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It's not just about being fair.

BY BERYL NELSON

The Data on Diversity

PEOPLE WORKING TOGETHER can achieve more than they can alone; this is a fundamental principle upon which organizations are founded. Social scientists have shown that teams and organizations whose members are heterogeneous in meaningful ways, for example, in skill set, education, work experiences, perspectives on a problem, cultural orientation, and so forth, have a higher potential for innovation than teams whose members are homogeneous. These findings are not without controversy, yet the implications for the computing industry are profound, given the relative homogeneity of the field along a few important dimensions. Take, for example, the composition of degrees awarded in computer science, computer engineering, and informatics in 2012 at research institutions in the U.S.

- 13.3% of BS degrees, 28.7% of MS degrees, and 19.2% of Ph.D.'s were awarded to female candidates, down from a high of 37% of BS degrees in computer science in 1986.
- 5.3% of BS degrees were awarded to African American candidates, as were 2.7% of MS degrees, and 2% of Ph.D.'s.

Among computing professionals, about 20% of CS faculty in U.S. universities are women, and 1.6% are African American.[50] Similar numbers exist in industry.

Diversity, bias, and stereotypes have traditionally been discussed in very relativistic terms: surveys of whether people thought there was bias, and so on. In recent years, imaginative researchers have developed ways to gather quantitative data about the benefits of, as well as the challenges to, having a diverse workforce. This article explores the benefits that diversity can bring to teams, and the cognitive factors—namely, stereotypes based on social group membership—that keep us from achieving optimal levels of diversity.

Benefits of Diversity

Diverse teams are more effective: they produce better financial results and better results in innovation. These results show that having a diverse organization is a business imperative.

» key insights

- **Teams and organizations whose members are heterogeneous in meaningful ways have a higher potential for innovation than teams whose members are homogeneous.**
- **Social science experiments using quantitative methods show bias, stereotype threat, and methods to combat them.**
- **Effectiveness of diverse teams depends on trusting and supportive cultures. Data publication is one of the most important tools to identify and combat identity threat and biased decision making.**
- **There is hope! There are tools that have been shown to combat bias and identity threat effectively.**

ILLUSTRATION BY SARAH HANSON

Financial results. Organizations that include a high percentage of women in senior positions show better financial results.

Companies in the top quartile for women in the executive committee from 2007–2009 had 41% greater return on equity, and 56% greater earnings before interest and taxes than companies with no women in the executive committee, for companies within the same industrial sector (see Figure 1).[15]

Financial results for companies with at least three women serving on the board of directors are better: in 2007, return on equity was 16.7%, as opposed to an average 11.5%; return on sales was 16.8%, as opposed to an average 11.5%; return on invested capital was 10%, as opposed to an average 6.2% (see Figure 2).[26]

This is also true in other geographies. Profits of Indian companies headed by women grew 56% within five years, but grew even faster, at the rate of 64%, within three years.[33] The BSE-30 companies posted a growth rate of 27% and 23%, respectively, during the same period.

Similar results have been found for race: organizations with greater racial diversity were associated with greater sales revenue, a larger number of customers, greater market share, and greater profits. In the same study,

greater gender diversity was also found to be associated with better results in sales revenue, number of customers, and profitability.[23]

These studies are correlational: causation can be inferred, but not proven. Researchers have posited that diversity may actually be one causal determinant of firm performance due to the increased innovation that occurs when organizations are diverse. The next section reviews this evidence.

Figure 1. Women at the top of corporations: Making it happen. Courtesy of McKinsey Report.[15]

