



# Increasing Women and Underrepresented Minorities in Computing: The Landscape and What You Can Do

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*Two experts on increasing women and underrepresented minorities in computing discuss the current landscape in academia and industry, presenting steps that organizations—and you the reader—can take to bring about changes to increase diversity and inclusion.*

**T**he excitement of technology is contagious. Technologies such as artificial intelligence, block chain, and edge computing promise to revolutionize our society and our lives. And yet technology creation still lacks significant participation from women, African Americans, Hispanics, Native Americans, and people with disabilities, who comprise well over half of the population. There is no question that diversity ensures increased financial performance as

well as more robust product offerings. As Paul Gomers and Silpa Kovvali noted with a study involving the venture capital industry, “Diversity significantly improves financial performance on measures such as profitable investments at the individual portfolio-company level and overall fund returns.”<sup>1</sup>

There are clear winners and losers with respect to participants in technology creation. Think of the technology geniuses you know—Bill Gates, Steve Wozniak, Steve

## TELLE'S STORY

As an undergraduate student, I arrived at the University of Utah committed to making a difference. It never occurred to me to consider a STEM field; in my life I was exposed to doctors and lawyers. It was only after my freshman year, desperate for advice, that I took an interest inventory test and found computer science (CS). This was in the 1970s, during the days of punch cards and massive computer systems (I used a Sperry Univac). But I found my passion. I graduated with a degree in CS from the University of Utah, and then went on to get a PhD. I loved the technology and I loved making a difference; but with 13 percent women at Caltech, I felt that I didn't belong.<sup>26</sup> For me, it was that desperate need for the community of other women that led me to partner with Anita Borg and found the Grace Hopper Celebration (GHC) in 1994. I relished my career in technology and was highly successful at a number of semiconductor start-ups, but I found nourishment and community through the volunteer work creating GHC. I worked in technology start-ups until taking over the Anita Borg Institute in 2002. I'd love to say that this is a story from the past, but my story is representative of many women's today. It is still true that students, especially women and underrepresented minorities, do not have exposure to

CS in high school. Those who do find their way to computing careers feel the isolation and lack of career advancement and leave—sometimes not only their organization but also the CS field.

I have lived and worked in Silicon Valley all of my professional life. I love the deep-seated passion in which many people create and launch new ideas. But there is this fundamental view of Silicon Valley as a meritocracy that simply isn't true for all participants. A few years ago, I met with the senior executive of a very successful Internet company. He told me, "I love our culture, it is a true meritocracy, and we just need more women." At the time, I was also aware of confidential feedback from senior and midlevel women at this same company who absolutely did not feel that it was a meritocracy for them. They did not feel heard, and they did not know how to advance. This exchange embodies the experience of many women and other underrepresented groups throughout the technology world. This common experience has led to women standing up and telling their story, including Ellen Pao<sup>27</sup> and many other female founders.<sup>28</sup> Today, women are finding their voice in many ways, including at GHC<sup>29</sup> and Richard Tapia Celebration of Diversity in Computing Conference,<sup>30</sup> but there is still much work to do. But change takes commitment and sustainable effort. It is not easy.

Jobs, Elon Musk, and so on. Do you see a theme? The movie "Hidden Figures" highlighted extraordinary contributions in history by African-American women, but today, most people don't know game changers such as Megan Smith, the first female US CTO; Fran Allen, the first woman to win the ACM Turing award; Diane Greene, the

cofounder of VMware; Marc Hannah, the cofounder of Silicon Graphics; or Ann Gates, Department Chair in computer science (CS) at the University of Texas at El Paso (UTEP) and founder of the Computing Alliance of Hispanic-Serving Institutions (CAHSI).<sup>2</sup>

Today, the demographics of undergraduate CS degrees at nonprofit

institutions sit at 20 percent women, 8.3 percent African Americans, 11 percent Hispanics, and 0.4 percent Native Americans.<sup>3</sup>

We want all people at the table creating technology.

In both of our own stories (see the sidebars, "Telle's Story" and "Valerie's Story"), you see themes that are still

### VALERIE'S STORY

I took my first computer science course when I was in high school. At that time, 1979, my high school provided access to a mainframe computer that was owned by the local hospital for billing purposes. Once a week, we were able to run our programs on the computer using punch cards. I excelled in my first programming course on FORTRAN, as I was intrigued by programming logic. I attended an all-girl high school, and was one of only two African Americans in the programming class.

