Why Women Aren't Where They Are Needed in the Workforce: Putting the Pieces Together

Patricia Rankin and Donna Caccamise

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Abstract

This paper provides a broad review of evidence-based research, underlying theories, and interventions related to women's representation in the workforce. It introduces the complex issues at play in today's workplace. These issues contribute to creating a work culture that too often is unfriendly to women and subtly or not so subtly drives women from the workforce, particularly from science, technology, engineering, and mathematics (STEM) related fields. A diverse workforce can lead to better outcomes, especially in a knowledge-based economy. The assertion here is that achieving a workforce fully inclusive of women, including at the leadership levels is desirable, and that this will require looking beyond laws and policies to address the biases that women face as well as practical concerns such as how to combine family life with a career. Simple steps such as using a qualifications checklist in the assessment of candidates for a position can help improve hiring, as would the availability of added career planning advice targeted at women and a greater awareness of the value of providing role models. Leadership programs designed to support the new models of collaborative work and encourage the participation of women can also help.

Overview

As the new knowledge-based economy grows in importance, there are both fundamental and practical arguments for ensuring that women are equal partners in it. The projections are that the population of the world will increase from around 6.5 billion in 2015 to around 9.3 billion in 2050. Over the same period, the projection is that the percentage of the population over 65 will double from 8% to 16% (Pew Research Center, 2014). Initially countries may benefit from a demographic dividend (United Nations Population Fund, 2017) of accelerated economic growth when mortality and fertility rates decline. However, there is only a limited window of opportunity before the old age dependency ratio (which measures the dependence of those over 65 on the working age population) increases and an aging population starts to have more and more negative impacts. The old age dependency ratio is rising rapidly in Japan and Indonesia compared to countries such as Sweden and Brazil (Magnus, 2014). These demographic shifts drive the necessity of quickly moving towards increasing women's representation in the workforce.

However, this is not just a matter of using women to bridge the gaps developing in the supply chain. Women bring unique perspectives to problem-solving, and complex problems benefit from the application of a diverse set of skills. Effective teams combine average ability with a complementary diversity of perspectives and expertise. It is likely that increasing the representation of women will have a multiplier effect on economic growth, increasing innovation, and improving responses to rapid change. In turn, the characteristics of organizations that make them welcoming to women often make them successful at innovating.

Achieving the desired level of involvement of women will require not just having more women become interested in traditionally male fields and in traditionally male roles, but also ensuring that they persist and are able to succeed. This paper focuses on the science, technology, engineering, and mathematics (STEM) fields because the representation of women in these fields is noticeably low. In particular, it considers the under-representation of women in leadership roles, such as leading a product development group, why this is a problem, and how this under-representation can be changed. Some of the steps needed to change the situation are concrete: a matter of adopting appropriate policies and allocating resources to address practical concerns such as balancing a family and a career. It is more difficult to change or at least mitigate, the effects of the underlying attitudes of both men and women that are contributing to the lack of women in this sector.

Below we highlight the key themes in this paper and indicate the sections containing more details about these themes.

Improving Problem-Solving ("Social, Economic and Scientific Problem-Solving: The Value of a Diverse Workforce" and "How Work Teams Thrive with the Right Norms")
• Modern business and societal challenges are complex and solving them requires experts from different disciplines to come together to work in interdisciplinary teams. This means that there needs to be a shift away from projects driven by individuals towards more holistic team-based problem-solving efforts in both academia and industry. These sections present arguments for how a more diverse workforce can lead to better social and economic outcomes if conditions are conducive.

Understanding Bias ("Cognitive Errors and Stereotype Threat" and "Biases Especially Impacting the Employment of Women")
• Many factors influence decision-making in ways that can cause us to devalue women without being aware of what we are doing. It is important to be both aware of these influences and to structure decision-making processes to minimize their impact to ensure that evaluations

are fair. Evidence shows that women and men vary in how they self-assess their abilities and even the wording of an advertisement can encourage or discourage women applicants. These sections discuss the issue of cognitive errors and their impacts on the employment of women.

Employment Patterns ("Patterns of Representation" and "The Cultural Impacts of the Employment of Women")
• The patterns of employment for women and men can be very different and many women "accumulate disadvantage" throughout their careers. Numerous factors affect women's career paths and progression, including social culture (for example, the fact that women are primarily responsible for childcare and other domestic work) and structure (for example, women are under-represented in leadership roles and science-related fields). The first section provides a general overview of employment patterns, and the second looks at issues such as how women are more likely to be employed in part-time work.

Leadership ("Women in Leadership Roles" and "The Impact of Leadership Styles")
• Less than one percent of CEOs in Japan are women, creating a lack of role models and other problems. However, leadership styles are evolving towards a transformational style, supporting collaborative and team based work and benefiting from interpersonal skills. The leadership style of the senior staff of an organization can support or hinder achieving gender equality depending on the level of responsibility individual leaders take for being part of the solution. Poor leadership can affect women more than it affects men.

Changing the Culture ("Addressing the Causes of Under-representation", "Keeping Women Interested", and "Work/Life Balance")
• Women are still under-represented in many industries, especially STEM-related professions and laws and policies alone will not change behaviors unless there is a shared sense of what is appropriate. Using an approach that incorporates different perspectives and integrates them into a more effective whole benefits everyone. However, it is also important to combat the mythology that simple inclusion is counter to a meritocracy. There is a need for better career planning advice and for role models. Women also often opt for lower status and/or part-time positions to gain the flexibility they need to manage their work/life balance. In these sections, we introduce work that shows how structured approaches can reduce bias and examine how recent initiatives to design flexible workplaces will help with retention.

Recruitment ("Better Ways to Recruit and Assess Individuals")
• In this section, we discuss approaches to tackle unconscious bias, many of which are surprisingly simple yet effective, such as using a qualifications checklist in the assessment of candidates for a position.

The Future of Leadership ("Developing Future Leaders with the Right Professional Skills")
• The design of leadership programs needs to support the new models of collaborative work and encourage the participation of women. The best way to disrupt the current status quo is to work in ways that do not directly challenge it. In this section, we discuss how emphasizing the value of following professional practice will help achieve change, and introduce the concept of T-shaped professionals.

Monitoring Progress ("Assessment of the Climate and Effectiveness of Interventions")
• Assessment of interventions is key to understanding their effectiveness. The ability to intervene and advance gender equity requires a new emphasis on assessment methods that are less reliant on self-reporting. Recent "big data"/computational approaches demonstrate great promise.

Considerations for the Future ("Recommendations" and "Conclusions")
• The discussion focuses on how effective organizational change needs to work across multiple

constituencies. Many of the issues facing us today originate in the fact that the current dominant leadership style tends to be competitive not co-operative, negatively impacting the long-term health of society as a whole. In view of this, we argue for a change in the working culture. It is particularly urgent to have more women participate fully in the workforce in Japan and parts of Asia due to the demographics and the comparative lack of natural resources. The importance of STEM workers to the knowledge-based economy means that there is an immediate return on investment in increasing the number of women. The low numbers of women in STEM makes it easier to highlight the issues and harder to resist the case for change. We close with recommendations for foundations and government agencies to consider related to designing programs and policies to increase women's participation in the workforce, and to promoting gender equality in all sectors and industries.

Social, Economic and Scientific Problem-Solving – the Value of a Diverse Workforce

There is growing recognition that continued progress requires new approaches to problem-solving including incorporating diverse perspectives. Much of the discussion centers around the need to shift from the traditional model in research of an individual researcher with expertise in a single discipline to a team-based approach that brings together experts from a variety of disciplines to solve problems that cross disciplinary boundaries. Industrial innovation also needs to adapt to shifting markets and find new ones. Page (2007) has put forth a convincing case that a diverse skill set promotes better problem-solving. The essential argument is that the more similar the skills are that two people bring to the table, the more redundancy there is in the system and this redundancy does not improve the likelihood of finding a solution. To open up a broader space to find a solution, you need to bring in someone with a different skill set. This different skill set increases the variety of tools that might be used in solving the problem. Page takes this further, which helps in understanding what types of problems are most likely to benefit from a diverse group approach.

From Page's (2007) perspective, some fields are more "ladder-like" than others are in that later concepts build upon earlier ones; that is, there is a generally agreed upon order in which to learn tools. Physics is a good example of a ladder-like field. Physicists, for example, study Newton's work before Einstein's. Consider a team made up of two physicists; the less experienced physicist will add little to the overall skill set of the pair. If you are solving a problem that only involves physics, there is likely to be little advantage to bringing in someone from a completely different field. Experts generally outperform random groups in finding solutions for problems where there is a high probability of there being only one right answer and a well-defined way to approach finding that answer (like algebra problems). In contrast, crowds do very well at estimating because low and high guesses tend to average out. They also do well on complex problems where there is likely to be a range of possible solutions each with advantages and disadvantages. In cases where skills from several disciplines are needed, a diverse problem-solving group is more likely to generate a wider range of possible solutions and more likely to find a robust solution.

The most important social and economic problems of the 21st century are sometimes called "Grand Challenge" problems (Whitehouse, 2012) because they do not fall neatly within discipline boundaries but instead require trans-disciplinary collaborations. The Horizon 2020 research framework of the European Commission, which was adopted in 2013, explicitly recognizes this through a funding program for research and innovation. Known as "Responsible Research and Innovation (RRI)" (Horizon, 2017), the program challenges scientists to pay more attention to what society wants and has to tell them, by taking a more inclusive, reflective, and anticipatory approach to their research. The goal is to better align both the process and outcomes of research and innovation with the needs, values, and expectations of European society.

These collaborations need to bring together practitioners not just from different fields, but also from different career paths, and involve governments, industries, universities, non-profits, and philanthropists in finding and deploying solutions. For example, as the population ages, healthcare needs will change (Rechel, Doyle, Grundy, and McKee, 2009). It is possible that depression and other chronic diseases could overwhelm the healthcare systems of many countries without advances in robotics and artificial intelligences to keep an aging population active and engaged. These problems are not ladder-like. Social scientists, engineers, healthcare practitioners, and policymakers will all need to play a role not just in producing the needed technologies, but in

making them accessible and acceptable.

The automobile industry is an excellent case study related to the importance of including women in the design process. [2] The consequences of male-only design teams go beyond seats that do not adjust far enough or difficult-to-reach controls. Women are 47% more likely to be seriously injured in a crash than men (Bose, Sequi-Gomez, and Crandall, 2011) based upon an analysis of accidents occurring from 1998 to 2008. The study's authors argued that this occurred because the vehicles' safety features were tailored with men in mind and not women. The investigators found that female drivers wearing seatbelts were more likely to be injured than male drivers wearing seatbelts, and that belted female drivers suffered more chest and spine injuries than belted male drivers in comparable crashes. In addition, in the U.S., women influence over 80% of all new car purchases. Women are gaining ground in the automobile industry and their numbers are increasing. In the U.S. in 2015, women made up just a little over one-quarter of the automotive industry's workforce (2015 Bureau of Labor Statistics) and as a result, women are becoming more central to the design process. For example in 2015, Nora Arellano, a Toyota Principal Design Engineer, was awarded a patent for side curtain airbag design used in the Toyota Tundra.

We can make a similar case in the biomedical sciences for the importance of considering the needs of women. Drug dosages not only need to take into account weight differences but also hormonal differences. In addition, since women are often the primary caregivers in a society, prioritizing their vaccination can better slow or prevent the spread of a disease. While, in principle, male scientists could have led a drive to study the differential impacts of treatments on women, in practice it was women practitioners who brought these concerns to the fore (the later section on "Keeping Women Interested" will discuss how publicizing the contributions of women also helps to encourage women to follow careers in the STEM fields).

Research on teams and the characteristics of successful teams strongly suggests that the skills that tend to be associated more with women (such as collaboration, better communication, and focus on the whole) than with men are the most important skills in ensuring teams function effectively (Wolley, Malone, and Berinato, 2011). It is generally agreed that women improve the quality of debates, focus more on possible human factors that could be influential, and tend to add accountability.