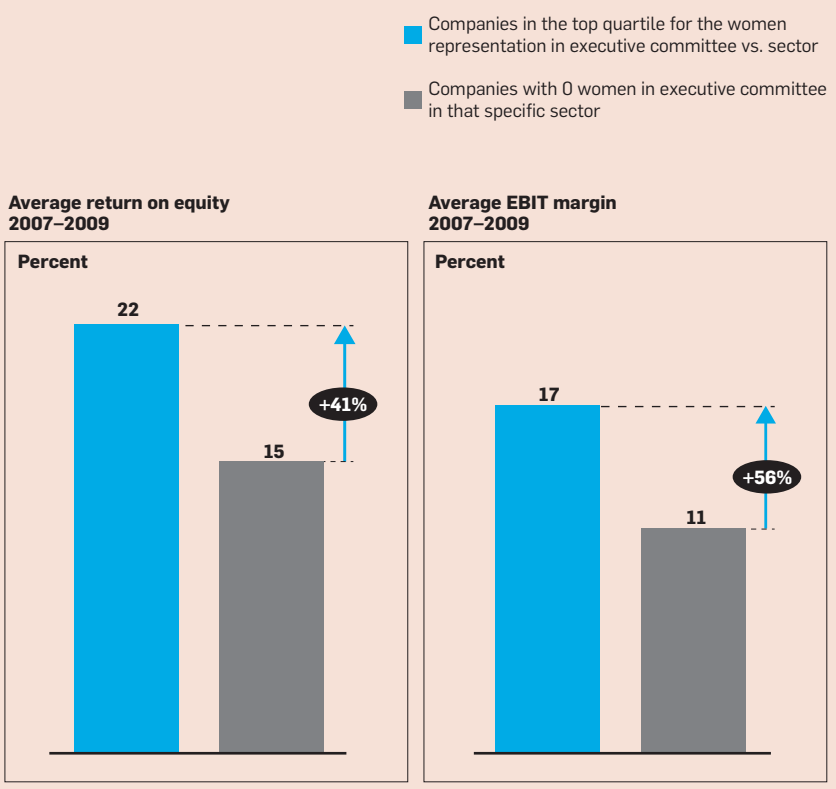
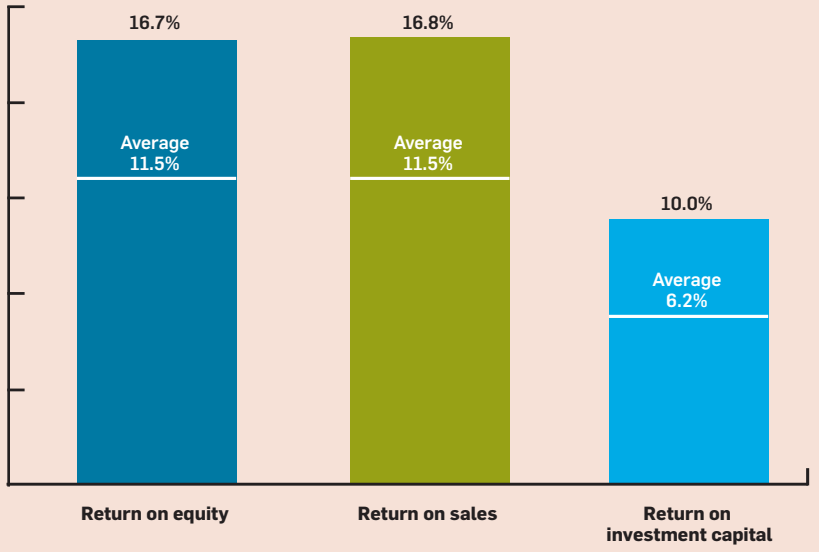


Figure 2. Financial performance at companies with three or more women board directors (WBD).



Courtesy of Catalyst Report[26]

Innovation. Diversity has been shown to create a cognitive and social environment that is a positive indicator for innovation and a negative indicator for routine tasks. These dynamics may have real-world consequences for scholarship in our field.

In a study of collective intelligence and creativity, researchers gave subjects aged 18 to 60 standard intelligence tests and assigned them randomly to teams. Each team of 3–5 people was asked to complete several tasks, including brainstorming, decision making, and visual puzzles, and to solve one complex problem that was too difficult for one brilliant individual to solve: that is, a team was required. Teams were given intelligence scores based on their performance.

The only predictor of team collective intelligence was whether there were women on the team. Note that all the high-scoring groups are close to 50% women; some of the low-scoring teams are also near 50%, but the groups with little gender mix did not score as highly. This was a surprise result to the researchers. With more investigation, it was found the difference was having the social skills that made it possible to use the contributions of all the team members, and these correlate more with women than with men. Figure 3 illustrates the relationship of team composition to success.[48,49]

Patent authorship is another area that shows a benefit of diversity. More than 90% of all computer technology patents issued in the U.S. since 1980 have been granted to men only. Yet mixed gender patents are cited 26% to 42% more than any single gender patent.[4] An update to this report in 2012 showed that mixed gender patents typically have a large number of authors. The higher citation rate (30% to 40% more in the 2012 update) is associated with higher numbers of authors. The reasons for this are not well understood.

These results show a correlation between diverse organizational composition, financial success, and innovation. While there is not a clear causal relationship shown between diversity and success, the results have been

shown with varying methodologies and in varying geographies, to a degree that demands attention.

Challenges Faced by Diverse Teams

Unfortunately, it is not easy to make diverse teams effective.[a] There are a number of forces that work against the desired effect: having the entire team productive. There can be potential negative effects of any of the following:

- unconscious bias,
- stereotype threat,
- exclusion from critical social networks,
- lack of role models, and
- unaware managers.

The following sections address primarily unconscious bias and stereotype threat.