Once in college at Purdue, I initially selected chemical engineering as my major because of broad exposure to this field while participating in summer engineering programs. Although I enjoyed programming, I did not consider this an option at first. Upon taking my first college-level programming course during my freshman year, I felt confident in my programming abilities because of my positive experience in high school. I found, however, that many of my peers had no programming experience. After my freshman year, I changed my major to computer engineering. Even today, it is important to allow those who have had little exposure to computing to find the discipline.

In many of my classes, there were only a handful of African Americans. By the time I was in

graduate school, I often had classes where I was "the only"—the only African-American woman, the only African American, or the only woman.

When considering faculty positions, I chose Northwestern University in part because there was an African-American woman faculty member in the Department of Electrical Engineering and Computer Sciences. It was wonderful to be in an environment with another African-American woman. As a faculty member, I recognized the obvious and urgent need for community among the students and faculty from underrepresented groups. I attended the first GHC in 1994 and helped organize GHCs in 1997, 2000, and 2002. These experiences with the Hopper Conference resulted in Bryant York, Cynthia Lanius, Ann Redelfs, and I launching the Tapia Conferences, with the first one held in 2001. In addition, Bryant York, Richard Ladner, Ron Eglash, Ann Gates, and I formed the Center for Minorities and People with Disabilities in IT (CMD-IT, pronounced "command it") to increase participation in computing from the target groups—African Americans, Hispanics, Native Americans and people with disabilities—and to explore innovation that gives back to the communities.<sup>22</sup> CMD-IT is now the presenter of the annual Tapia Conferences.

true today for many computing participants from underrepresented communities. For women, there is still a sense of not belonging. But for African Americans, Hispanics, Native Americans, and people with disabilities, where the numbers are incredibly small, it is even worse. Although there is significant investment in increasing

the participation of students from underrepresented groups, as we will discuss, the isolation that both of us experienced has not gone away. The feeling of not belonging or of being "the only" remains true for many of us even after significant time and work. It is time for all of us to stand up and commit to real change.

A sea change is happening now, and we are excited about the potential for transformation. Having said that, change requires persistence and a sustainable commitment. It is still too early to know whether these changes will stick. Some universities are creating change within their undergraduate classes to be more inclusive of a

diverse student population. Universities such as Harvey Mudd (which increased its percentage of women baccalaureate graduates in CS to 40 percent in 2015 from 12 percent in 2006), University of Maryland, Baltimore County (which increased its percentage of African-American baccalaureate graduates in CS to 15 percent in 2015 from 11 percent in 2006), and Texas A&M University (which increased its percentage of Hispanic baccalaureate graduates in CS to 22 percent in 2015 from 6 percent in 2006) are seeing positive outcomes from making changes.<sup>3</sup> But what will these students face as they graduate and take jobs in industry or pursue graduate school? Is the culture they will encounter truly welcoming? One way to measure the change is to look at the numbers. What you measure you will change.

In industry, the percentage of entry-level technical women is 26 percent; the percentage of underrepresented minorities is worse: 8.3 percent African Americans and 6.3 Hispanics.<sup>4</sup> In contrast, according to 2017 Census data, the US is 50.8 percent women, 13.4 percent black or African American, and 18.1 percent Hispanic or Latino.<sup>5</sup> Do women and underrepresented minorities stay with a given company after entry? The Anita Borg Institute Top Company report from 2017 shows an increase in technical women at the midcareer and executive levels over the last two years for the 63 participating companies, but the numbers are still small.<sup>6</sup> Although we have seen increased participation in entry level to 28 percent, the numbers at the executive level are still only 15 percent. The deeply held belief that this is because women leave when they have children is not true. Women leave because they feel isolated and do not see a path to

advancement. Change is not easy, but continuing commitment results in benefits too numerous to count.

## WHAT CAN YOU DO?

The following sections describe some of the important work that is happening today to change the trends. We start with primary and secondary education, and then cover postsecondary academic institutions and industry organizations.

### K-12

K-12 is an important time for creating change. Several organizations have made profound changes in high school and have increased middle school student's access to computing education. Among the organizations that provide important programs are Code.org,<sup>7</sup> Girls who Code,<sup>8</sup> Black Girls Code,<sup>9</sup> the National Center for Women and Information Technology (NCWIT) Aspirations award winners,<sup>10</sup> and the Level Playing Field Institute's SMASH program.<sup>11</sup>

These efforts have had an impact. In just a few years, the national conversation has changed to one that focuses on computing as a valued discipline. CSForAll is a national consortium working with state and city education systems to provide resources, with the goal of providing quality CS education to all children.<sup>12</sup>

What do these young aspiring students face when they cross the chasm into the workforce? As the excitement of creating technology takes hold of these students, will they enter organizations where the isolation does not dominate them? The jury is still out.