Historically, university professors have worked alone or led teams of more junior researchers. However, with the recognition that real-life problems are becoming more and more complex and can no longer be addressed by simple laboratory experiments, research funding agencies are now showing a preference for supporting multidisciplinary teams across institutions. Teamwork among faculty peers is becoming increasingly necessary and expected (which will drive changes in the reward system for faculty scholarship). In contrast, teams have been active in STEM-related industries for some time.

Page's (2007) work is based on theoretical skill sets that represent intellectual diversity. His framework is often used to support the inclusion of members of under-represented groups and broadening participation because people with different backgrounds and experiences can bring different perspectives. However, what is the evidence that they do?

One interesting study of corporate boards and the impact of women on those boards found some apparently encouraging results. Fortune 500 companies with the highest representation of women on their boards generally outperformed those with the lowest representation of women on their boards on some key financial indicators (Catalyst, 2011). The return on equity was 53%

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better; the return on sales was 42% better on average; and the return on invested capital was 66% better. The study was done by ranking the Fortune 500 companies by the percentage of women on their boards and comparing the top and bottom quartiles. A similar study based on European firms by McKinsey (Desvaux, Devillard-Hoellinger, and Baumgerten, 2007) found similar benefits. What these studies show is that in certain specific cases there is a correlation between the percentage of women on a board and the firm's performance. This is not the same as saying that there is a causal relationship. More detailed analyses show the complexity of the situation (Eagly, 2016), and it is important to understand these complexities to make effective recommendations.

First, analyzing the boardroom data to look for causality shows that there are little to no direct effects, and secondly, increasing the percentage of women does not always have a positive impact. These findings are perhaps not too surprising. There are many reasons why a firm may be performing well, including an ability to adapt to changing markets and produce innovative goods. The culture that makes a firm open to innovation may also make it more open to nontraditional hires. The presence of women on the board may reflect a culture of professional development of aspiring leaders who empower people at all levels of the company. Furthermore, companies that are doing well financially could be more willing to take risks on hiring decisions; conversely, there is some evidence that firms doing very poorly are also willing to take risks. For example, Yahoo hired Marissa Mayer and HP hired Carly Fiorina after these organizations encountered difficulties (known as the Glass Cliff effect; this is discussed more in the section on "Women in Leadership Roles"). Finally, and perhaps most importantly, if the women come into a situation as outsiders, they may not have the influence needed to impact decisions. Moreover, if the women do not have the respect of the rest of the group, then they could be more of a distraction than an advantage to the team. Hiring women, in and of itself, is not enough to make a difference.

We believe that the use of quotas needs to be carefully considered. Quotas are most likely to be effective in situations where the evidence suggests that there is a pool of women who are being overlooked and where efforts are made to support the full integration of the women hired into the organization. Nagoya University in Japan, for example, has made effective use of quotas to recruit women faculty. Nagoya University is a "HeForShe" Impact Champion (UN Women 2016) and has a strong overall organizational commitment to gender equity.

To complete the overview of some of the key assumptions and concepts behind this paper, the next section will provide a quick review of how human thought processes can be influenced in ways that complicate attaining gender equity in organizations.

Cognitive Errors and Stereotype Threat

Decades of research show that despite peoples' best intentions to make unbiased decisions, that this can be difficult to achieve. Valian (1997) in her influential book, "Why so Slow" lays out a compelling case. Psychologists presented with a CV from real-life scientists are more likely to hire the candidate with a male name (Steinpres, Anders and Ritzke, 1999). Success is more likely to be attributed to "luck" for women and "skill" for men (Deaux and Emswiller, 1974). Evaluators under stress (such as needing to complete many ratings in a short-time period) give women lower ratings than they do men with the same written evaluations of performance (Martell, 1991). Study after study shows that there are differences between how men and women are judged, and how much weight is given to their credentials.

The "Swedish Postdoctoral Study" (Wenneras and Wold, 1997) describes a review of 114 postdoctoral applications in 1995 where there were 62 male applicants and 52 women. Sixteen men received awards but only four women did. The review process seemed very fair — applications were read by one of 11 committees; each application was reviewed by five people, and scored from 0 to 4 on scientific competence, relevance of proposal, quality of proposal, and methodology. Scores were then multiplied together (0-64) and averaged over the reviewers to produce a ranking based on impact factor and one to three names were submitted to a final committee. A regression analysis showed that a major factor in getting an award was the competence rating and men consistently received higher competence ratings. Wenneras and Wold found a model that did a good job of predicting the competence rating for the men by looking at the number of their publications weighted by the quality of the journals they had published in and the number of their citations to determine an impact points rating. However, the model did not fit the women applicants who needed at least 100 impact points to be rated the same as a man with 40 impact points.

A salary study by two economists, Egan and Bendick (1994) demonstrates again that qualifications can be weighted differently for men and women. The survey examined 17 factors that could influence salary, such as the kind of degree they had, how many hours they worked a week, their years of experience, and so on. Of the 17 factors, 14 helped men more than they helped women. For example, having lived outside the US added $9,200 to men's salaries but subtracted $7,700 from women's salaries.

What could be going on?

Valian (1997) argues that there exist a set of implicit hypotheses about the differences between the sexes that shape the conceptions of men and women, which she calls gender schema (to help differentiate them from stereotypes). It is important to note that both men and women hold to the same hypotheses. When we are looking at a population, we understand that anything we use to characterize individuals has an associated distribution. However, when we are considering an individual, we tend to assume that they are described in terms of the means of these distributions. Once we classify people as men or women, we find that this affects our perceptions, even in the case of objective characteristics like height. In one example, a study by Biernat, Maris and Nelson (1991), college students were given a sample of photographs of men and women and asked to guess the heights of the people in the photographs. The pictures always contained a reference item (for example, a desk or chair) to help in the height estimate. The sample was set up (unknown to students) to match every man in the sample with a woman of the same height. Male and female students estimated the average height of the sample of women to be less than

that of the sample of men, presumably because men are expected to be taller.

This helps us to understand the data on the lower value of womens credentials. Employers interpret them differently for men than they do for women. In the case of men, employers will see spending time abroad as an affirmative choice to aid career preparation. However, since women are assumed to make choices based on their intrinsic value, it might be thought that a woman travelled for pleasure and thus time spent abroad could be wrongly interpreted as signaling indifference to their career.

We live in a complex world and we are often information overloaded. As a result, we filter out much of the information coming in via our senses to just what we need for the current task. Thus, we often make decisions based on a small amount of information and we often make these decisions automatically; thus, we are influenced by assumptions we may not realize are influencing our decision-making; this is the underlying cause of "Unconscious Bias".

The research and literature on decision-making, in particular studies related to cognition, helps us to understand what is going on. Think Better (Hurson, 2008) and Think Again (Finkelstein, Whitehead, and Campbell, 2008) are both good resources for anyone who would like to learn more about improving decision-making. In the past, our survival required a rapid assessment of the threat level of a situation and we developed a largely automatic fight or flight response that tended to assess different levels of danger. You enhance survival by ensuring safety rather than by taking a possible risk. Therefore, the need for a quick response to a real threat favors false alarms. What this translates to in today's environment is that we tend to react first to new ideas with instinctive caution. Over time, the neural cortex takes over with a more analytical response (think about driving a car; in an emergency, you will slam on the brakes before becoming fully aware of what is happening).

Our brains have evolved to impose order and look for patterns in order to automate at least some of our decision-making for efficiency and speed. This level of processing is typically unconscious. When it comes to judging individuals, the cognitive errors coming from unconscious decision-making can introduce bias. However, we want to stress that while this can have discriminatory impact, the person judging may be trying hard not to be biased.

A related bias is known as Affinity Bias, which is the tendency when selecting someone to unconsciously select the person who seems most like you. We tend to look for points of connection to individuals we meet, such as if we attended the same school, or shared experiences, or if we like the same music/films/sports they are interested in. If we find these points of connection, then both the person we are talking to and us tend to relax and become more at ease with each other. In an interview situation, an interviewee being at ease can help them respond better to the interviewer's questions. This in turn leads to the interviewer responding even more favorably to the interviewee.

We also tend to resist changing decisions once made — an effect known as Re-enforcement Bias. Once we have decided on something, we tend to look for evidence that we made the right choice. For example, you may be making a choice between a red and a white car but finding it hard to decide. Before you decide, however, you might make a list of advantages and disadvantages for each color; but after you decide, you are likely to start to focus on the advantages of the color you chose and the disadvantages of the color you did not choose. After a decision is made, individuals usually become more confident that they are right (we do not enjoy thinking we made a mistake).

The concept of Cognitive Dissonance dates back to the 1950s and is associated with Leon Festinger. He discussed how it is hard to maintain two concepts if they seem to be in conflict (this is important in understanding how interventions that work to change some of the underlying

assumptions we make that are wrong can be made effective). We have a tendency to justify our actions and the actions of those around us — for example, Sally and Sam work for the same company, with the same credentials, doing the same job, but Sally discovers that Sam is making more money for the same work. This sets up the cognitive dissonance in Sally's mind that on the one hand, she and Sam are equal with respect to the job they do, but on the other hand, the company values Sam's work more. To relieve the stress caused by these two incompatible ideas, Sally can either leave the job, or come up with a reason in her mind that justifies Sam's higher pay. It does not matter whether the latter rationalization is true; as long as Sally believes it, it will help to relieve her cognitive dissonance.

Cognitive dissonance wants internal consistency in what we are thinking. A related concept Confirmation Bias wants external consistency because this benefits us by reducing our need to think about something and our need to change our actions. In this framing, schemas are mental constructs. We want to avoid calling them stereotypes because this term tends to make people defensive about their views, which makes it harder to change their perceptions. Many of our schemas are based on a person's or a group's main characteristics and the relationship between features; thus following schemas act as a form of hypothesis that:

• Allows us to perceive and classify new individuals;
• Provides explanations of people's actions; and
• Provides us with a basis to predict future behaviors.

They tend to be persistent and conflicting information rarely changes schema because we re-interpret conflicting data to explain it away. This often allows us to assume we are dealing with an exception. As we will discuss more in the section on "Women in Leadership Roles", the traditional view is that leaders need to be charismatic, strong, decisive, and assertive and we tend to associate these abilities with men. This is why the more feminine a woman is viewed as being; the less likely she will be seen as a leader. Worse, the more a woman is regarded as a leader; the more likely she will also be seen as deviant. Thus, women can be penalized for acting too like men (they are expected to be politer and, spend more time on "niceties" such as helping clean up after events). The good news is that raising awareness of unconscious biases helps counter their effects.

Another helpful concept to understand is the value of Tacit Knowledge, a term usually applied to information that is difficult to write down or otherwise transfer. Often it is just assumed to be known. "Boulder is in Colorado" is a fact   — explicit knowledge that can be written down, transmitted, and understood by the recipient. You can describe solving a Sudoku problem and it is possible to write down the rules to follow — but not everyone finds it equally easy to solve a puzzle. Finally, when it comes to riding a bicycle — you really have to experience doing it to learn how to do it.

Evidence is mounting that tacit/hidden knowledge plays an important role in helping people to be successful. Every field has its own jargon, unchallenged assumptions (for example, must work 24/7), and common culture. Consider the process of replicating an experiment. Sometimes when it seems like a patent or a journal article contains all of the relevant information, replication may still prove to be difficult, as was the case when people first tried to replicate the process to make Bessemer steel. Bessemer could make the process work, but others could not. Nonaka and Takeuchi (1995) hypothesize that hidden knowledge is a property of social networks — held and communicated to its members by informal means. Thus, if women and men have different networks, they gain different knowledge, and in the case of women, they are just not privy to the important aspects of corporate culture and politics that are part of the "good ole boys'" network (Rankin, Nielsen, and Stanley, 2007).