Unconscious bias. One of the factors that both limits the diversity present in a team or organization, and that inhibits the potential success of diverse teams, is the unconscious bias, that is, stereotypes, that we hold toward people based on the social groups to which they belong. Stereotypes are, simply, a constellation of traits, characteristics, skills, and values that we ascribe to members of social groups, such as gender, race, age, religion, nationality, and others. These are learned through cultural messages and stories, comments from family and friends, portrayals in the media, and so forth. These stereotypes, despite our best intentions, can bias our impressions of, and affect our actions toward, others in our environment. The stereotypes especially relevant in work situations include those characteristics that are visible, such as sex, race, weight, and age; but also those not visible but relatively easy to discern, such as educational background and nationality.

Project Implicit at Harvard hosts an online test of implicit associations: the user's implicit association between two concepts is measured via user response time. There are reports for many associations, and the results are stunning.[5]

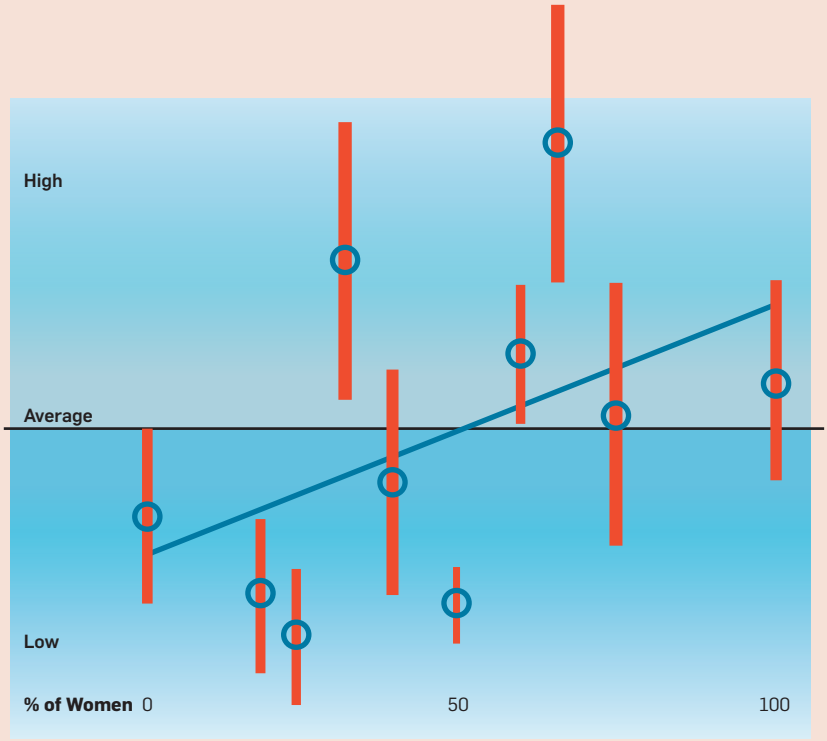
- Almost everyone has measurable biases (for example, 70%–80% have biases against women in technology, or preferring white to African American, or preferring young people).
- Almost no one reports such biases (for example, 15% report a preference for white people).
- Even the people who are the subject of a bias may have that bias. For example, I tested as moderately biased against women in science and technology, and this is totally against my self-interest.

The book *Blindspot*[5] explains the development of the implicit association test and its results, exploring the reasons for differences between unconscious perception and our assumptions. For example, it has been found that age is one of the strongest biases tested; this is true even among the elderly, and in societies in Asia that traditionally have valued the wisdom of age and experience.[5] *Blindspot* also considers the evidence for any predictive link between measured biases and outcomes or behaviors; results are not yet conclusive in this area.

In individual cases, bias can be very difficult to verify. In aggregate, however, bias and other forms of unconscious decision-making are readily apparent:

- About 58% of CEOs of Fortune 500 companies are taller than 6ft. (about 183cm), and almost a third are taller than 6ft. 2in. (about 188cm). In the population in general, about 14.5% are taller than 6ft., and 3.9% taller than 6ft. 2in.[17] Most people would not believe height predicts competence, and yet, these choices are frequently made. In fact, height is strongly correlated with career success.
- In a laboratory situation, applicants were seen in the waiting room either alone, or sitting next to another applicant. Applicants who were seen sitting next to an overweight applicant were less likely to be hired than an applicant sitting alone or next to an average weight applicant,

Figure 3. Collective Intelligence vs. Team Composition.