### Corporate organizations

For almost all corporate organizations, diversity is a focus area. Corporate

executives understand the business case for diversity and inclusion. Although many companies have activities focused on diversity, often we see activity without results. To create true change at an organization, one needs to focus on results, and commit to changing the culture and environment to be welcoming to all.

Deploying practices in a systematic and measurable way *will* result in change. Of course, companies need to first recruit a diverse entry-level workforce. Both the Grace Hopper Celebration and the Richard Tapia Celebration (see sidebars) provide platforms to recruit students from underrepresented groups. But if a company doesn't understand that retention and advancement are key, it will ultimately lose much of its new talent. The following practices can—and will—result in overall cultural changes.

**Hold leadership accountable.** For any organization that embarks on true change, two of the most critical factors are support from the top and a way to measure change. What is most important is the clear, vocal support of the CEO and senior leaders. With this support and the CEO's commitment to being accountable to change, organizations can diagnose where problems occur, and then deploy targeted programs to address the areas where there is loss of employees, or where advancement is not occurring. The Anita Borg Top Companies program provides a set of metrics that measures the technical workforce at the entry, mid, senior, and executive levels; there are also other metrics that organizations have adopted. Many successful companies tie senior executives' bonuses to positive change within their technical workforce.



**Evaluate the effectiveness of diversity and inclusion initiatives.** Many organizations have created diversity and inclusion programs. But it is easy to get caught up in feel-good programs that ultimately result in little change. The single most important approach an organization can adopt is to define clear diversity and inclusion goals and evaluate the programs according to these goals. For example, women's networks are very popular in organizations, and there is often nothing more satisfying than getting to know key role models at these networking events. It is inspiring to meet the female senior vice president who is obviously one of the new thought leaders at the organization, or to have a conversation with the black executive who has taken on one of the most strategic initiatives at the company. But if your company is investing in these networks, you want to ensure that the content at the monthly meetings feeds into programs that result in higher promotion rates for the underrepresented groups participating. Mandatory diversity and bias training have also become very popular. In their *Harvard Business Review* article, Frank Dobbin and Alexandra Kalev indicate that often there is poor return on popular diversity programs, whereas other diversity programs result in increased representation in managers.<sup>13</sup> The best companies ensure that they are measuring the outcomes of their programs.

**Diagnose bias in hiring and promotion practices.** A common diversity and inclusion activity at many companies is to deploy bias training for all employees. Although bias training can provide an "aha" moment for participants, onetime training does not

result in cultural change. But applying the same bias diagnosis to the ways in which a company hires and promotes can result in significant change. For example, some companies have analyzed the language of their job descriptions and revised it to be more neutral.<sup>14</sup> Further, organizations have evaluated and changed where they recruit, resulting in increased participation from women and underrepresented minorities. One of the most significant changes that an organization can make is to evaluate promotion practices. Using the diagnosis tools mentioned above, it is possible to pinpoint where the organization is losing people and evaluate the pipeline. Once it has the diagnosis, the company can deploy targeted development programs to extend the skills of a broader set of employees in the pipeline, as well as add processes to the ways in which key assignments are made and increase the participation of a broader set of employees in these assignments.

**Develop leadership programs that rigorously adhere to performance and minimize inherent biases.** Many organizations see significant positive results by creating leadership development programs that are tied to the organizations' overall goals and accountability. When designing and deploying leadership programs, it is important to ensure that the skills participants are developing adhere to the skills that result in being promoted. As one example, an organization found that many of their employees who remained on the technical track needed more practice presenting their key ideas to a technical audience. This organization deployed a training program focused on how to command respect and articulate technical

results to a technical audience, and over a number of years, increased promotions among women on the technical track.

