.

> When I started my career in the early mid '90s, to be perfectly honest, there was a perception that it was a boys' club. The president of the company—you were either in the boys' club or you weren't. If you weren't in the boys' club, they didn't hire you.
>
> I don't think that was necessarily true racially speaking, because we had a couple of engineers come through, Black male engineers, who were very good at their job. . . . I think for the

> females, it was a boys' club. The president was male and pretty chauvinistic. The vice presidents were pretty chauvinistic. That attitude I don't think still prevails in the industry, but at the time it certainly did.
>
> I never saw anyone say, "No, we're not going to hire any women," or, "Women are stupid," or anything like that. I think it was less direct than that. But the women that did work there were more in administrative roles and whatnot, and when they tried to get ahead, they had a real tough time doing it. If they wanted to do it, they had to leave the company.[188]

The vast gulf in perceptions held by White male interviewees and others in this report mirrors results from other surveys—including, as noted above, AEI's July 2020 poll—and reveals mismatched perspectives on the extent of racism and sexism in the workplace. AEI's survey, for instance, found that just 26 percent of White people think Black workers face more obstacles in STEM than in other fields, while only 34 percent of men say women face more hurdles to advancement (in contrast to majorities of non-White respondents). In Coqual's 2019 survey, 65 percent of Black professionals said "Black employees have to work harder to advance," while only 16 percent of White professionals said the same.[189]

These findings in turn reflect broader, societal disagreements about the persistence and pervasiveness of racism. For instance, a June 2020 analysis by Gallup found that 67 percent of White people believe that Black Americans "have as good a chance as whites to get any kind of job for which they are qualified"—compared to just 30 percent of Black respondents who agreed.[190]

Research also finds that White people and racial minorities are divided on the nature of racism as well. In a July 2020 NBC News/*Wall Street Journal* poll, 65 percent of Black voters (and 46 percent overall) said that racism is systemic or "built into American society, including into the country's policies and institutions." Forty-eight percent of White voters, however, said racism is not systemic but "perpetrated by individuals with racist views."[191]

These results hint at a potentially significant underlying cause for the lack of progress on diversity in STEM: disagreement on the extent of the

problem and its causes. Those who believe racism is largely the result of individual acts and behaviors are less likely to support structural reforms and more inclined to believe discrimination is aberrant behavior by a few "bad apples." Changing attitudes is also far more difficult than changing policies, which explains why tweaks in recruitment and hiring practices haven't succeeded in reforming the prevailing culture of STEM. Nevertheless, as the next section argues, the right policy changes can still accelerate the culture change badly needed in STEM fields if women and underrepresented minorities are to access the same breadth of opportunities that White men now enjoy.

Part III:
The Way Forward

The talent, productivity, and creative energy sacrificed because of STEM's diversity crisis is a heavy blow to America's economic competitiveness and its self-image as a land of equal opportunity for all. The interviews conducted for this report show that these problems are deeply rooted in hard-to-shift attitudinal biases and differences in perception about the causes and severity of the challenges that women and non-White STEM workers face. There are no easy policy fixes—and certainly no silver bullets.

Nevertheless, policy and structural change can support and nudge along the cultural shifts necessary to bring about real reform.

Structural Factors for Success

Despite the obstacles they described, the women and workers of color interviewed in this report still enjoyed numerous structural advantages that enabled their achievements. A majority had college-educated parents, for instance, and many had parents and family with backgrounds in STEM. None mentioned that advanced math and science curricula were unavailable at their schools. "I am blessed [that] my entire extended family is very well educated," said J. S., the veterinarian. "They are lawyers. They are school principals. They are engineers. The whole family."[192]

"My grandmother was a teacher," said agricultural scientist Leigh H. "My family is very big in education, so we didn't know there was any other option but to go and pursue a degree."[193]

Many reported their teachers, often also people of color, encouraged them. David B., the naval engineer, recalled that his high school geometry teacher pushed him to enter a minority engineering program for high

school students at Drexel University, which ultimately launched his career.

> He said, "You're a really good math student. I think you would like engineering." And he said, "There's this cool program." And I was a basketball player, and I was going to basketball camp that year. And he had said, "I want you to go and take the summer and go to Drexel in this program." And I'm thinking, "I'm going to basketball camp. I'm not doing that."
>
> And I do remember him being adamant. As a matter of fact, I believe he called my parents and said, "I know this is what he wants to do, but he needs to be in this program.". . . If it wasn't for him, I don't think I would have been [in] science and technology.[194]

Several interviewees mentioned the importance of having Black teachers and mentors of color. Although she attended a segregated high school in Mississippi, agricultural researcher Leigh H. said her experience nonetheless came with an unexpected advantage.