The horizontal axis indicates team composition. The blue circles represent averages for each percentage level; the red bars indicate standard deviation. Courtesy of Woolley and Malone.[49]

a Many studies referenced here refer to women, but these results should largely be considered to apply across all axes of diversity; for example, gender, cultural and national origin, sexual orientation, age, educational background, religion, and other life experiences. It is more difficult to study differences that are not externally visible, such as differences in economic class, than visible differences like gender or race, but these less-visible differences are also important to consider in conversations about diversity.

and regardless of their own weight.[46]

▸ In an examination of data on wages of a given population over the course of five years, it was observed that there is a correlation between weight and income: for women, this is a negative correlation; for men, a positive correlation, excluding obesity.[27]

▸ A disturbing finding is that African Americans and other minorities receive less effective healthcare interventions and outcomes, even when controlling for socioeconomic class and insurance coverage.[5]

▸ At a coffee station at a company in Northern England, the sign for the amount to pay for milk (to put in tea or coffee, on an honor system) had a photo of flowers or eyes on alternate weeks. The amount of money received was about double in the weeks with eyes over the weeks with flowers. And if the eyes were looking directly out, the amount received was much higher; see Figure 4. Although their behavior was apparently heavily influenced by the photos, at the end of the trial, no one remembered the photos changing.[7] Clearly, there was unconscious decision making in each of these cases, but the data alone does not give tools to overcome bias.

Science faculty at respected U.S. research institutions show measurable bias toward male students: the faculty were given applications for lab manager that varied only in the gender of the name. Male students were rated significantly more competent, and were given higher average salaries and more mentoring opportunities than women students. Importantly, even the female faculty showed this bias.[32] Male faculty offered $30,520.83 to male students on average, and $27,111.11 to female students. Female faculty offered $29,333.33 to male students on average, and $25,000.00 to female students.

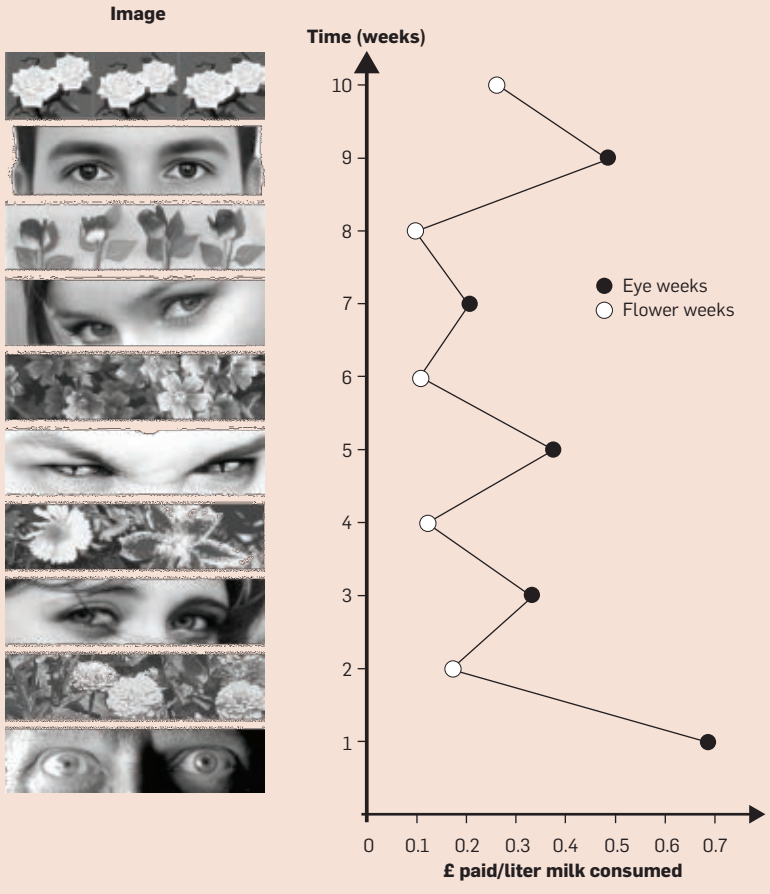
Shankar Vedantam explains the bias illustrated in these examples by saying that we create a set of mental shortcuts, or heuristics, for the situations we experience every day, and that we actively work against those biases for the most part, to the extent we think the bias is not "good." For example, you see very small children, as well as people with dementia, expressing strong bias; or politicians may make a slip of the tongue when they are tired.[46]

Until this point, I have been describing the stereotyping process as a negative force for individual and team functioning. However, this process actually stems from an adaptive, often functional psychological process. Mental heuristics and cognitive shortcuts enable us to process information without conscious deliberation: they fill in the informational gaps we often experience when making decisions. In other words, habits of mind help us to save brain power for more difficult tasks. Joseph Pieper's classic *Leisure, the Basic of Culture*[35] sets out this theory well. In the 1980s, people thought we could create expert systems by interviewing experts like brain surgeons or oil exploration specialists, and creating a rule chaining prolog environment that would recreate their decision-making ability. The problem was the experts did not know how they knew what they knew. That is, experts are creating associations between disparate experiences and pieces of knowledge, using the subconscious brain. In software development, we see this in our most skillful engineers: they can debug a complex problem, but they will probably not be able to specify a set of rules that would work as well as consulting the expert.