To be complete, we should also mention the concept of Stereotype Threat and especially the

impact this can have on test performance. Especially at early stages of a career, how well people score on tests can be an important selection criterion for entry to prestigious schools. We have long known that performance gaps exist in the STEM fields (though these vary widely from country to country). Explanations of why they exist range from genetics (nature) to societal causes (nurture) and the variation from country to country argues for the latter. Steele and Aronson (1995) showed that performance is influenced by expectations. Suppose you take a group of white male engineering students in the US and give them a mathematics test, if the person supervising the test tells the students in advance that Asian students generally perform better, then the average grade for the white students taking the test drops. The fact that this effect can be demonstrated using a privileged group in the U.S. suggests that it is more complex in origin than an internalized response to stereotyping. Later research has shown that there are physiological effects on the test takers — their blood pressure increases when the test takers are told they are not expected to do well. Studies show that women's performance in mathematics and science is consistently disadvantaged by this phenomenon (Spencer, Steele and Quinn, 1999).

Stereotype threat can have a larger impact on people if they are invested in doing well, for example, the pioneering members of under-represented groups who are the first to move into new areas. A comparison of women students who did not care about how they did in mathematics to women in a mathematics honors class who wanted to pursue careers in science showed that the honors students were more impacted by being told they were not expected to do well. Stereotype threat can be invoked just by asking test takers to note their gender (thus, if this question is important in tracking achievement as a function of gender, it should be asked at the end of the test taking when it will not affect performance). This research also has important implications for the delivery of feedback on performance; hence, letting students know that "We have high standards and we expect you to be able to meet them…." produces better results than telling students that "You will find this difficult but try your best".

Now that we have this background, the next section surveys the current situation, looking at the available data on the representation of women in the workplace and the research into what women experience.

Patterns of Women's Representation

The Association of Pacific Rim Universities' gender gap report (APRU, 2013) examined 45 universities; among them, eight universities were in Asian countries, including Japan. Examining the percentage of women professors in STEM with roles as senior management and/or Deans, the Japanese universities were at the bottom of the scale, with a high of two percent representation and half of the universities scoring zero; overall, the highest scoring country had universities with 50% women in these leadership roles. The percentages of women serving as Department Chairs in Japan were only slightly better. This points to women facing barriers in achieving a successful arc for their career milestones over their lifetime, with leadership pointedly withheld. The ratio of women scientists in Japan has been reported annually since 1992 by the Gender Equality Bureau, Government of Japan, which indicates in 2016 women make up 15.3% of researchers, up from 11.9% in 2005. This includes the even lower representation of women researchers in companies at 8.7% in 2016 (Gender Equality Bureau, 2017). Other demographic data on Japan are highlighted on the website of the Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering (EPMEWSE, 2017). A recent EPMEWSE survey showed that the ratio of women scientists in scientific societies in Japan varies depending on their fields, from 2% (Mechanical Engineers) to 24% (Molecular Biology). Only 10 out of 82 societies have female Presidents/Vice Presidents (Ohtsubo, Ogawa, Sato, and Hirata-Kohno, 2017).This is a worldwide problem as well as an important issue to tackle in Japan if we hope to effectively utilize half of the intellectual talent available. Despite the widely-held belief that the STEM fields operate as a meritocracy and, therefore, there is a purely logical and just system that determines hiring and promotion decisions, we will discuss below why this is not the case (see especially the sections on the "Impact of Leadership Styles" and "Biases Especially Impacting the Employment of Women"). We want to emphasize that the pattern of promotion is not due to the women being less able (see the "Better Ways to Recruit and Assess Individuals").

In Japan, surveys indicate that family responsibilities play an important role in this outcome and drive upwards of 70% of educated female workers to leave the workforce entirely or move to part-time work — the latter being an undervalued employment status. In general, university and junior college educated women who leave the workforce in Japan are much less likely to re-enter the workforce after marriage and childrearing compared to less educated counterparts (Raymo and So-Jung, 2011). For Japanese women surgeons, 54% work full-time, whereas 80% of women surgeons in the US and Hong Kong work full-time during childrearing years. Studies of the career trajectories of women surgeons in Japan, just one example of possible STEM-based career choices, find that women are still significantly under-represented in the field, despite the Equal Employment Opportunity Law (EEOL) enacted several years ago. In addition, only 35% of Japanese women surgeons believe they will achieve higher professional status in 10 years, compared to 55% in the US and 87% in Hong Kong. One distinguishing factor is that Hong Kong surgeons have access to newly enacted programs that provide a clear path to enhancing their careers and the resources necessary to achieve this. A confounding factor is that the Hong Kong cohort was less likely to be married (or had delayed marriage) and overall, the survey outcomes are dependent on the individuals' circumstances who chose to respond (Kawase et al., 2012).

Abe (2011) looked at the impact of Japan's EEOL on women's employment for the period of 1987-2007. Exploring the increase by marital status/age/education revealed that the increase in regular (full-time) employment for university graduate women at young ages (under 40) was the result of a delay or decline in marriage. However, regular employment did not go up for either married or single women post-EEOL. For educational groups other than university graduates, the regular employment rate for post-EEOL single women fell. The data indicated that middle-aged women are more likely to participate in part-time employment (reflecting a re-entry into the job force, although it is important to note that benefits and pay were not the same, and

that they were lower than they were at the time of their original employment). Abe found that university graduate women are much less likely to work as part-timers compared to senior high school graduates. In addition, university graduate women had two distinct patterns of labor force participation; either a persistent participation in paid employment or a complete exit from the labor market after marriage or childbirth. Further, women do the bulk of part-time work. Overall, these findings indicate that the EEOL may not be having the intended impact on Japan's workforce demographics.

It is worth commenting here on the idea that the observed data patterns might reflect demographic inertia. This concept argues that it takes time for improvements in the percentage representation of women in the early stages of a career to propagate on up through all the stages of a career. Thus, even if the percentage of women assistant professors can be increased to 50%, you will need to wait five to ten years for those women to be promoted to see the percentage of new associate professors to also reach 50%. We are currently still far away from 50% entry levels in most professions Most computer modelling of how the representation of women will change over time based on current improvement trends does not lead to parity (Marschke, Laursen, Nielsen, and Rankin, 2007).

Cultural Impacts on Employment of Women

In Japan, as it is to varying degrees worldwide, women are held responsible for looking after children and the elderly, as well as taking on other domestic duties, disproportionately more than men. Yamamoto and Brinton (2010) point to the belief in Japan (and likely elsewhere) that it is advantageous, even status enhancing, to have a stay-at-home mother who is educated. They further report that some scholars in Japan suggest that education is pursued more to achieve an advantageous marriage match more than occupational status. These culturally mediated pressures represent only a portion of the pressures that cause women to leave challenging and rewarding careers, such as those in STEM. There are other factors in the workplace that also exert, often subconscious, but relentless pressure and stress that also contribute to women leaving the careers they trained for. These will be explored in more detail later in this paper, including in the section on the "Impact of Leadership Styles".

Cultural differences between men and women with regard to childrearing and other domestic responsibilities is not a new idea, and some institutions have policies designed to help with this imbalance. However, the problem continues to be an issue and, therefore, it is important to understand the seeming lack of impact of these policies to be able to move to solutions that are more effective. In addition, there are many other causes of stress in the workplace affecting women and their success and willingness to remain in the workforce. These stressors include unconscious biases, such as the beauty premium trap, halo effects, confirmation bias, the differential value placed on a part-time versus a full-time commitment to work, inherent beliefs that women are somehow "lesser than" men, and manifest low self-esteem in women. Integrated with these issues are the reported differences in career development opportunities between men and women such that systemically, women are subject to a pattern of failure. Some of the issues include reduced preparation (educational track and opportunities), reduced academic and career opportunities that provide professional growth and mentorship, work not equally valued or promoted, and lack of opportunities for leadership — all necessary ingredients for a full career arc. In Japan, biases can begin as early as middle school and the high school application process, when teachers make decisions about a student's "fit" based on socio-economic and family background. The underlying assumption is that students will be happiest if their placement is based on family expectations and aspirations. While academic performance is also an important factor in Japan as in elsewhere, parental background also influences the decision process (Yamamoto and Brinton, 2010; Yamamoto, 2015). All this has an immense effect on any student's future opportunities and prospects.

 The many factors that have a negative impact on women's careers lead them to accumulate disadvantage, which puts them further and further behind men at each career stage. As Valian (2007) says, "Even very small amounts of disadvantage accumulate. This is the lesson of compound interest and the lesson of evolution. Very small imbalances, if encountered repeatedly, add up over time to major differences". Even a small bias (one percent) in promotion at each stage of the career ladder can lead to a significant imbalance at the highest leadership levels. Martell, Lane and Emrich (1996) considered an eight-level hierarchical institution with a pyramidal structure. They staffed this hypothetical institution with equal numbers of men and women. They then set up a computer simulation and examined what happens when the promotions between levels in the organization were biased very slightly in favor of men. This bias was set at one percent; a level most of us would assume would not be significant. However, over time, the balance of men and women at the top level shifted, ending up at 65% in favor of men at the end of the simulation.

Finally, it is worth considering some studies about the culture of STEM workplaces. Issues in these cultures often act in combination with the other cultural issues that women face.

Models for Workplace Cultures in STEM

An interesting approach taken to understand variation in the representation of women was one that focused on the field of physics in European countries. Physics tends to be one of the STEM fields with the lowest representation of women in all countries and is considered to epitomize the abstract, mathematical sciences. Understanding why women leave physics and figuring out how to keep them interested and retain them might be a way to come up with robust solutions that will apply to all other STEM fields. Most science and engineering disciplines require some training in physics and the percentage of women physicists is below parity in most European countries. However, the exact percentage of women physicists who start a career in physics but then leave the field varies widely across the European member states. Generally, the representation of women in the Northern European countries is much lower than that in Eastern and Southern European countries. The details of the career paths of men and women also differ from country to country. Studying men and women physicists in Europe provides a way to probe into cultural influences as well as the role of gender traits.

These reasons and the fact Europe is also facing demographic shifts has motivated what is known as the "Understanding Puzzles in the Gendered European Map (UPGEM)" project (Hasse and TrentemÖller, 2008). The UPGEM project sought to explain the representation of women in physics in terms of interactions between the cultural norms of different European countries and the different styles of doing physics. The researchers analyze the data (interviews with men and women physicists) in terms of gender (male/female), persistence (stay/leave the field), and culture (both the culture of physics and the role of physics in the national culture).

The UPGEM researchers identified three different physics workplace cultures: the Hercules culture, the Caretaker culture, and the Worker Bee culture. These three cultures differ in the importance placed on work versus outside interests, on competition, on power relationships, and finally, on the role of gender. The Hercules culture is characterized as an environment in which physics is the only thing that matters to an individual and there is a focus on individual success. There is an emphasis on competition and this competition can use any weapon to win, including exploiting gender identity negatively, for example by asserting that women may be more interested in having a family and, thus, it may not make sense to invest in their careers. In the Caretaker culture, the group is important and membership in a group is likened to being part of a family. Physics is still important but not the only thing that matters. Competition is between groups and there is an acceptance of gender roles in relation to the groups. In countries like Italy, for example, bringing children to work is ok. Finally, in the Worker Bee culture, physics is not seen as being centrally important to participants' lives and members of this culture are not interested in competition. Little attention is paid to gender, but being a physicist may not carry the status that it confers in the other cultures.

The situation is complicated by the fact that in practice, individuals and countries display a mix of ideal characteristics. However, the balance between these cultures differs from country to country, and the career paths in these countries often reflect which culture dominates. In Scandinavian countries, for example, the Hercules culture is more important, while the Worker Bee culture is found most frequently in Eastern European countries. The inclination for one or the other cultures to be dominant in each country has a major impact not just on the likely level of gender representation in physics but also on the prestige attached to the career.