> We had primarily Black teachers, and they had certain expectations, because these were not just your teachers. These were your family's friends, you went to church with them, and they had certain expectations about what you can achieve. So they always pushed us.[195]

Leigh H. said she then went on to attend an HBCU, as did Carla A. and Lois T. Each woman said the experience was instrumental to her aspirations, because success was not unusual but expected. "That was big for me, because I went from a situation where I had primarily Black teachers [in high school] to a Black college," said Leigh H. "They expected you to do well, and they pushed you to do well."[196]

Some interviewees said that their employment in the military or the federal government was also a boon to their career, because the relative meritocracy of the military and the civil service system neutralized discrimination to some extent. "If you're good at what you do, or you've done it without complaints, they're just okay for you to keep doing that,"[197] said

veterinarian and animal scientist J. S. Naval engineer David B. said the Department of Defense was "quantitative" in the way it evaluated employees' performances, which worked to his advantage.[198]

> It was basically, "These are the things that you are responsible for." And when you had your review, you checked the box, you either did it or you didn't. . . . Other places might be . . . qualitative, and so your manager could say, "Yeah, you did that, but I don't think you did it as well as you should have."[199]

Policy Implications for Structural Reform

All these experiences hint at policy solutions that can shore up the structural supports available to underrepresented minority students and encourage their pursuit of STEM and career success. For instance, broadening access to higher education will mean that more children will grow up in households with college-educated parents, thereby increasing their odds of college completion. K–12 educational reform can ensure that all children have equitable access to advanced science and math curricula, such as AP, and that all children are equipped to succeed in these classes.

There are several other vital policy goals for structural reform.

Dramatically Increasing the Share of Black and Hispanic Teachers in STEM. While the share of female K–12 teachers in STEM has increased over the past two decades, there's been relatively little progress in the share of STEM teachers who are Black or Hispanic. According to research by Tuan Nguyen of Kansas State University and Christopher Redding of the University of Florida, just 6 percent of STEM teachers in 2012 were Black, and 6 percent were Hispanic.[200] Increasing the number of minority teachers in STEM would provide more minority students with the kind of role models and mentors interviewees for this report said they benefited from and have tried to be. In the case of Chicago math teacher Lois T., her influence was nothing short of transformational, as the following account relates.

> I had one young lady, she didn't live that far from me. I taught her geometry, and I was also her class advisor. She said, "Miss T.," she said, "I don't know what I really want to be in my life, but what I do know is what I don't want to do," she said, because, see, where I worked was the inner city, and most of the students [had] single parents, and they really didn't have anything. She said, "I know what I don't want to be.". . .
>
> She was the first person in her family to graduate from high school. I said, "I'll tell you what. If you want to make something out of yourself, I'll help you." She said, "Look, I want to go to college." I said, "Okay, I'll help you." I was the one who took her to college. Of course she was from a single parent. Her mother lived with a guy.
>
> They said, "You don't need to go anywhere." She said, "I don't want that. I don't want my life to be like that." She went to college, and she graduated from college. She has a master's degree. Her oldest child is in dental school. Her second child, he has graduated from college too, but he's going to medical school. He wants to become a doctor. Her youngest child is a sophomore in college. He's thinking in terms of going into the medical field. They're doing wonderfully well. To this day, every week she calls me at least once a week.[201]

But as it is, role models and mentors like Lois T. are too few. Agricultural scientist Leigh H. says when she visits high schools to talk about her job, "I first introduce myself and I ask them, 'Well, have you ever met a Black doctor?' And of course, nine times out of 10, they have not."[202]

Supporting HBCUs. At HBCUs and other minority-serving academic environments, interviewees said, the scrutiny and stereotyping that is the usual baggage of being a minority disappears. As one result, students are primed to excel. Research by Rutgers University finds that HBCUs are a potentially effective engine of upward income mobility, with two-thirds of low-income students eventually finding their way into the middle class.[203]

Black students attending HBCUs are also more likely to major in STEM than are Black students attending predominantly White institutions.[204]

According to UNCF, HBCUs graduate 25 percent of all Black STEM graduates, including nearly half of STEM degrees awarded to Black women.[205] Many HBCUs, however, have been struggling financially,[206] with as many as one in 10 financially fragile even before the pandemic.[207]

Pending relief may turn this around in the short term. HBCUs were set to receive about $3 billion in emergency funding from the recently passed American Rescue Plan. In May 2021, former New York mayor and presidential candidate Michael Bloomberg announced a $150 million gift to his alma mater, Johns Hopkins University, to spur partnerships with HBCUs and other minority-serving institutions aimed at growing the pipeline of Black and Hispanic PhDs. Both are crucial investments in the continued survival[208] of HBCUs, and policymakers should look for other ways to expand both public and private support for effective HBCUs.