What it does say, however, is that we should have better knowledge of our own biases and unconscious decision-making.

Stereotype threat. In *Whistling Vivaldi*,[47] Claude Steele published a history of research about stereotype effects and identity threat. The original problem he tried to solve was, why were college entrance scores not predictive of college success for African Americans? Steele asserts we each have multiple identities (such as I am a woman; I am an MIT alumna; I am American); and that we respond

Figure 4. Coffee station pictures and money collected. Courtesy of Bateson et al.[7]



to the identity under threat. He says, "Being threatened because we have a given characteristic is what makes us most aware of being a particular type of person." In Steele's terminology, each of these identities can have what he calls "identity contingencies;" each of these contingencies can be positive, neutral, or negative in a given social situation.[47]

Based on research into this and other areas, including the success of girls and women in science and math, it has been established that when someone is confronted with a situation that is consistent with a stereotype, and that stereotype places his or her identity with a negative contingency, and if the person cares about this, then performance suffers. For example:

- Girls perform as well as boys in math tests when there is no stereotype threat, but significantly worse when there is high stereotype threat.[39]
- It starts young: Girls aged 5–7 show worse performance on a math test if they first color a picture of a girl holding a doll, compared to coloring a picture with an Asian child eating with chopsticks, or a landscape.[2]
- Women do well at math tasks if told that women do well at these sorts of exercises, or if they read about successful women before the test.[30]
- White men perform worse in math when reminded of the Asian math stereotype.[3]
- Black men perform better than white in athletics ability tests.[42]
- But worse if the problem is presented as a problem of "sports strategic intelligence."[42]
- Note that the stereotype does not have to be explicitly mentioned for the effect to be felt.[40]

People in general do not report they are under stereotype threat; they say they do not feel any stress.[47] But there are physiological effects that can be measured: blood pressure, sweat; and which correlate with performance.[14]

Why is this important? We want to distinguish between people who can do work but are stressed, and people who cannot do the work. Moreover, these effects are continuous: it does not end at the job interview. An ideal environment allows everyone to perform at their maximal level, but stereotype threat interferes with this.

Stereotype threat can be mitigated in a number of ways. Note that developing trust is essential, and several of these suggestions help:

- A credible statement that "this test has been shown to not be subject to the stereotype threat" or "this test is a study of problem solving, not diagnostic of individual ability."[39]
- Remind the subject of a positive stereotype: "You are a student at Stanford," or "You are Asian."[36]
- Critical mass is defined by Steele as "the point at which there are enough minorities in a setting that other minorities no longer feel uncomfortable there because they are minorities." An exact number needed is difficult to define, but in orchestras, 40% women was seen to be the critical mass: "the point at which men and women alike began to report more satisfying experiences."[47] In the U.S. Supreme Court, adding a second woman made a difference.[44] In another experiment, a job brochure had photographs of employees; African American applicants start to feel safe in applying once they saw 33% of the faces being minority, whereas white applicants felt safe at all levels of minorities (33% was the highest used in the experiment).[37] When women take a math test in a group of three women, they do better than women in groups with two women and one man; and women in those groups do better than women in groups with one woman and two men.[25]
- Offering a credible narrative: It helps to hear the experiences of people who have been through similar experiences and who have overcome the situation.[47] This includes an expandable view of intelligence (that is, you can learn), and self-affirmation, as explained in the next point:
- Spending 15 minutes writing an affirmation of one's positive values has been shown to have an enduring positive effect on classroom performance.[12]
- Improving critical feedback: neutral feedback, or encouragement, does not work to reduce the stress of identity threat. It works to say, "I have high standards, I think you can meet

Unsung Heros

Many women[1] and minorities[47] have been essential contributors to the development of computing; but their contributions are not well known.[28] Here are just a few:

Augusta Ada Byron King (1815–1852). Countess of Lovelace, analyst, mathematician, the world's first programmer Ada wrote a program for Babbage's Analytical Engine that computed a sequence of Bernoulli numbers.

Rear Admiral Grace Hopper (1906–1991). Hopper was a mathematician who joined the Navy during the World War II. She was assigned to Harvard, where she initially programmed the Mark I to solve complex differential equations. She was a fantastic educator and spokesperson for computing and the sciences, known for her explanation of the nanosecond. She was one of the developers of Cobol and an early advocate of compiled languages, and believed strongly that the future was going to be in the speeding up of networks and computing speed.