Women in Leadership Roles

A general and telling statistic is that in Japan, only 0.8% of CEOs are women, compared to 10% in the UK. In Japan, 10% of managers are women compared to 43% in the U.S. (Davidson and Burke, 2011). These statistics highlight the importance of exploring effective ways to develop and promote qualified women into leadership roles. Understanding the patterns of representation (or lack thereof) may also reveal some clues as to how to best achieve a higher participation of women across countries and economies, as did the UPGEM study.

The ability to move into leadership roles is a natural progression in any career field and one women in STEM fields have been systematically denied. The factors that contribute to this are complex. As we define the issues and processes of successful leadership below, the unconscious biases defined above interact with this process to reinforce barriers to women aspiring to and succeeding in leadership roles.

Women are particularly absent from senior positions later in the career arc that typically involve leadership roles of some sort, from team leader to unit head, to Dean or Chancellor or company CEO. This also creates a dearth of possible role models and mentors, consistently identified as a key ingredient to helping women achieve success in STEM careers. What then are the issues that seemingly block women's rise to leadership roles? First, we look at accepted norms and definitions of leadership, as these underlying definitions and related assumptions guide the recognition and hiring of likely candidates. These norms also influence perceived success in the leadership position, both in academia and companies.

Schools of thought about leadership focus on traits, biologically and/or culturally dictated versus malleable skills that can be learned and tailored to the nature of the work. Societal norms/life experiences and malleable skills are more widely supported in the research literature. Because of the evidence for societal influences, and the malleability of leadership skills, female leadership traits may become more dominant or not based on cultural pressures and ultimately on what works (De la Rey, 2005). While there are individual differences in one's innate tendencies toward leadership that crosses gender lines, leadership programs that address cultural experiences, beliefs, as well as successful leadership practices, stand to make a difference.

A traditional view of leadership is known as the transactional form and is virtually synonymous with accepted and entrenched stereotypes of masculine traits. It is hierarchical, and emphasizes assertive individualism, aggressive and competitive behaviors, authoritarianism, and technical competence. In contrast, the transformational form of leadership encourages greater collaboration, more consultative decision-making, and is suited to more collegial workplaces (De La Rey, 2005). Transformational traits are usually associated with a woman's leadership style and are consistent with stereotypic norms of female traits in general. The characteristics associated with this feminine style include being participatory, democratic, more sensitive, nurturing, tolerant and empathetic. In addition, these leaders have excellent listening skills, in addition to having good conflict management and interpersonal skills. In further support of this gender stratification of leadership styles, a meta-analysis study by Eagly and Johnson (1990) concluded that women adopted a more democratic or participative style while men adopted a more autocratic or directive style. This trend in favor of gender differences in leadership has been supported in more recent research. An Australian study on senior women executives (Chesterman, Ross-Smith and Peters, 2004) reported that women encouraged greater collaboration, more consultative decision-making, and more collegial workplaces.

Interestingly, in the Clark, Chandler, and Barry (1999) study, they found that both men and women preferred the transformational style of leadership. Organizations have started to adopt a

flatter structure (versus the traditional vertical hierarchy) in which interpersonal and participatory skills are more critical. Women leaders are described in the Chesterman, Ross-Smith, and Peters (2004) article as possessing the entrepreneurial vision and effective communication skills that better fits modern team-based work environments. Women are more likely to acknowledge and reward the collective team, which results in a work atmosphere where all individuals are motivated and work together to achieve the organization's mission.

Twenty-first century enterprises increasingly rely on team-based knowledge work. With today's complex problems, hierarchical leadership, rewards for individual innovation, and performance are giving way to cross functional and self-managed work teams, creating new challenges for effective leadership (Bligh, Pearce, and Kohles, 2006). Managing the complex processes and needs of team members to achieve an integrated efficient and effective outcome seems better suited to the leadership skills typically attributed to women, where they are capable of sharing leadership, lead from behind, employ compassionate and empathetic skills, and display nurturing behaviors. This contrasts with the traditional model of leadership that values traditional masculine traits such as showing highly ambitious, highly competitive, and aggressive behaviors.

In perhaps a nod to quotas to get women into leadership roles, we find that they are appointed under very different circumstances than men. Women are significantly more likely than men to find themselves on the "glass cliff", as mentioned earlier. Given equal leadership abilities, a study of FTSE 100 companies found that women were more likely to be tapped for leadership roles when the company performance prior to their leadership appointment was in turmoil and experienced consistent poor performance in the months leading up to their appointment. These circumstances set the appointees (that is, the women) up to fail, as continued poor performance of the company overall is typically linked with the new female leadership regardless of what was already underway and established before their arrival. Men are given far more opportunities; thus, it is unusual to find men on the "glass cliff" (Haslam and Ryan, 2008) since they feel less obligated to take the chance on risky leadership position offers.

A much better known and related phenomenon is the "glass ceiling" and earlier reported statistics seem to speak to this when we see that women do not hold senior/executive level leadership positions. Eagly and Carli (2007) use the analogy that women have to navigate a labyrinth over their careers. At each career decision stage, the time women need to take to determine their best option slows down their progress compared to that of their male peers who typically have more career information easily at their disposal. If women make the wrong choice, they can end their careers. Valian (1997) and Eagly (2016) are each arguing that it is the accumulation of many small biases rather than the existence of one major hurdle (the glass ceiling) that explains the patterns of women's employment. However, it is also possible to consider the glass ceiling as the final barrier that women who negotiate the labyrinth need to make it through to reach their desired final destination in the executive suite. Thus, it is no surprise that recent research demonstrates that women in leadership roles may be more vulnerable and less likely to achieve sustained leadership success than men with comparable professional experience. Without more women in leadership roles, we fail to obtain a critical mass necessary to affect real change (Morahan, Rosen, Richman and Gleason, 2011).

Impact of Leadership Styles

Up to now, we have been discussing leadership skills in women compared to men. Another important aspect of leadership when it comes to the gender gap concerns the leaders under which women build their career and eventually rise to their own leadership position. There are a host of behaviors by women, their male peers, and their leaders that are important attributes to understand as they affect the degree of gender bias and inform the methods of assessment of organizational climates (in both academia and industry) and well as inform possible climate/gender bias interventions.

McClelland and Holland (2015) examined leaders' perceptions of responsibility as it affects gender bias and diversity in STEM academic departments. Their study employed semi-structured interviews of 31 STEM department Chairs and Deans at a large public university in the U.S. In interpreting their results, they used a modified version of the Brickman et al. (1982) model of helping and coping to understand attribution of responsibility for a problem versus attribution of responsibility for a solution. Using this model, they were able to characterize and distinguish their study respondents according to two groups: high versus low responsibility. The example they put forth to describe how high versus low responsibility in leaders works involves nurses. Nurses working in a hospital can be considered low in responsibility for causing a patient's problems but high in responsibility for providing solutions to the problems. At the same time, a nurse would ascribe high responsibility to themselves when they help to solve each patient's problems, but low responsibility to the patient to solve his own problems. This four-dimensional model is the framework McClelland and Holland (2015) use to understand how individuals see their own level of participation in changing themselves and/or the status quo. "People may not even be aware of the assumptions they have made about responsibility for problems and responsibility for solutions. But they cannot, as social actors, avoid making such assumptions, and the assumptions they make in turn have consequences both for their own behavior and for the behavior of others they influence" (Brickman et al., 1982, p. 370).

The outcome of the McClelland and Holland (2015) study indicated the following. High Responsibility (HR) leaders described themselves as "actively involved" in terms of hiring women onto their faculty. They positioned themselves as leaders of their teams and saw themselves as responsible for being a role model to others in their unit for how women were perceived in their organization. For instance, one department head quantified who and how many were being asked to serve on committees, how often, and so forth. Studies show that women are frequently asked to do more "service" work such as being on more committees than their male colleagues (for example, Adams, 2002, Blackburn et al., 1999). By taking the active step of simply quantifying the number of committees his faculty were on, the Chair was able to determine who appeared over or undertaxed. The HR leaders also proactively talked about becoming sensitized to the issue of gender bias as they saw themselves as needing to educate themselves and their peers about what inequity looked like and that change did not occur simply with time or through retirements of "dinosaurs".

Low responsibility (LR) leaders tended to describe change with regard to solving gender bias as not being needed. They said things such as "things are good enough", "better than others", "better than before", "simply not a problem" because "20% of our faculty are female, which is great!" "more time will take care of the issue," and similar rationalizations. If these LR leaders admitted change was needed, they attributed responsibility to someone or something else, such as not enough students in the pipeline, not enough institutional support, and so on (McClelland and Holland, 2015).

McClelland and Holland (2015) also noted that the construct of "pipeline" is an ineffective

metaphor as "it does not locate responsibility in anyone's hands. The pipeline construct creates a passive relationship between those who are able to change things and structures that need to be changed" (McClelland and Holland, 2015, p. 217). Furthermore, Morahan et al., (2011) describes the pipeline model as a failure because of several interacting factors including outdated institutional policies, a lack of family-friendly policies, a lack of successful women mentors and role models who hold leadership positions, and the continued disproportionate domestic responsibility expected of women as compared to men. Hewlett (2007) has proposed that a better metaphor is to think of career paths in terms of a highway with on and off ramps which implies agency. This is an improvement over the pipeline metaphor since it encourages people to think of ways to get back onto the path through interventions that can help people restart their careers or enter in non-traditional ways.

How unit and institution leaders talk about women faculty also impacts how others in the organization view these women, their skills, abilities, and achievements. LR leaders essentially viewed women faculty as being responsible for their own gender inequity, as well as being responsible for the solution! For instance, LR leaders saw choices made by women faculty such as having children, lack of aggressiveness within the department, and not having the "right" attitude, as negative choices and the cause of any perceived inequity on their part. The LR leaders even implied that these women did not have a "natural inclination" toward science. The takeaway is that LR leaders project to their followers that it is all the women's fault that women are underrepresented in STEM and thus LR leaders do not spend any time considering their leadership role or possible actions they (the LR leaders) might take to solve this problem. Even worse, some HR leaders who responded also allowed that women's choice to have children will negatively impact on their ability to move from assistant to associate, or associate to full professor (McClelland and Holland, 2015). It is important to note that these same choices were never an issue for male faculty.

The idea that the decision to have children negatively impacts women's persistence and upward success in their STEM careers is ubiquitous in the literature, supported by examples from across the world, and is pervasive among leaders, peers, and the women themselves. This occurs unabated in spite of the availability of maternity leave as an institutional benefit. Although there may be a program, such as maternity leave, designed to provide some assistance, the reality is that utilizing it may not be a good idea especially if the women employee wants to "stay on track." One way to help address women's retention is to make policies "opt out" rather than "opt in", which reinforces the idea that the taking of leave from work is an organizational norm.

Women faculty attitudes were also often mentioned. While the construct of "attitude" seems a bit murky, it appears to boil down to the idea that women are expected to change themselves to be more like men to "fit in". Even when lack of support was offered as being part of the problem, it was followed up with the expectation that women should more aggressively procure support and that it was not the department head's job to offer such support.

HR leaders more frequently named their male colleagues as responsible for promoting gender equity along with themselves, with few mentions of women faculty. Conversely, LR leaders pointed to women as being the cause and the solution to gender inequity. Sometimes LR leaders could appear to be supportive and even invite change, but when it came to actually doing something to make a difference, they typically deflected the change effort from themselves or other men and redirected it to the women. These sleight of hand actions, as McClelland and Holland (2015) called them, are important to observe and understand to have any equity initiative be successful.

In the end, based on biases and myths, women's underrepresentation in STEM for LR leaders was all their own fault, begging the question of who and what will fix this. Placing the blame on women themselves does nothing to disrupt organizational systems that devalue women, their

scholarship, and their capabilities. Thus, success of diversity initiatives to achieve gender equity requires the participation of women, the implementation of institutional policies, male colleagues taking responsibility for their behaviors, and the roles and responsibilities of department leadership actively aligning with equitable practices. These behaviors are fundamental to any leadership role and while this study took place in academia, we believe that low and high responsibility leaders can exist in any enterprise.