Preserving the Role of the Military and the Public Sector as Engines of Upward Mobility. Numerous interviewees for this report (including three of the six White male interviewees) pursued careers in public-sector employment or the military, and several credited government service with providing them more opportunities than they might have had otherwise. Their experiences bolster the role of government service as an important avenue for career mobility.

For Black Americans in particular, government work has long been recognized as a source of economic stability and advancement. As Michael Madowitz, Anne Price, and Christian E. Weller write:

> Employment with numerous federal, state, and local government agencies throughout the 20th century not only offered a leg up to millions of Black families, but also became so identified with a path to the middle class that they hold cultural significance to many Black Americans.[209]

The US Postal Service, for instance, was one of the first organizations to hire large numbers of Black Americans during Reconstruction, and the federal government hires Black workers at significantly higher rates than the private sector does.

Today, nearly one in five Black workers is employed by the federal, state, or local government.[210] Likewise, the US military paved the way for broader societal desegregation when President Harry S. Truman ordered the military's integration in 1948.[211] One of Truman's executive orders declared "that there shall be equality of treatment and opportunity for all persons in the armed services without regard to race, color, religion or national origin"—a pronouncement that Purdue University Professor Cornelius L. Bynum calls "one of the most momentous steps toward achieving a more equal society" in the history of American civil rights.[212]

Given the public sector's outsized role in creating economic opportunity for marginalized populations, policymakers should consider the equity impact of proposals affecting the size of the federal workforce or privatizing governmental functions. They should also consider policies that could affect the military's commitment to diversity and inclusiveness.

Expanding Access to Career Counseling and Early Work Experience. For some interviewees, such as Laura M. and Artie S., access to school and career counseling and internships could have made a major difference in the trajectory of their careers. Neither interviewee had a clear sense of the career options available to them after college based on their choice of majors, early work experience that could have boosted their resumes or guided their career decisions, or support in finding their first job after graduation.

Voluminous research (including multiple publications by AEI) documents the value of work-based learning and early work experiences in ensuring that young people find a productive path through school and career. Research also finds that high school and college counselors can play an invaluable role in promoting college and career readiness, especially for lower-income students. Among other things, counselors can assist students with career exploration, course selection, college selection, and admissions and internship opportunities.[213]

Counselors are, however, in exceedingly short supply, leaving many students to make these crucial decisions in a vacuum. According to the American School Counselor Association, the national student-to-counselor ratio in public high schools was 424:1 in 2019–20 (compared to a recommended

ratio of 250:1). In some states, such as Arizona, Michigan, and Minnesota, student-to-counselor ratios exceed 600:1.[214]

Although many jurisdictions face ever-tightening budgets for K–12 and higher education, funding for college and career counseling must remain a priority, as should support for paid internships and other work experiences that can help a young person choose a career path and gain valuable experience. Especially noteworthy are technology-focused internship programs led by nonprofits such as Year Up, which provides yearlong supported apprenticeships for low- and moderate-income high school graduates in five technical fields, including IT[215] and software development. Year Up provides pre-internship training and support throughout an intern's tenure with a company. A 2018 evaluation found that the program increased participants' earnings by 30 to 40 percent four years after graduation, making it one of the most successful workforce development programs supported by federal dollars.[216]

Encouraging Educational Innovation to Combat Stereotypes. Many interviewees for this report blamed lack of "interest" for the low levels of diversity in STEM careers, but a growing body of research now finds that "STEM identity"—whether young people think of themselves as scientists—determines their pursuit of and success in STEM. Moreover, STEM identity is shaped early on through gender norms, race-based expectations, and other external forces.[217] "Occupational aspirations tend to be in line with identity, and gender is a very salient part of human identity," said sociology professor Maria Charles of the University of California, Santa Barbara.[218]