The ENIAC Programmers: Betty Snyder Holberton, Jean Jennings Bartik, Kathleen McNulty Mauchly Antonelli, Marlyn Wescoff Meltzer, Ruth Lichterman Teitelbaum, and Frances Bilas Spence. During World War II, many women with a mathematics background were hired to compute ballistic trajectory tables at the University of Pennsylvania. In 1945, six of these women were assigned to the ENIAC, the first all-electronic digital computer. Equipped only with logic diagrams, they built the first programs, using the 3,000 switches and dozens of cables and digit trays. Betty Holberton invented the first Sort routine, and the first software application.[28]

Frances Elizabeth Allen, recipient of the 2006 ACM A.M. Turing Award, for pioneering contributions to the theory and practice of optimizing compiler techniques that laid the foundation for modern optimizing compilers and automatic parallel execution.

Barbara Liskov, recipient of the 2009 ACM A.M. Turing Award, for contributions to practical and theoretical foundations of programming language and system design, especially related to data abstraction, fault tolerance, and distributed computing.

Clarence "Skip" Ellis was the first African American to receive a Ph.D. in computer science, in 1969. Among his many accomplishments, he was on the team that built the first icon-based GUI at Xerox PARC.

Mark Dean was the first African American to be named an IBM Fellow, in 1996. He holds three of the original nine patents for the IBM PC, and was on the team that developed the ISA systems bus, that allows the PC to communicate to external devices.

them, and we are going to work together to make this happen." The difference is engagement.[13]

▸ Communities of support: a key difference between African American students and Asian students at U.S. colleges turned out to be that the Asian students would get together, share their experiences, and study together. People who feel isolated sometimes refuse help, as they think that it will confirm the stereotype. The African American students did not tend to form study groups naturally; when these communities were introduced, their performance increased dramatically.[45]

▸ Fostering intergroup conversations as learning opportunities. These conversations are difficult, as people are afraid of appearing to be biased or ill informed, so they often steer away from the situation. Subconsciously, they pull their chairs further apart. When a facilitator starts a conversation by saying that tensions are natural, but the conversation should be treated as a learning experience, that signals to people that differences can be learned. People pull their chairs closer together. This does not happen when the facilitator says the participants will not be judged, nor when the facilitator says all points of view are welcome.[18]

Consequences of stereotyping. As mentioned earlier, there are a number of other forces that can hinder the ability of diverse teams to function optimally.

Stereotypes make us feel as though we have useful information about people's strengths, weaknesses, and personal characteristics. But they operate in a more prescriptive way as well: They shape our expectations of what people should be doing, especially at work. Thus, women are expected to be nurturing and collaborative at work, in accord with their stereotyped strengths. When they deviate from that, they incur penalties. Men are not expected to be altruistic, but if they are, then they are given credit for giving assistance. This was demonstrated in an experimental setting in which a person was asked for help with a technical task: men were given an increased performance rating if they gave assistance, whereas a woman who assisted was not; her performance rating remained at the base level. If a man refused to assist, then the rating of his work was not changed from the norm; if a woman refused to assist, her performance rating decreased.[21]

Most people would not believe that height predicts competence, and yet, these choices are frequently made. In fact, height is strongly correlated with career success.

If a man and a woman perform a male-stereotyped task together, the majority of people will attribute the success of that task to the man, unless

▸ the contributions of the woman are specifically attributed, or

▸ there is information about the way the task was structured, or

▸ there is some clear example of prior competence by the woman.[22]

There are differences in the communication styles considered acceptable in men and women leaders: women have a very narrow band of acceptable behaviors. In general, women are given less time to speak, are more likely to be interrupted, and if they do interrupt someone, that is most likely to be another woman.[43] As a consequence, women are less likely to be able to hold the floor in meetings: an important quality in a leader.

Career advancement strategies that work for men do not always work for women. When comparing only women who have not taken career breaks for family with men, there are still significant differences in achievement levels.[10] The study on the Myth of the Ideal Worker says, "Women benefit most by making their achievements known. Men benefit most by scanning for external opportunities and blurring work-life boundaries. Both benefit by gaining access to powerful others." The report also says, "changing jobs accelerated compensation growth for men, but slowed it for women." It has been shown that sponsorship, in which a sponsor actively promotes and takes risks for the sponsee, is more effective for women than mentorship, in which the mentor merely gives advice.[24]

There are other career differences observable between men and women as well: women are more than 10% less likely than men to change jobs for a raise in salary or for a promotion; but they are almost 10% more likely than men to change jobs because of a bad manager (see Figure 5).[9] The numbers who leave jobs to take care of family are very small for both men and women. In Japan as well, significantly fewer women report they have off-

ramped because of childcare-related reasons (32%) than those who have off-ramped because they feel stymied and stalled at work (49%).[11] One interpretation: It is difficult to balance both working and parenting, and one is not likely to want to stay unless the work is rewarding. Moreover, career priorities differ: A one-size-fits-all management structure will not work well for a diverse organization.