**Work together on change.** Ultimately, change happens when an organization's leadership decides that change is a priority. Efforts to increase the participation of all people often build on networks of women and/or underrepresented minorities. But to create true change, it is important to engage with all leaders. Many people are committed to creating change but need understanding about effective participation. It is often difficult for majority leaders to understand the experience of minorities. However, many successful programs have been developed to expose all people to others' experiences.<sup>15</sup> The experience of walking in another's shoes can create a profound cultural mind shift. For example, GHC is 95 percent women. For the 5 percent men who attend, many walk away with a much deeper understanding of their female colleagues who work in an environment in which they are a minority every day. At the Tapia Conference, for some white male attendees it is an eye-opening experience to listen to the stories of minority students and professionals. A first step is realization, but a subsequent step is to use their newfound knowledge to support programs such as those described above for hiring, development, and promotion processes to address inherent biases. But, you might be asking, what can I do today? Simple changes such as ensuring that for any meeting you lead all participants are heard and given credit for their ideas can result in behavior change.

In summary, creating organizational change is possible, but it is

critical to design programs that are based on a set of goals and that have accountability at the heart of everything done. Ultimately, change does not occur unless the culture evolves into one that is welcoming to all and encourages all to thrive.

Resources and practical advice are available from organizations such as NCWIT,<sup>16</sup> the Clayman Institute on Gender Research,<sup>17</sup> the Kapor Center for Social Responsibility,<sup>18</sup> Project Include,<sup>19</sup> and the Anita Borg Institute.<sup>20</sup>

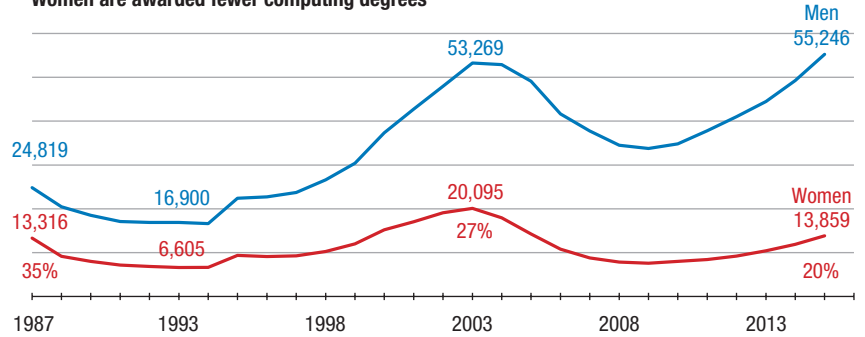
### Postsecondary academic institutions

Enrollment of CS undergraduate students has exploded in recent years as the attractiveness of the major becomes better understood by the broader community—CS is where the jobs are. But there is still a lack of participation among women and underrepresented minorities. Figures 1 and 2 illustrate national participation of women and underrepresented minorities in computing education.

But there is huge variance across academic institutions. Some, by carefully managing their approach, have made a substantial difference in their undergraduate degree production. For example, in 2015, 40 percent of the baccalaureate CS degrees awarded by Harvey Mudd College were to women and 15 percent were to Hispanics. Likewise in 2015, women represented 30 percent and Hispanics 22 percent of CS degree recipients from Texas A&M, College Station; and the percentage of black CS graduates from the University of Maryland, Baltimore County, grew to 15 percent.<sup>3</sup>

What makes a difference? The BRAID (Building, Recruiting, And Inclusion for Diversity) initiative builds

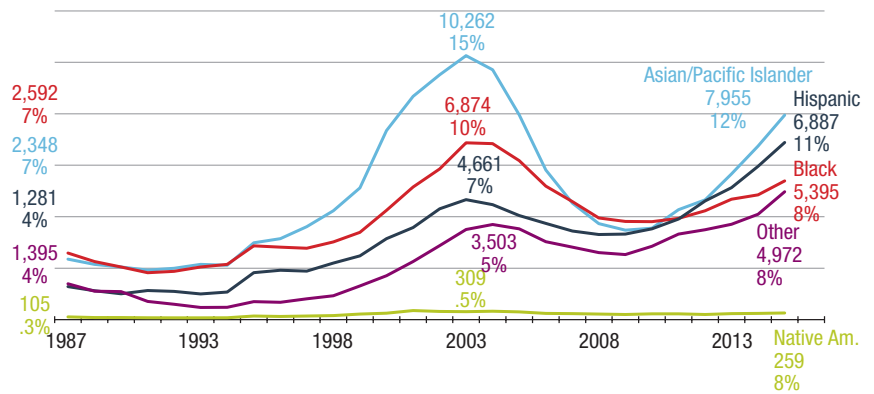
Women are awarded fewer computing degrees



Source: IPEDS data as tabulated by the UCLA BRAID Research team. Learn more at [braid.gseis.ucla.edu](http://braid.gseis.ucla.edu).

FIGURE 1. Number of bachelor's degrees in computing awarded in the US, by gender (1987–2015).