We want to note that one promising program to recognize and encourage HR leaders is the HeforShe campaign set up by UN Women (UN Women, 2014), which encourages men to take actions to advance gender equality.

Another important aspect of leadership as it interacts with gender concerns issues around toxic leaders — an all too frequent occurrence in work environments. According to Chua and Murray (2015), men and women respond to toxic leaders differentially, with men overall having better "survival" skills. We could approach this in two ways: (1) help women learn how to navigate toxic leaders in STEM work environments, and/or (2) institute initiatives that neutralize toxic leaders. Let us first understand the phenomena of toxic leadership as well as examine the response differences between male and female employees. Chua and Murray (2015) describe six types of toxic leadership: abusive, tyrannical, destructive, bullying, laissez-faire, and toxic. Manifestations of these forms of bad leadership practices include attacks on one's personality, character, abilities and emotional stability. Examples of this sort of behavior the authors give include criticism of the employee's performance, using employee's ideas as their own, and humiliating employees in front of their colleagues, which open the door for possible objective quantification to get to the real workplace climate as opposed to a perceived one. Finding new ways to objectively identify and then quantify inequitable behaviors may do a better job of shedding light on what needs to change.

With regard to toxic leaders and the toxic climate they foster, a caveat in the literature is that it is the follower's perceptions that indicates whether or not the situation is toxic (Lipman-Blumen, 2005), and this is where Chua and Murray (2015) describe some noteworthy differences between the genders. In fact, Padilla, Hogan and Kaiser (2007) talk about this phenomenon as a "Toxic Triangle" made up of leaders, followers, and the environment. According to Padilla et al., a toxic leader will likely fit a profile characterized by an ideology of hate, high levels of narcissism and charisma, a personal need for power, and negative life themes. Toxic environments are described as being unstable, which could include some perceived level of threat to the employee or organization, disregard for cultural and ethical values, and an absence of checks and balances as part of the organization's policies. These are organizational factors to consider when looking for effective interventions and programs to achieve equity within an organization.

Padilla, Hogan and Kaiser (2007) characterize followers as being of two types — conformers and colluders. An employee who is a conformer is described as generally going along with whatever the toxic leader wants, but not for personal gain and even if it conflicts with the follower's own personal values or positions. Conforming followers are characterized as those with low maturity, unmet needs, and low self-esteem, believing that they deserve to be treated with disrespect. Colluders, on the other hand, see potential for personal gain by following a toxic leader. According to Offerman (2004, p. 56), "Although destructive leadership creates negative outcomes for organizations, some members might prosper". Enron is an example of this when employees assisted their charismatic leaders to commit illegal and immoral business dealings based on personal ambition and potential for personal gain. Overall, men are viewed as more likely to be colluders and women conformers seemingly reflecting traditional gender roles. Qualities typical of colluders are stereotypically more masculine, while conformer characteristics align with traditional stereotypes of female roles.

Adding more nuance to these constructs, Chua and Murray (2015) also examined information

processing, communication styles and differences between males and females that they claim can mediate whether an employee sees leadership behaviors as toxic, and how they respond to these circumstances. They report that the results they found conform with broad generalizations of gender in accordance to societal stereotypes. They characterize women as placing greater emphasis on negative information from leaders because for them it has greater salience. This greater salience, according to the authors, is because studies show that women are more attuned to subtle, false, and or inconsistent cues. Males, on the other hand, tend to be more heuristic, big picture thinkers and place more emphasis on positive information. In general, women see toxic leaders significantly more negatively compared to men, regardless of the gender of the leader. However, both genders are more attuned to toxic communications and subtleties when they come from a same-sex leader. Other factors that may be important but not fully nailed down in the literature may interact with these issues. For instance, perceptions of toxic leadership may be mediated by age, and there is evidence that "attractiveness" may also mediate the communication outcomes (Braun, Peus and Frey, 2015). In addition, the "distance" from toxic leadership may mitigate some of the toxicity. However, with flatter organizations becoming the norm in the modern workplace, toxic behaviors may be harder to avoid and increase perceived (and real) problems in the workplace culture.

While overall, the patterns of information processing and communication in employees, tend to indicate gender-based behavior differences in employees, it is still the case that individual differences can cause counter examples based on gender. Furthermore, these complex, interacting factors of leadership style, employee personality traits, and cognitive style will likely interplay in a malleable manner given well-designed and implemented organizational policies designed to mitigate these inequitable practices and beliefs. Important aspects of successful implementation will involve thorough, relevant, and effective definitions for acceptable behaviors, as well as assessment techniques aligned with the definitions for acceptable behaviors to yield meaningful performance assessment.

Biases Especially Impacting the Employment of Women

Bohnet (2016) studies bias and the use of structural approaches to reduce bias. Bohnet argues that language is naturally gendered. Without actively assessing this, we begin the process of sorting and not including women (or men) in various job sectors. Not surprisingly, the language in STEM enterprises tend to be solidly gendered toward men. Bohnet considers the role of the job advertisement as an early and clear sorting tool. For instance, does the advertisement say they are looking for communal or agentic characteristics? You will recognize that this distinction came up when we were discussing gendered leadership styles. If the advertisement says they are looking for candidates with good interpersonal skills, and uses words like understanding, compassionate, and supportive, the advertisement is much more likely to lead to applications from women. In addition, if the gender balance in the workplace is measured for hiring organizations that use this type of advertisement, one is likely to find more women in existing positions. In contrast, advertisements that say they are looking for ambitious, competitive, assertive individuals, are more likely to receive applications from men, and one will find men predominate in existing positions. Gendered advertisements tell applicants something about whether they "belong" in that organization, and women are particularly attuned to whether they "belong". Economists call it sorting; and people sort themselves all the time into jobs, where they live, clubs they belong to, schools, and so forth, based on linguistic cues. These cues tell a person whether they fit in or if the "cost" would be too high. When it comes to women in STEM careers, this kind of gendered language sorts 50% of the world's population away from this choice, regardless of whether they would actually be good at the job.

It is also known that women are more risk aversive and more likely to opt out of work environments that are described as competitive and use variable pay structures. The net result is that under-confident qualified women are less likely to apply for jobs they would be good at, while over-confident but perhaps under-qualified males routinely apply for and get these same jobs. Finding a gender neutral evaluation method/measurement would be helpful in properly sorting and assigning both men and women to jobs that fit them best. Interestingly, this opting out pattern in women reverses if they are competing in teams. Teams tend to attract women candidates, while pushing away males (consistent with the male meritocracy, individualistic worldview).

With a nod to removing stereotype threats, an organization can move to gender equity by removing gendered language and creating environments that are inclusive of different risk-taking types and promotes universal job flexibility (see below for more on flexibility in section on "Work/Life Balance"). These are parameters for possible inclusion in computational models assessing organizational climate. Other notable factors discussed by Bohnet (2016) that are important when considering gender equity interventions include the methods of organizational climate assessment. For example, it is advisable not to share self-evaluations with supervisors because women consistently under-rate themselves and this factors in negatively when supervisors try to balance women's self-evaluations with those of their male peers. Companies need to consider giving early objective performance feedback to all employees and compensate them accordingly. Organizational climate can be measured, rated, and ranked across companies.

Addressing the Causes of Under-Representation

The history of previous efforts to increase the representation of women in STEM fields, and work to increase their leadership roles, offers some insights into what is needed for sustainable change and to realize the benefits of broadening participation. Up to now, work on diversifying the demographics of STEM seems to have gone in waves. First, there was a focus on role models and then on active recruitment methods and programs aimed at helping members of under-represented populations develop skills to work in whatever dominant culture they find themselves in. Neither approach had a truly transformational impact. Role models by nature often seem to be exceptional people that many potential students struggle to see themselves emulating. Teaching women to negotiate, for example, seems to directly address a problem women face but later research showed women who negotiated the way men did failed to get the same benefits and faced pushbacks (Catalyst, 2007). Initial improvements in numbers without a focus on retention and on changing the conditions which make women under-represented in the first place usually leads to temporary gains. Further complicating the situation, once some women have been hired, the existence of this group can cause the active recruitment efforts to stall out because there is no longer seen to be a need for any action.

If organizations continue to pursue the problem of gender inequity in their workplace, after initial attempts such as those described above prove less than adequate to solve the problem in a sustainable way, the next step is usually a more structured approach. The National Science Foundation ADVANCE Institutional Transformation program (ADVANCE, 2017) is a good example as it systematically looks at the research into why women are under-represented and uses this to inform programs designed to introduce sustainable organizational change with built in assessments of this change. These programs often involve a policy review/update component. Some of these policy changes or recommendations can be very effective. For example, while an institution might allow a faculty member to ask to stop the tenure clock in the case of a pregnancy; the use of this policy was often dependent on the woman faculty member having a department Chair who understood the importance of the policy. Switching to automatically stopping the tenure clock when a faculty member took medical leave took away the perception that there needed to be a negotiation over the use of this policy and this change made it much easier on the faculty member. While these policies help, starting and stopping a science career is not easy. This is why programs that help women stay involved in their research, perhaps by providing temporary funds to hire additional laboratory staff, as some programs in Japan have, also need to be considered.

However, what works in one organization or country may not work in another because the reasons for following a certain career path or leaving one are complex. As discussed, underlying much of what is going on is the influence of unconscious biases or persistent myths about the nature of being a scientist or engineer. While the myths can be rooted in reality, for example, it is hard to balance a STEM career and family life, these are often seen more as absolutes — that is, you cannot have a family and a career. U.S. data that looks at how participation by specific groups decreases at different career stages shows that the patterns of decrease vary widely from field to field (Diversity in Science Association, 2007). This means that the best interventions to increase participation in chemistry, for example, may not be as effective in molecular biology. Overlaying these patterns are data showing that in any field, there is significant variation from country to country that must also be considered when developing leadership models and considering what policies to put in place.

Nevertheless, understanding these patterns of loss, and why apparently similar programs can

have very different outcomes, may provide useful frameworks for thinking about future programs. As we have discussed, bad teaching, stereotype threat, unconscious bias, micro-aggressions, too many off ramps (ways to leave a field without an easy route to return, for example after childbirth), poor balance in integrating work and life, and lack of opportunity, all contribute to the loss. We know that the people who leave STEM (academia and industry) are smart and that losing their skill sets hurts a country's ability to make progress. We know that demographic inertia does not explain the data and that without interventions, the demographics of STEM will not change as significantly as needed. We need to find innovative, disruptive, and scalable approaches to addressing and reversing the losses of our very capable women in the workplace.

Laws and policies are not enough. For example, in Japan, women STEM worker demographics have not significantly changed, even after the passage of the EEOL. This raises the question: how does one create a climate of inclusion, whether it is in academia, or some STEM-based enterprise? Avery (2011) distinguishes the difference between diversity endorsement and actual activism to make change happen. He discusses two general reasons why an employee might endorse or oppose initiatives aimed at promoting diversity and inclusion. One is self-interest — humans tend to be motivated by whatever maximizes their personal outcomes; another is ideology — there are many factors in this category. For instance, how does the individual feel about intergroup equity? Some folks see inequity as justifiable, perhaps because of work ethic, but also because of forms of prejudice, such as race, gender, and so forth (that is, my group is superior to yours). People can differ in their openness to otherness and to diversity beliefs. Some may see diversity as lowering standards, creating conflict, and diminishing performance, while others may view diversity as enhancing creativity, and decision-making, thereby improving performance. But these beliefs are very much subject to being influenced by those in a position of authority, or even co-workers. Employees who feel their core beliefs are counter to authority or other workers' belief systems may feel pressure not to show their true self for fear of repercussions, if there is not an accepted constructive process for dissent. This creates cognitive dissonance in a worker out of sync with others, and is typically quite taxing psychologically (Elliot and Devine, 1994), which could result in emotional exhaustion and diminished performance. On the other hand, if the belief system held by one in authority is rife with prejudice and biased behaviors, this gives license to employees who share those beliefs to give full rein to that kind of inappropriate behavior. Typically, diversity advocacy seems to be associated with minority groups whereas diversity opposition tends to be associated with the privileged majority (Avery, 2011).