Stereotypes, STEM identity, and achievement are mutually reinforcing and self-fulfilling. Research confirms that when girls believe boys are "better" at math, girls are less inclined to be interested in math and less likely to do well in that subject. The strength of national-level stereotypes about math and science strongly predicts the male-female gap in science achievement,[219] according to a 2009 study. On the individual level, studies also find that students who identify with the sciences are more likely to do well in their studies on that topic—and that women are less likely to identify as scientists.[220]

Scholars like Charles argue that educators need to be more aware of the ways in which STEM fields are taught and portrayed so that stereotypes are

combated rather than perpetuated. This can come down to something as simple as the decorations in a science teacher's classroom. Posters for Star Trek and video games are apt to make middle-school girls less interested in subjects such as computer science, Charles says, whereas classroom decorations that don't play to stereotypes may not have that effect. Similarly, she argues, college websites might be able to attract more women to fields such as engineering simply by changing course descriptions and providing more information about what engineers do in a gender-neutral way. "Engineering is extremely collaborative but has the image of being asocial, which does not align well with stereotypes of women's nature," she said.[221]

Combating stereotypes is why Smith College, an all-female liberal arts school, launched an engineering program in 2004. The program now has about 40 students, double what it was at the start, but Director Andrew Guswa said growing the program is not the goal.

> The number of students that we are graduating is dwarfed by the number of women at, say, Purdue University, even if they're only 20 percent of the student body there. . . . It's more of taking a leadership position and saying, "This is an important field for women to be in."

Rather than crushing freshmen with "weed-out" classes designed to encourage dropout, the college accommodates students who enter the program who lack high-level prerequisites such as calculus. The faculty is predominantly female, and the curriculum is cross-disciplinary, incorporating a liberal arts perspective. "One of the things that's essential to good engineering is that it's not a purely technical skill," said Guswa. "You also need to understand the context in which you're working and the needs of the people for whom you're working."[222]

Pedagogical innovations like these, if adopted more broadly, could help attract more women and underrepresented groups into STEM fields and help them succeed. Over time, they could also help shift the culture of engineering and other fields by creating a new generation of engineers that is not only more diverse but more inclusive in its approach from the start.

Part IV:
Conclusion

Policy change will ultimately prove ineffective, however, if there is consistent and persistent societal resistance to the ideals of diversity, equity, and inclusion—and if private-sector leadership works to maintain its preference for the status quo.

The good news is that attitudes evolve. Progress is coming, even if its pace is slower than it should be. Engineer Bob C. said his perspectives shifted after he left the "boys' club," where he began his engineering degree, to join a medical device company, where he was one of the few White men. "It was a refreshing change," he said.[223] CEOs, he said, need to realize what they give up when company culture remains monolithic.

> You have to set the mentality that says, "Look, if we don't hire out of this group of people, we're missing some great talent. We're missing not only talented people, but a different perspective. If we only have White males in our organization, we're missing out on a whole different perspective on how to make some of these things work, technical or business wise.". . . There's so many great, valid perspectives out there that, just to have one, you're really missing out on things that could be making your company better.[224]

The tragedy is the breadth of potential abandoned on the sidelines in the meantime. Computer programmer John D. said he entered his current field because he was denied a chance to become a pilot for the military. A member of the Alabama Air Guard, he said he would have been his unit's first Black fighter pilot had his commanding officer not refused to recommend him for promotion despite performing well on all his tests. John D. said, "He says . . . 'If I have anything to do

with you, you'll never be a pilot.'"[225] The lost opportunity still haunts him.

> Since I was nine years old, I always knew I wanted to be a . . . military pilot. . . . It's almost like being a basketball star, or being on a team of the varsity. You can't substitute that type of feeling with just playing in the backyard with the guys. . . . I'm . . . 56 years old and always thought that the feeling will go away, but I still have that desire to do that. . . . It's something I have to take to the grave. . . . I don't know how far I would have went.[226]

Appendix

This report is based on 25 qualitative interviews conducted between November 15, 2020, and March 23, 2021. Twenty-one of the 25 interviewees also participated in AEI's July 2020 quantitative survey of workers with STEM degrees. Most interviews lasted roughly one hour and were conducted by phone or Zoom. Interviewees were asked similar sets of questions about their educational backgrounds and career trajectories, opportunities for training and advancement, and their experiences and perceptions about diversity in STEM.

Thirteen interviewees were women, including eight women of color; 12 were men, including six men of color. Fourteen interviewees possessed advanced degrees, while two interviewees held two-year degrees. Names have been changed in some instances or identifying details were omitted to protect interviewees' privacy.