This theory is supported by a study of why women stay in engineering: people who choose to stay are engaged and basically hopeful, and are proactive about the problems they see.[8]

Even a small bias can result in a large difference in the representation of minorities at the top levels of a company. A simulation of promotions was performed with only 1% of bias in ratings of women, and a posited eight levels for promotion. The simulation starts with 50% women at each level, and ends when the entire organization has been replaced with new employees. At the end of the simulation, at the lowest level of the organization there are 53% women, and the top levels of an organization go to only 35% women.[29]

Transgender studies show some fundamental differences in the ways that society treats the same person as either a man or a woman. These studies are particularly interesting in that the same person experiences life as both genders. The studies consistently show that men who change to women have an average lower salary after the change, and women who change to men have a higher salary, as well as finding everyday life situations easier.[38] A very powerful example is the history of two biologists at Stanford University, Ben Barres (a man, formerly a woman) and Joan Roughgarden (a woman, formerly a man).[46]

Ben Barres has said, "When it comes to bias, it seems that the desire to believe in a meritocracy is so powerful that until a person has experienced sufficient career-harming bias themselves they simply do not believe it exists ... By far, the main difference that I have noticed is that people who don't know I am transgendered treat me with much more respect: I can even complete a whole sentence without being interrupted by a man." Joan Roughgarden, on the other hand, has said that as a woman, "You get interrupted when you are talking, you can't command attention, but above all you can't frame the issues."

Ben Barres also wrote a strong commentary in *Nature*[6] refuting Lawrence Summers' speech, in which Summers implied that women inherently have less aptitude for science. He cited studies showing that many selection processes set an extremely high bar for competence for women and minorities: 2.5 times in the case of a research grant proposal. And yet, most people have a strong desire to believe the world is fair, so there is widespread belief that little discrimination exists. He gave a number of recommendations to reduce discrimination.

Case Studies: What Works

Many of the issues described so far are major societal issues, which lead to a diffuse pipeline of minority students into the workforce. Despite the challenges posed by a narrow pipeline, bold leaders have made significant strides in reducing the gender gap in computing, as we will show through a few examples.

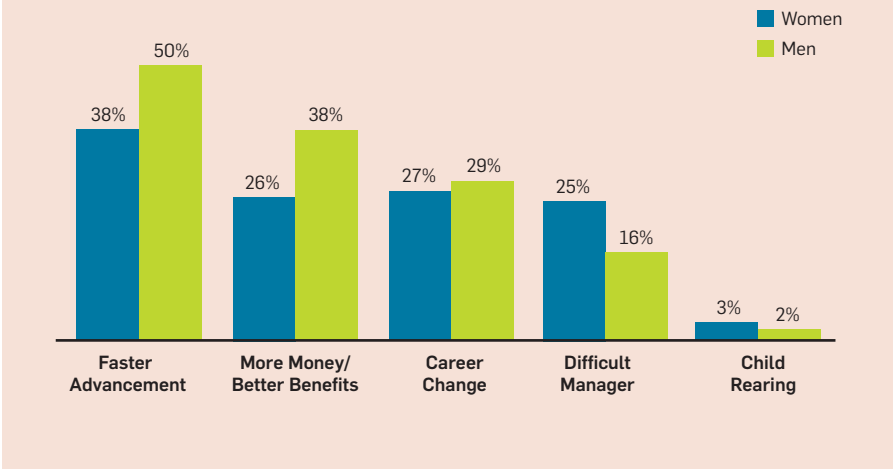
At Harvey Mudd College, a liberal arts college of science and engineering, the college went from the average 12% of women in CS to about 40% in five years by taking these actions:[19]

- The introductory CS class was changed to be more holistic, and not assume the students already know how to program. The act of designing systems to solve problems that one cares about is a big motivator. A CS class is required for all students in the first semester.
- First-year women students are encouraged to attend the Grace Hopper Celebration of Women in Computing, a large (about 4,000 attendees) conference, regardless of major; a large percentage of the students choose to attend. This provides role models and breaks the stereotype about what computing is about: hundreds of happy, successful, technical women attend, at all stages of their careers. Even the women who choose not to study computer science say this event has a huge impact on their career choices, and many do decide to study computer science as a result.
- A research program was offered after the first year for about 10 female students each year for four years. At this time, it is still true that some students (both male and female) have access to research after the first year.

None of these suggestions offer a particularly new insight alone, but in combination they have had a dramatic and lasting effect. Consider these results:

- In the same period, enrollment by women at Harvey Mudd increased from 33% to 46%.
- These changes have attracted more computer science majors overall: Harvey Mudd graduated over 70 CS majors in 2014, compared formerly with 25 to 30.
- In 2014, 56% of those graduating with engineering degrees from Mudd were female. The proportion of grad-

Figure 5. Reasons for leaving a first job. Courtesy of Carter et al.[9]



uating CS majors who were female was 39.4%.