A diversity climate is a shared sense of how employees are treated with respect to inclusion and fairness (McKay, Avery, and Morris, 2008). These climates are believed to be affected by malleable factors that can impact employees' personal stance and behaviors. There are examples of obtaining a positive influence on building an inclusive work climate via awareness training sessions (see below). But more importantly, the organizational leadership must, by their actions, send a strong signal for their expectations for inclusion and respectful interactions. This includes punishing bad behavior, such as harassment, bullying, discrimination, and rewarding good behavior, such as instances of employees helping dissimilar coworkers and customers   — all of which makes a difference. Not punishing bad behavior sends a signal that this unacceptable behavior is acceptable not only to the perpetrator, but also to every other employee in that organization. But once again, this intersects with assessment. We must get smarter about the tell-tail signs of bias that can be observed and quantified (in the absence of a good leader overseeing everything that goes on in his or her unit — that is not a scalable solution!).

Van den Brink and Stobbe (2014, p. 187) point out the elephant in the room. While governments, businesses, and universities have shown considerable interest in implementing gender equity programs, they are still met "with open resistance and they are considered highly controversial". Their argument goes back to studies discussed above about what typically underlies work cultures with gender gaps, which is the perception that these equity programs are forcing men to put up with women who "couldn't make it" on their own. Further, the supports that men

routinely receive are taken for granted, while women are expected to fix themselves and any external problems causing their perceived inequitable work environment. Not surprisingly and exacerbating the problem, equity initiatives are typically framed as being about diversity and equal opportunity and are, thus, perceived as standing in the way of traditional notions of a work culture based on meritocracy and individual advancement (Lamont, 2009).

Van den Brink and Stobbe (2014) go on to describe three broad types of gender equity interventions implemented to date, but it is noteworthy that all of them involve various aspects of traditional views around skills that women need to develop to fix the problem. There is a perception that these programs also lower the standards for female hiring and promotion. Morahan et al. (2011) list components of a traditional intervention model that corroborates this traditional approach. Their model relies on deficit skills training including mentoring initiatives, strategic career planning, finance courses, and strategies to increase women's self-efficacy and self-confidence. Another typical approach that is part of their strategy deals with policies and is often coupled with deficit training; these include equal opportunity via policies and procedures designed to address barriers to advancement that disproportionately affect women, but may be viewed by at least some men as added supports for under-qualified women. Are these approaches of any real value? The persistent trend of women leaving STEM fields and overall significant underrepresentation in the work force at all levels suggest that these policies and procedures are not enough. According to Van den Brink and Stobbe (2014), men in academia (and likely other work sectors) fail to recognize the informal support systems they have. When interviewed, they will tell you they succeeded in their career based on the merit of their work/performance. They consistently fail to recognize their privileged position and do not see their considerable informal support structure where men do other men favors all the time as a form of help or support. Even with mentoring, Ibarra, Snook, and Ramo (2010) found that mentors are much more likely to go beyond giving advice to men (but not women) in that they would additionally and actively sponsor men by advocating for them for positions and promotions with other senior men in the organization. Women see and know they do not have the same support. Perhaps re-framing these equity initiatives in a manner that appears to equally benefit all team members, men and women alike, would be a key distinction that has not been tried with most existing interventions and may work.

Working from the perspective of successful organizational change initiatives, Thomas and Ely (1996) offer an interesting framework for thinking about efforts to increase representation. They discuss three paradigms:

- The Discrimination and Fairness Paradigm. This starts from the position that everyone should have equal opportunities to succeed and is sometimes termed the assimilation paradigm since the focus is on treating everyone the same rather than on the end results. Since this focuses on equality of initial treatment rather than on outcomes, the tendency is to expect people to adopt the existing norms to be successful.
- The Access and Legitimacy Paradigm. This recognizes that the world is increasingly multicultural and that remaining competitive requires a more diverse workforce that is culturally competent. This paradigm focuses on what makes people different from each other with a result that it tends to assign people to particular niches but discourages people from working outside of areas they are assumed to be competent in because of their experiences.
- The Learning and Effectiveness Paradigm. This paradigm is a balance between the first two — it looks for ways to incorporate different perspectives and integrate approaches into a more effective whole.

Institutions and industries that develop managerial and leadership practices that support attaining the third paradigm are those who benefit most from diversity.

Thomas and Ely (1996) list the eight characteristics that are reflected in the operations of

successful third paradigm groups:

• The leadership understands that a diverse workforce embodies different perspectives and approaches to work, and demonstrates that they truly value a variety of opinions and insight;
• The leadership recognizes both the learning opportunities and the challenges that the expression of different perspectives present for an organization;
• The organizational culture creates an expectation of high standards of performance from everyone;
• The organizational culture stimulates personal development;
• The organizational culture encourages openness;
• The organizational culture must make workers feel valued;
• The organization has a well-articulated and widely understood mission; and
• The organization has a structure that is relatively egalitarian and not bureaucratic.

The key to the effectiveness of a third paradigm approach is that there is a shift from focusing efforts on helping women survive (first paradigm) or treating women as different from the norm (second paradigm) towards making the working environment one that benefits everyone and recognizes the value of anyone who is part of it.

Studies indicate that what attracts men[3] to STEM are aspects of the work that are seen as consistent with masculine traits such as logic, objectivity, abstract thought, and independent effort. Like traditional masculine leadership, STEM fields are historically practiced as hierarchical, highly structured, context-free, and value neutral arenas. What attracts women to STEM also resonates with their perceived traditional approach to leadership. Overwhelmingly women are attracted to STEM for its social usefulness and ability to help people. For women there is an emphasis on flexibility, inclusion, collaboration over competition, interactive/integrative methods, communication and situating science in its social context. These are all things called for in both followers and leaders of 21st century problem-solving within cross-functional work teams (Kezar, 2009). These are important constructs to consider when creating STEM education that attracts and retains women, as well as when assessing current and constructing new progressive organizational workplace policies and climates in the hope of attracting and retaining women.

What has to change if women are to have the opportunity to have complex, demanding careers? While the focus below and for the rest of this paper is on women in the STEM fields, these are really conditions that if met would benefit all employees (male and female) across the professions.

I. Need to keep women engaged. This is especially important during the secondary education stage where there is the most to gain in terms of numbers in STEM fields, both in academia and industry, including business fields such as economics. The need is to mitigate the precipitous decrease in women in STEM disciplines which is observed when comparing the number of women studying science at high school with the significant reduction of women majoring in STEM once they are in university. However, women exit STEM careers at all career stages.
II. Need to provide solutions that allow for flexible careers so that it is possible to balance life events and work more easily. Many women see the need to choose between a career and a family or to accept a less demanding career in order to accommodate family needs. This means that there is a need for programs that allow women to continue their careers, perhaps at a reduced level, while pregnant and when the children are young. It also means looking for effective ways to help women return to the STEM workforce as children become older.

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3   This is probably a good place to remind the reader that we are generalizing here. An individual may deviate quite strongly from these norms.

Ultimately, finding ways to include women in the workforce regardless of their life stages, such as childrearing, would enable them to retain and steadily enhance their skills and build necessary confidence in their career. Increasingly, work life balance is of interest to men as well as women and it could help in recruitment.

III. Need to ensure that women have the same opportunities as men to be successful, especially in leadership roles. The fact that some women can succeed does not mean that there are no biases against women in the system.

The rest of this paper looks at current efforts underway to help develop an environment that meets these conditions, and importantly how to use what has been learned through research studies and move towards evidence-driven solutions.

Keeping Women Interested

Women start to drop out of STEM careers in their teenage years. There are lots of reasons proposed to explain this trend including a lack of encouragement from teachers and parents to continue on as well as perceptions about what a career in science entails, and a lack of confidence that they can be successful. To counter this, many outreach programs work to provide opportunities for girls to learn more about what STEM careers really entail, emphasizing practical problems likely to appeal to them. These programs often also work to publicize successful women scientists and engineers who can act as role models.

The value of providing role models has come up consistently across the literature. Bohnet (2016) describes studies at the Harvard Kennedy School. Women perform better on a task when they are first shown pictures of, or even just told about successful, famous women doing their work (famous role models did not affect male performance). Bohnet notes that when you enter a boardroom, pictures of previous and current company leaders matter — for example, are they all male? This creates an implicit stereotype threat to women lower on the organization's ladder, whereas a more balanced board sends the message that indeed, women are serving and, thus, seen as role models as company leaders. In fact, McGinn and Milkman (2010) did a study at a law firm and discovered when there were a limited number of women partners, this sent a message to women lawyers just starting out in their careers that there was limited opportunity for advancement. This was exacerbated if more junior women were hired, as the women saw greater competition for limited advancement opportunities, which likely contributed to most of the younger lawyers leaving the firm within five years. Related to this finding in academia, a woman associate professor on a faculty promotion committee is significantly less likely (38% less) to promote a woman assistant professor than is a male associate professor. This same sex gender bias disappears at the full professor level, presumably because of a desire to have and embrace someone similar at their rank. Building the workforce so that there are constructive, effective female role models at every level is important to demonstrate a positive, collaborative trajectory among women instead of competition — that we too often see the competitive side speaks to the hallmark behavior of any group where opportunities and resources are scarce. In STEM companies, the hierarchical, individualistic culture is giving way to team environments as interdisciplinary problem-solving becomes the norm, while individualism still characterizes academia.

In addition to outreach and promoting women role models, some interdisciplinary programs seem to be effective at recruiting and retaining women — for example, the undergraduate courses at Singapore University of Technology and Design (SUTD) and the graduate courses at Okinawa Institute of Science and Technology (OIST). SUTD has a goal of producing engineers who will serve societal needs and aims (successfully) at a 40% female class. They ran an effective recruitment program focusing on the contributions of women engineers and scientists. SUTD's educational offerings are arranged around "pillars" such as "Engineering Product Development", which may be more appealing to women than the more traditional engineering curriculum. OIST is an explicitly interdisciplinary graduate school that requires incoming students to rotate between areas of study. OIST also has a demonstrated organizational commitment to work/life balance and provides onsite childcare — factors that also help it recruit women students and faculty.

Work/Life Balance

The competitive culture of STEM as well as the focus on a 24/7 commitment to succeed is a key reason women choose other options. Work/life related issues such as conflicts between family and career can affect the likelihood of depression and other illnesses, and gender plays an important role in these conflicts (Fujimoto, Kawamira-Shinohara, and Oohira, 2012), (Fujimoto, Azmat, and Härtel, 2013). Anecdotally, interviews with successful women scientists highlight the importance of this issue — either as comments on the importance of marrying a supportive spouse or as comments about feeling that a choice had to be made between having a career or a family.

Traditionally, women opt for lower status, part-time positions to gain the flexibility they need to manage their work/life balance. Up to now, this has been a key factor in gender separation in the labor market (see statistics supplied earlier in this paper). Typically in STEM careers, to secure higher pay and better positions, one is expected to work all the time, continuously, with little regard to family.

Recent initiatives are revolutionizing the notion of a flexible workplace. As an example of this change at the Australian company Telstra, workplace flexibility is the default   — all roles flex, and this remains the default, unless proven not to work for a particular role. This allows a work/life balance for everyone   — both males and females   — without apologies. This organization-wide culture shift removes inherent discrimination against anyone seeking flexibility (heretofore mostly women) since everyone in the organization is doing it.

Given declining birthrates and longer life spans, as well as the technological advances that make working remotely increasingly possible, it seems like the time is right to rethink the role of work in a person's life. Rather than taking a kaizen or incremental approach, this is a problem that Hurson (2008) would argue deserves tenkaizen[4] thinking because it requires being willing to be disruptive of the current norms. While this may seem difficult, the 24/7 lifestyle is a comparatively recent phenomenon and one that comes with many negative impacts on the health and capacity for creative thought by individuals.