Interviewee Profiles

- **Carla A., 40s, Black female.** Bachelor's degree in electrical engineering, master's degree in business administration. Worked as an engineer in IT and computer manufacturing; currently works as human resources manager for a law firm in Atlanta.

- **David B., 60s, Black male.** Bachelor's and master's degrees in mechanical engineering. Retired career civilian employee for the US Navy. Lives in eastern Maryland.

- **Todd B., 60s, White male.** Bachelor's degree in forestry with a minor in wildlife conservation. Works as a wildlife biologist for a state fish and wildlife agency.

- **Bob C., 50s, White male.** Bachelor's degree in interdisciplinary engineering and management, master's degree in business administration. Has worked in sales and engineering for advanced manufacturing and medical device companies. Currently works as a project manager at a manufacturer in Massachusetts.

- **Tiffany C., 30s, Asian female.** Bachelor's degree in English, University of California, Berkeley; master's degree in information science. Worked in IT and engineering design and is currently pursuing a doctorate in sociology.

- **LeeAnn C., 30s, White female.** Bachelor's degree in wildlife and wildland conservation, Brigham Young University. Currently a stay-at-home parent.

- **John D., 56, Black male.** Bachelor's degree in computer technology. Former high school math, science, and technology teacher for 17 years. Currently works as a computer programmer and software tester in Alabama.

- **Kurt E., 40s, White male.** Bachelor's degree in computer science. Former hub operations manager for a major airline. Currently works as a data scientist for a defense contracting firm in Virginia.

- **Christian G., 50s, White male.** Bachelor's degree in mechanical engineering, master's degree in business administration. Product manager for an advanced manufacturing firm in Ohio.

- **Jack H., 70s, White male.** Bachelor's degree in veterinary science, master's degree in entomology, PhD in invertebrate physiology, University of Florida. Career analytical chemist and material hazards expert for the US Army. Currently retired in the Washington, DC, metro area.

- **Leigh H., 60s, Black male.** Bachelor's degree in biology; PhD in horticulture, Auburn University; postdoctoral fellow, North Carolina State University. Works as a federal agricultural research scientist in Mississippi.

- **Terri H., 60s, White female.** Bachelor's degrees in geology and civil engineering. Recently retired as an environmental engineer and geologist in Alabama.

- **Karen L., 70s, White female.** Bachelor's and master's degrees in medical technology. Retired professor of clinical laboratory science in West Virginia.

- **Lonnie L., 50s, Asian female.** Bachelor's degree in computer information systems. Worked in IT support for 20 years in northern California. Currently looking for work.

- **Nicole L., 40s, White female.** Bachelor's degree in computer information systems, master's degree in business administration, former doctoral candidate in information technology. Worked as a lecturer for University of California schools and is currently an IT auditor for a state agency.

- **Laura M., 20s, Hispanic female.** Bachelor's degrees in biology and psychology. Currently pursuing a master's degree in data science at a university in California.

- **Sarah N., 50s, Black female.** PhD in chemistry, California Institute of Technology. Chemist and staff scientist working at a biotechnology startup in Silicon Valley.

- **Hector P., age not disclosed, Hispanic male.** Bachelor's degree in computer science. Works in server administration and end-user support for a small-to-medium-sized IT consulting firm in Virginia.

- **Michelle P., 50s, White female.** Associate degree in computer science. Works as a technical instructor of IT certification courses in Arizona.

- **Artie S., late 20s, Hispanic male.** Bachelor's degrees in biology and botany, Humboldt State University. Former lab technician for two

commercial laboratories in California. Currently lives in New Mexico as a full-time stay-at-home parent.

- **J. S., 50s, Black female.** Doctorate in veterinary science. Currently works as a veterinarian and animal science researcher for the federal government.

- **Fred B., 66, Black male.** Bachelor's degree in math with a minor in computer science. Worked as an independent consultant in telecommunications systems engineering for 20 years and is currently retired. Lives in New Jersey.

- **Mike K., 50s, Black male.** Bachelor's degree in electrical engineering. Worked as a software engineer and is currently an IT consultant working in northern California.

- **Ron L., 60s, White male.** Associate degree in computer programming. Worked as a programmer and computer operator for the US Navy. Retired small-business owner of a framing store in Missouri.

- **Lois T., 80s, Black female.** Bachelor's and master's degrees in mathematics. Retired high school mathematics teacher and administrator for Chicago Public Schools.

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