Taken together, they break the stereotypes that girls often have about CS, they provide confidence and role models, and they show all students, not just women, the impact they can have in computer science.

The importance of collecting and publishing data is illustrated by the example of the science faculty at MIT. Around 1993, a few of the senior women faculty in science at MIT felt there was bias in the way lab space was allocated, committee appointments were made, and so on. They were able to get support from the dean, and a comprehensive study was undertaken, starting in 1995, which showed that indeed, in some of the science departments, there were differences in salary, resources, awards, and allocated space between men and women with similar accomplishments. The committee then established goals to address these issues. An important factor in the success of the study was the use of data, and the inclusion of both senior women faculty and men who were or had been department chairs, in the committees. A report was published in 1999, and it is all the more remarkable for its openness.[31] Importantly, part of the follow-up was to continue to collect and review data. A follow-up study in 2011 showed distinct progress: for example, a woman was hired as president of the institute. Hiring was increased: women represented about 8% of faculty for the 10, or even 20, years prior to the study. Women faculty increased from 30 to 52 in science, and 32 to 60 in engineering; and women now hold some senior administrative positions.

To give an example of the contribution of diversity to team success, the closed captioning feature of YouTube at Google was developed and its release driven by a deaf engineer, Ken Harrenstien.[20] Closed captioning turned out to have a huge business impact, beyond the community of those who cannot hear; well beyond what was anticipated. It happened, in large part, because of the efforts and advocacy of Harrenstien and the accessibility engineer who worked with him, Naomi Black.

Stereotypes make us feel as though we have useful information about people's strengths, weaknesses, and personal characteristics.

Conclusion

Diversity is important to organizations that innovate, but the culture of an organization determines whether minority members of the community can thrive. Computer science as a discipline has not done well in attracting and retaining women and minority practitioners in any proportional scale to population representation: the percentage of BS degrees conferred to women peaked in 1986 and is still on a downturn.[34] People from minority groups have contributed at the highest level to the CS discipline since its inception, despite obstacles they have faced, including limited visibility of their achievements. As noted earlier, as little as 1% of bias in ratings can result in reduced promotion rates and a skewed population of the top levels of organizations.[29] This makes awareness of the reproducible relevant research extremely important.[b]

To summarize, things that can be done by leaders to make diverse teams effective:

Make data available. Note the stunning changes that were effected as a result of the MIT Science Faculty Study, because of the insights provided by the data collected, and the open publication of the results.[31]

Create an atmosphere of trust. Recall that women who stay in engineering are engaged and hopeful.[8]

Pay attention to critical mass.[25,41,44] In order to attain critical mass, organizations should take actions to remove bias from the hiring and promotion processes.

Provide a credible narrative. Provide opportunities for everyone to see themselves as successful: to meet more experienced, successful people,

b This research is particularly meaningful to me because of my experience of living in foreign countries from 1995–2014. I have come to understand that people see me through the lens of their own experiences and cultural attitudes. Similarly, I have come to better understand the biases that my own native cutlure has toward these other cultures, sometimes causing fundamental misunderstandings. Probably the most effective training that a person can have in terms of understanding what it is to be a minority is to become one: live in a place where you are the only one like you. However, these studies can help to understand some of what it means in day to day life to be Other.

similar to themselves, and who have faced the same barriers.[30,41] Know the history of minority contributors to the field, and make sure these achievements are known.

Adopt an expandable view of intelligence: demonstrate you believe that skills can be learned.[41]

Know your own biases. Read some of the literature about unconscious bias and about the IAT, and then take the Implicit Attitude test[5] at https://implicit.harvard.edu/implicit/.

Embrace differences: recall the women in the management study,[9] and as a manager, pay attention to differences in needs by individuals.

Foster intergroup conversations as learning opportunities.[18]

Remember the subject of a bias is not always aware of the effects on him or her.[41]

For organizations, it is important for individuals in key positions to sponsor promising women and minorities.[10,24]

An organization that says "we value diversity" is more trusted than one that says "we are color blind."[37]

Values affirmation has been shown to have long enduring positive effects on classroom performance.[12,41]

Before important decisions, make sure you are well fed: in one study, subjects were tested for their bias against homosexuals. Half of the subjects drank lemonade with sugar before the test; the other half drank lemonade with a sugar substitute. The subjects who had sugar showed less bias than those who had a sugar substitute.[16]

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For a full reference list, please refer to Supplemental Materials in the ACM Digital Library or to my blog http://rule-of-one.blogspot.com.

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