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4   Tenkaizen refers to revolutionary change (for example, disruptive to existing practices), in contrast to another popular form of thinking about problems and solutions in business called kaizen, which is about incremental change and continuous improvement.

Work Teams Thrive with the Right Norms

In creating effective work teams, the recommendation (and the effectiveness of this can be assessed) is to combine average ability with complementary diversity of perspectives and expertise. There should be a critical mass of each subgroup[5] to prevent tokenism. These teams should have norms for their processes that embrace inclusiveness to allow for diverse perspectives to be contributed and heard. The willingness to speak up can be different for those outside of the privileged majority and, thus, process rules such as unanimity or sensitivity to opposing perspectives should be built into the team norms to mitigate threats to full and inclusive performance among team members. Studies suggest that you can turn descriptive norms into actionable norms simply by telling people about them.

An area that has not been really well studied concerns determining best practices for work teams and strategies to communication these norms. A useful project and a deliverable for organizations to use would be to survey and elaborate which set of rules and codes of conduct characterize highly effective teams in given contexts. One recommendation is to study and measure communication around norms such that they are framed in terms of positive results (for example, discussing successful companies that have gender diverse boards and/or employees, rather than focusing on the performance of companies with too few women) since this may be more effective. Development of a company ranking index could then be used to motivate companies and people to compete on gender equity.

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5   Subgroup in this context refers to whatever range of personnel that makes up a work team such as women, minorities, privileged males, experts, product users, etc. The idea is that there should be a balance such that no one is treated as a "token" member.

Better Ways to Recruit and Assess Individuals

There are several promising areas of research that are looking into ways to reduce the impacts of unconscious bias on hiring and on individual's perceptions of themselves. Even steps as basic as using a qualifications checklist in the assessment of candidates for a position can decrease unconscious bias. This is most effective when a discussion of the needed qualifications is undertaken before any candidate files are reviewed. Taking this a step further, The Behavioural Insights Team (2017) is working to apply research findings from the behavioral sciences to public services including recruitment. Their work is grounded in an empirical, research-based approach. Recently, an offshoot called BI Ventures put out a tool called "Applied" (The Behavioral Insights Team, 2017) aimed at reducing bias in hiring.

There is also a significant amount of work going into ways to improve student achievement, especially ways to close achievement gaps such as between men and women and, more generally, between members of majority groups and members of under-represented groups. Yeager and Walton (2011) have done an extensive review of how short exercises such as asking students to write about their personal values or discussions of how mathematics ability can be developed through effort can change student outcomes. They also look at the challenges that can be involved in scaling these interventions and how to overcome them. The encouraging results are that there are some straightforward ways to improve the current situation.

Developing Leadership Potential — Existing Programs

As we argued above, access to leadership opportunities is critical to women achieving a full and successful career arc. Data demonstrate that women do not tend to move into leadership positions at anywhere near the degree to which men do because of issues such as the "glass ceiling" effect. Furthermore, when women are offered leadership opportunities, they too often represent a false and precarious path to leadership (for example, the glass cliff). Without the same opportunities as men (leadership being an important example), it has been documented that women eventually leave the workforce, accept a significantly reduced role, or opt out of mainstream enterprise for the riskier entrepreneurial path where they can call their own shots. Since leadership is pivotal to a successful work career, what then are the opportunities for leadership development?

Kezar and colleagues (2009) take a deep dive into academic leadership programs provided to men and women with the recognition of today's complex, multicultural and global environment. These programs attempt to examine foundational leadership skills as they pertain to the academic workplace. They found that while there are a couple of programs that have lasted for decades (others have come and gone in the meantime) and are trusted and well branded, they appear to suffer from systemic issues that do not address today's leadership needs. That is, these programs remain viable in the marketplace because of their robust branding, longevity, and trust, rather than any pretense at meeting actual needs for modern-day leadership development. They categorized these programs as being offered internally, by external groups, and by associations for a given field. Internal programs are described as informal and ad hoc; many are characterized by being organized by volunteers who have "day jobs" and, thus, not providing much consistent commitment to the mission of the training. The overall organization of these programs is lacking and is best characterized by a collection of experts delivering modules in their area of expertise, with only the program director having some degree of overall vision of offering a broad and engaging set of modules within the "program." Most academic programs target leadership at the executive level (for example, Higher Education Resource Services (HERS,2017)) and tend to neglect the middle and junior employees. Those addressing the latter tend to be offered by disciplinary associations and are too few to meet the need and demand. Moreover, the executive level is geared more at the national level, whereas any leadership development offered to more junior, rising employees tends to be focused on issues within the institution. It is argued that both levels of focus need to be a part of a full leadership development curricula.

A recognized world expert in this field, McDade (2009) argues that there seems to be inertia among the well-regarded programs that are well-branded and trusted, yet out of touch with current thinking and the need for updated leadership development initiatives. These programs seem to choose to maintain their curricula as opposed to evolving them to meet current needs, apparently because of having achieved trust in their brand. It is a marketplace issue in that they can rely on their strong branding as a result of ambiguity and lack of knowledge by consumers of the fundamental constructs for successful leadership. That is, an organization may rely on a well-branded, trusted program in the marketplace based on those marketing features rather than a thorough understanding of what their organization needs for an effective leadership development program tailored to their needs and context. Recognizing the issues of these programs' shortcomings can provide the basis for better programs and interventions in the future.

Currently, virtually all programs are designed (typically in the 60s and 70s) to maintain the status quo notion of leadership as a hierarchical, individualistic, top-down, authority-based approach, meeting the needs of current organizational leadership that typically represents this type of

leadership! (Kezar and Beesemyer, 2008). More importantly, these programs typically do not foster collaboration and team leadership — identified as important to 21st century enterprise.

McDade (2009) points out that there is actually very little empirical research about leadership development programs, and a very small cadre of scholars talking and writing about the issues related to the effectiveness of these programs. From our survey of the extant research literature, a review of both programs and evaluations by scholars seems to be directed toward the academic context. Leadership development needs and programs in industry appear to be even less studied, perhaps because the direction of business planning follows market outcomes and is agnostic when it comes to equity and diversity issues, regulations notwithstanding.

There are a few programs that McDade (2009) argues show promise and could be models to build on. The American Council on Education (ACE) offers national workshops, including leadership programs directed at women and minorities in academia. Their Campus Internationalization program, while offered off-campus (cost factors are higher to send groups off-campus) does offer campus team participation and team-building opportunities in their forums and laboratory offerings. The overall focus of this program is at the University Presidential level.

Moreover, the Executive Leadership in Academic Medicine (ELAM) at Drexel University supports collaboration and cooperation in their program activities. McDade (2009) points out that via a Robert Wood Johnson grant, there are studies being done on this program documenting the contribution of this program on participants' leadership and career opportunities and success in the long term, with women who participated, showing an advantage over women who did not participate in the program.

Developing Future Leaders with the Right Professional Skills

Building Leadership development programs that meet the current revolution in leadership strategies (for example, team-based, collaborative, egalitarian, democratic, and so forth) requires revolutionary changes in mission, format, curriculum and participants. So who pays for this? Traditionally, institutions and individuals hoping to improve their career track pay to participate in these programs, with some funding coming from endowments and foundations. Budgetary limitations in all sectors are not a trivial factor. The cost of this revolution will not be simple; exploring a funding model is an important goal in and of itself. Nevertheless, one important way to improve the retention of women is through the spread of effective best practices that improve the climate they experience by reducing unconscious bias and the incidence of microaggressions [6].

The research literature points to the existence of bias in hiring, graduate admissions, mentoring, and building learning environments (including scientific laboratory environments). As we have discussed, the scientific culture is rooted in the belief that the best individuals succeed in rising to the top, and that awards and recognition go to those most deserving and that the STEM fields are a meritocracy (that is, with little consideration of other contextual and cultural factors that inhibit or facilitate success). Again, as we have shown, the literature on unconscious bias in hiring suggests otherwise (Bertrand and Mullainathan, 2003), as do studies of scientific selection processes (Wenneras and Wold, 1997). Our understanding of cognitive dissonance theory suggests that the best way to disrupt the current status quo is to work in ways that do not directly challenge the status quo, but instead emphasize the value of professional practice in hiring, selecting, and building learning environments, as well as in supporting and mentoring newcomers into the scientific community (Bohnet, 2016).

Just as auditioning orchestra players behind a screen increased the number of women orchestra players and demonstrated that the prior selection process had indeed been gender biased (Goldin and Rouse, 2000), evidence also shows that adopting a more structured review process also helps increase the likelihood of hiring members of underrepresented groups (Wilson, Dalton, Scheer and Grammich, 2010). A professional practices curriculum will spread processes that can act like the "screen" and can disrupt the mindset that a meritocracy currently exists, leading to better decision-making and more equitable environments.
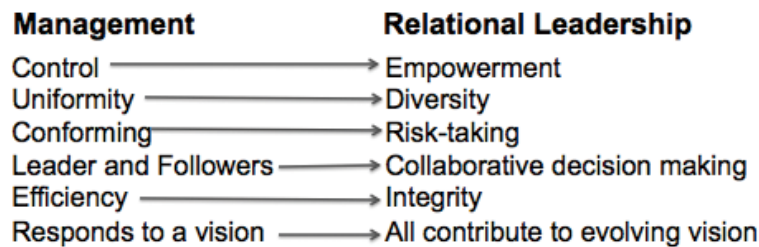
One way to do this is to focus on the development of professional skills that look at effective, research-driven ways to recruit and retain staff. We argue that this training is not common for STEM practitioners, which is one reason why women are currently so under-represented in this group.

Complex adaptive systems have four broad characteristics: (1) the solution to the challenges this group faces are initially unknown; (2) challenges are ongoing, emergent, and unpredictable; (3) the varied and diverse experiences of each member is required in order to address the complex problems the group faces; and (4) the system is interdependent (Dooley, 1997). These four characteristics describe the typical scientific research setting well — a complex adaptive system

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6   Microaggressions are the everyday verbal, nonverbal, and environmental slights, snubs, or insults, whether intentional or unintentional, which communicate hostile, derogatory, or negative messages to target persons based solely upon their marginalized group membership (Sue and Rivera 2010).

must learn to solve novel problems that could not have been predicted as opposed to applying prescribed solutions to known problems (Daft, 2008). The notion of complex adaptive systems has recently been used in conjunction with relational leadership theories to develop a model of institutional change (Borrego and Henderson, 2014). Relational leadership is contrasted with management leadership, as shown in Figure 1.

Figure 1. Relational models bring sociocultural considerations into the theory of leadership

Management		Relational Leadership
Control	→	Empowerment
Uniformity	→	Diversity
Conforming	→	Risk-taking
Leader and Followers	→	Collaborative decision making
Efficiency	→	Integrity
Responds to a vision	→	All contribute to evolving vision

Leadership within adaptive systems is defined as a relational process that engages all participants and enables each person to contribute to achieving an evolving vision (Uhl-Bien, 2006). This type of environment is more equitable than one that depends on leaders and followers. Because the focus is on professional practices rather than on the cultural competencies that it might bring about, it may be more accessible and immediately useable by majority and minority researchers and other STEM workgroups. Our expectation is that a focus on professional practices will lead to the overall development of processes that aid the recruitment and retention of members of under-represented groups (URGs), as well as helping researchers establish more inclusive mentoring and advocacy practices and build more equitable work environments.

One promising approach is the T-shaped professional movement. The concept of T-shaped professionals [7] is often used to describe individuals who are trained for interdisciplinary work.

They balance the deep skills needed in a single discipline (the vertical part of the T) with the broad skills needed to succeed in working in teams and across discipline boundaries (the horizontal bar of the T). The goal is to work to develop these broad skills in a large fraction of the population. T-shaped training programs are suitable for everyone to take, and emphasize building effective skills that teams can apply to a broad range of problems. Since T-shaped training programs do not focus specifically on increasing inclusion, using this approach could increase the likelihood of broad acceptance and adoption. This is a general approach that unifies rather than separates by having both majority and minority practitioners learn together.