Significant variance in degrees by race



Source: IPEDS data as tabulated by the UCLA BRAID Research team. Learn more at [braid.gseis.ucla.edu](http://braid.gseis.ucla.edu).

FIGURE 2. Number of bachelor's degrees in computing awarded in the US, by race/ethnicity (1987–2015).

on strategies that worked to increase participation at 15 universities. The following BRAID strategies have been shown to make a difference.<sup>21</sup>

First, modify introductory CS courses to make them more appealing and less intimidating to underrepresented students. The first courses in CS are often students' introduction to the

discipline. Students arrive with different levels of programming experience; this is particularly true for women and underrepresented minorities. Exposure to new ideas as well as to the superior experience of other students can be intimidating. By segregating the initial classes according to skill level, both new and experienced students

have a more satisfactory experience. In a relatively short amount of time, the classes can be combined.

Second, lead outreach programs for high school teachers and students to build a diverse pipeline of students. By diversifying where students come from, institutions can often reach more diverse students. This is especially true for state universities, whose students typically enter from state high schools.

Third, build confidence and community among underrepresented students. Underrepresented students often feel isolated within a school environment. Many universities take their women students to GHC and their underrepresented students to the Tapia Conference as a way to both build community among these students and expose them to role models. This approach has demonstrated success over many years.

Finally, develop and/or promote joint majors in areas like CS and biology that are attractive to underrepresented students. We have found that joint majors are appealing to a broader group of students. Many universities increasingly allow students to pursue joint majors and are making this path easier.

In 2017, CMD-IT launched the University Award for Retention of Minorities and Students with Disabilities in Computer Science.<sup>22</sup> The award is based on qualitative data about the description of the programs and qualitative data about student retention over the past five years. In addition to the BRAID recommendations, CMD-IT offers further recommendations for corporate and peer-mentoring programs, which provide support and guidance to students throughout their academic careers as well as providing role models.

Change at universities is often slow, but it can be done. The NCWIT extension services program offers universities a chance to understand where their needs are and to systematically change their culture.<sup>16</sup> Recently, the American Association for the Advancement of Science (AAAS) launched SEA Change, a program to create institutional systems that improve the outcomes and opportunities for underrepresented and underserved groups in STEM. Under the new program, educational institutions commit to removing barriers to STEM achievement for women, minorities, and people with disabilities through participation in a program of voluntary self-assessment.<sup>23</sup>

The National Science Foundation Directorate for Computer and Information Science and Engineering has supported a set of Broadening Participation in Computing (BPC) Alliances, which create good practices and educational resources to increase diversity in computing. The current NSF BPC Alliances are AccessComputing, CAHSI, Expanding Computing Education Pathways (ECEP) Alliance, Institute for African-American Mentoring in Computing Sciences (IAAMCS), Into the Loop, NCWIT, STARS Computing Corps, and Sustainable Diversity in the Computing Research Pipeline.<sup>24</sup>

The CMD-IT FLIP (Diversifying Future Leadership in the Professoriate) Alliance brings together the very small number of departments (11) responsible for producing the majority of professors with individuals and organizations that understand how to recruit, retain, and develop students from underrepresented groups to create a network that can quickly change the diversity of computing's professoriate. A more diverse professoriate can increase diversity across the field


of computing. Diversifying the PhD students at these top universities will ultimately lead to increased diversity of faculty at many universities, further impacting student diversity.<sup>25</sup>

As with industry, change requires leadership support from both the department chair and university-wide administration. It is important to have goals. All of these programs provide frameworks within which institutions can work toward their desired goals.

**T**oday, there has never been so much interest from universities, corporations, and individuals in creating meaningful change. We want all people at the table creating the technology that is changing our lives. The good news is that *we know what to do to create change*, and many institutions—both in academics and industry—are adopting these practices, creating cultures and environments in which all people can thrive.

And yet, after years of investment, the isolation and sense of being “the only” still exist for many of the brilliant students and young professionals entering today's computing work force. This is especially the case for the many who ultimately decide to opt out of computing. So we need your help!

We hope this article encourages readers to engage in a national dialogue about effective practices that create cultures and environments in which all people thrive. In particular, we challenge you to provide information about your effective practices at the following URL: [increasediversitycomputing.org](http://increasediversitycomputing.org).

We will share this information at town hall meetings at the Tapia 2019 and Hopper 2019 conferences to promote this national dialogue. Stand up and make a difference! 

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