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7   A brief introduction to this movement can be found at:

Assessment of the Climate and Effectiveness of Interventions

The ability to intervene in these issues seems to hinge on assessment. There are two general categories of assessment that we will consider here. First, there is the enterprise of assessing an organization's culture and work climate. There is a separate issue of assessment as it pertains to objective and fair performance assessment of individuals. Nielsen, Marschke, Sheff and Rankin (2005) propose that basic quantitative data does not necessarily provide the information needed to monitor the climate and progress towards equity goals. Traditionally, we have relied on surveys that involve self-reporting to tell us about the culture, climate, and belief systems of individuals that comprise some working group, from teams to whole organizations. Self-report strategies in any context are inherently biased, and perhaps more so when the subject of the survey is exploring gender or racial biases. To be of value, one needs to explore methodically and understand how a self-report can be faulty within each context it is used, and take steps to mitigate this bias. Alternatively, we can look to more objective assessment approaches. Fortunately, recent computational approaches are providing tools that may provide the objectivity that can overlook what a respondent says about their biases and take an objective look at what they actually do that impacts potential inequitable outcomes (that is, provide a way to quantify whether a respondent "walks the talk").

As we have seen with studies of leadership, what people say about their beliefs, and what they do on a daily basis, can be quite different. Who a student, professor or employee interacts with on a daily basis or who they actually go to for advice can provide important insights into their actual access to the people with power who might aid their career trajectory. An emerging strategy to understand these community networks comes from recent advances in computational strategies of assessment. This is a metadata approach that shows promise, but the caution is that treating metadata as "ground truth" can introduce theoretical and practical problems in interpreting the results in terms of real-world network structures. In fact, assigned metadata labels can mask important contributions of subgroups. These subgroups can be overlooked because the metadata labels correspond to an attractively simple network and explanation. Peel, Larremore, and Clauset (2016) address this issue by introducing statistical methods that show promise in quantifying the relationship between metadata and community structure and thus in yielding insights of genuine worth. Community networks have been explored to identify many connections, including allegiances or personal interests in social (or working) networks. Clauset (2017) presented work conducted in his laboratory where, by utilizing this statistical network modeling technique, he could reliably sort working colleagues of an organization based on asking insightful questions about who they spoke to at work. What is noteworthy is that the type of questions asked elicited straightforward reports of who people had spoken to in the work environment, and when they did so. The questions were asked in a manner that was unlikely to invoke posturing associated with power and biases — issues that can be implicit in self-report surveys of cultural climate within the organization. Clusters emerged, and in the example studied, racial and gender biases were quite pronounced. At the end of the day, carefully-designed questions are critical. Equally critical is the interpretation of the model/cluster results, and these can be meaningful with careful consideration of relevant factors that co-occur in the data.

Clauset, Arbesman, and Larremore (2015) report a fully realized application of this technique as it applies to the faculty job market in three quite different disciplines: computer science, a STEM

URL:<http://agileleanlife.com/t-shaped-skills-every-area-life/>(accessed April 30, 2017).

field with low female participation; business; and history. Faculty hiring is an expensive and de-centralized process. Clauset, Arbesman, and Larremore (2015) examined 19,000 faculty hiring in North America. They found that 25% of institutions accounted for 71% to 86% of all tenure-track faculty placements. Looking at institution prestige, scholarly productivity, and placement outcomes revealed prestige hierarchies in faculty hiring networks that make a pure meritocracy implausible, suggesting influences of non-meritocratic factors such as social status. The more prestigious the institution granting one's doctorate, the more prestigious the placement. Even the likelihood of receiving any placement at all increases. An objective view of the complex interplay of factors impacting female academic and career success emerge, as we combine this finding with other work that demonstrates that important aspects of scholarly success show gender inequity. For instance, studies have reported that grant proposal and peer review success rates can be higher for men than women (for example, Kaatz, Gutierrez, and Carnes, 2014; van der Lee and Ellemers, 2015) implying implicit biases in the evaluation process (Clauset, et. al., 2015).

Recommendations

Effective organizational change needs to work across multiple constituencies. In Figure 2, we outline a theory of action for ongoing work in this field. We propose some specific steps to advance these concepts and encourage their adoption into practice in both academia and industry. The goal is to have a significant impact on STEM workers and the STEM workforce culture.

Broader Issues for Gender Equity Programs:

• Recommendation: a project to explore models and develop evidence-based performance evaluations. This is complex, given the literature cited above that demonstrated such things as women are given fewer opportunities, have their work undervalued, and are less likely to get published than men. However, an objective assessment of a woman's capability to thrive is key to developing a gender fair environment.

• Recommendation: undertake a detailed survey of gender equity initiatives worldwide. First, build a rubric that characterizes a traditional focus that sets up women against men versus initiatives that build T-shaped skills for women and men alike, giving them the skills to productively work together. Qualify and quantify the organizational policies that allow flexible work hours for both men and women to accommodate their private lives. Build a model that compares these qualities with quantifiable success, such as long-term gains in women in STEM careers and their retention beyond a threshold (five years was used in a law study (McGinn and Milkman 2010)). Also, quantify changes in numbers of women moving into leadership roles, and record how long they remain in the leadership position.

Design considerations for gender equity:

• Recommendation: build a demographically blind algorithm to match-make and compare a STEM job with the objective skills and abilities of candidates. Building this computational model requires understanding and quantifying these attributes. This measurement can be applied to letters of recommendation (known to be shorter, with a greater use of hedges and negative language for women than for comparable male candidates), as well as resumes, curriculum vitae, and job advertisements.

Assessment:

• Recommendation: Organizations need an objective rating method and a normed index that rates and ranks them according to how well they have attained a gender-neutral work environment. A worthwhile project would be to deepen our understanding of the scope and dynamics of workplace cultures that impact gender equity by developing and implementing a detailed survey of these many issues and initiatives worldwide, using evaluation strategies with particular attention to the emerging computational network approaches that do not rely on direct self-reports about one's biases. Rather, if properly crafted, these surveys with the right evaluation strategies can provide objective evidence of behaviors that are known to underlie gender bias or gender neutrality. These surveys should undergo pilot testing and norming in real workplace environments. EPMEWSE has already developed significant infrastructure to survey and track the gender gap in STEM in Japan — an organization such as this may be a natural home for this algorithmic development.

Professional Development:

• Recommendation: Survey the existing leadership programs in industry and academe to

determine what exists as well as the longitudinal outcomes where they have been applied (for example, numbers of women in STEM and in leadership roles) and to determine components of their curriculum and costs for an overall assessment of cost versus effectiveness. It is also important to address what seems to be working versus what appears not to be working, and to propose recommendations for change, including a cost model and funding strategy. This could be followed up with a pilot implementation of the best practices that emerge from the data in representative workplaces (that is, business and academia) to determine efficacy.

Recommendations Regarding Gender-Gap Related Programs in Japan:

• We note that there are several initiatives based in Japan that show promise for decreasing the gender gap. Longitudinal research should be done (or continued, if already in place) on these and other initiatives to demonstrate that they actually impact persistence in STEM careers among women. Among these are the KASOKU program — a program to accelerate promotion among women researchers at Kyushu University [8]. This program could have the positive impact of establishing women leaders in their departments and provide experienced mentors for junior researchers. Another program that targets a key problem with persistence and restarting one's career after childcare leave, the Restart Postdoctoral Fellowship (RPD)[9], also shows promise. From 2006 when it started until 2016, the program has gone from 30 awardees per year to approximately 70 awardees per year, although applications have remained consistent in the 200 to 250 range. Of those that participate, the data demonstrate that after five years, participants move from 63% full-time employment to 90%. Over a career (longitudinal data) is there increased persistence in STEM employment (both academic and industry) for women? If this has been the case, how can this program be expanded to help more women who had been educated and had worked in the STEM fields to re-enter the workforce after childbirth? We recommend continuing to develop and explore further these initiatives.

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8   Directed by Eriko Jotaki, Office for the Promotion of the Equal Opportunity in the Workplace. Kyushu University

9   A Japan Society for the Promotion of Science (JSPS) Fellowship – more details can be found at: URL:<http://www.jsps.go.jp/english/e-quart/17/02.html>(accessed April 30, 2017).

Figure 2. Project Theory of Action/Logic Model for Gender Equity in STEM careers

Problem	Activity	Outcomes
1. Women make up a very small percentage of the STEM workforce, both in academia and industry. 2. Not enough women in college career prep for STEM; not enough women in the STEM faculty. 3. With an aging population, we need all the capable talent, having equal accessibility to STEM careers. 4. Women do not persist in STEM careers. 5. Women do not complete a career arc by moving into leadership as compared to men. 6. Many programs and interventions have been around for many years, yet the numbers of women succeeding and persisting in STEM careers have not changed much.	Develop an objective index that scores and ranks organizations on gender equity practices related to 1, 3 and 4. Explore pipeline issues and make recommendations for best practices to build interest and foundational skills including among those in pre-college and college to address 2. Document successful leadership traits for types of work by different organizations; create criteria for expected performance to use in recruiting and training leaders to meet 5. Explore retention issues; document evidenced-based factors that impact retention; cross-cut these issues with intervention curriculum for which there are measures of impact; make recommendations for best practices in evidence-based interventions, with additional recommendations for added curriculum to address all key organizational practices documented to impact persistence; and pilot programs to meet 4, 5 and 6.	An index provides transparency about where equity problems exist and where intervention needs to be focused, and creates a measure that, in turn, creates opportunity for competition for the best talent. Provides easily communicated description of organizational practices that foster employee equity and career success. Creates guidelines/ interventions for better organizational leadership and equitable opportunities for under-represented groups, particularly women. Provides guidelines for effective equity practices and interventions Demonstrates over time that these practices and interventions increase women's sustained participation in STEM careers.

Conclusions

Many of the issues facing us today originate in the fact that the leadership style that dominates is competitive, with a win at all costs, "me first" thinking, focused on achieving short term benefits. There seems to be little interest or ability to develop strategies that consider long-term impacts. Thus, we are seeing an erosion of public trust in the political leadership, and ethical breakdowns in research and business.

The long-term health of society as a whole, such as a better quality of life and access to fundamental rights including the right to food and education for all, demands a change in the working culture. We need collaborative leaders who are willing to take on global problems and work for the long-term benefit of society. This is the leadership style embodied by High Responsibility leaders and which is more effective for complex problem-solving. This is a leadership style that we know tends to be more the norm for women, and given the relatively low representation of women in leadership, we know there is a large potential pool of leaders in this group. Hence, working to increase the presence of women in leadership arguably provides the quickest way to shift to a better leadership style. In addition, changing demographic trends make it imperative to increase the participation of women in the workforce (and also make it important that this is achieved in a way that does not discourage women from having and raising a family).

This paper focuses on women in the STEM fields because the representation of women in STEM is particularly low in Japan and many other countries in the world, not because the STEM fields have unique problems, but because most of the problems faced by women in the workforce are found in their most extreme forms in the STEM fields. The importance of STEM workers to the knowledge-based economy means that there is an immediate return on investments in increasing the number of women. As a result, not only has there already been much work in this area, but also there is a general ongoing willingness and interest in improving the representation of women in STEM. The extreme lack of representation in STEM makes it easier to highlight the issues around raising women's numbers in this sector and harder to resist the case change is needed. Programs in STEM, especially successful ones, receive attention. Programs in STEM produce a beneficial feedback loop; raising the numbers of women and recognizing the skill set these women bring to the STEM enterprise reinforces the necessity to work on global issues to attract more women. In other words, what works in STEM-related careers can be adapted for use in other fields. We believe that this is the right time to advocate for gender equity — there is an understanding of the salient issues, increasing ability to assess programs and invest effectively in them and, most importantly, a true need. We challenge everyone to make attaining gender equity their goal and responsibility. We can all make a difference!

Acknowledgements

Useful Materials/Further Reading

We include below references that that could be useful for following up on themes in this paper or act as the basis for further work.

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