

**Bias Literacy:  
A Review of concepts in research on discrimination**

February, 2008

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## Abstract

The paper offers a quick digest of the evidence for discrimination, especially with reference to women in science and engineering. It explains common terminology and lists relevant legislation and national policy initiatives. The paper summarizes the difference between tradition and bias, conscious and unconscious discrimination, overt and covert discrimination, and personal versus institution bias. Drawing on research in psychology and social science, it summarizes core concepts including: gender schema, accumulative advantage, stereotype threat, implicit bias, glass ceiling, mommy track, occupational segregation, statistical profiling, climate study, and the value of diversity in learning. A short section lists some national and international approaches to measuring whether discrimination is occurring and how improvements are benchmarked. There is a list of major organizations working for diversity, with links. The paper is a short tour for people new to the topic, especially education practitioners, policy people, and individuals who participate in the discourse on discrimination but typically do not read the whole gamut of social science research literature. Many of the concepts are more fully described in the recent national report *Beyond Bias and Barriers* (2007), which inspired this “literacy” effort.

## Literacy

The idea of literacy is applied to many types of knowledge and skills. For example, you can be considered literate in reading and writing, in finance, computers/technology, information, health, and religion. Literacy can refer to basic competencies in daily life: "Know how to scramble eggs." It can refer to basic competencies in specialized professions: media, mathematics, technology, culture, science, or economics.

The common gist about literacy is that it is a way to isolate a knowledge domain and give us measures for basic competency. Usually the idea of literacy includes: a vocabulary, the facility to converse about widely shared ideas and facts, the ability to recognize issues and problems that arise, the basis to question and to explore, knowing how the literacy impacts every-day and work life, and knowing how to use it to understand or solve problems in your personal and professional life.

Who dictates what it is to be literate? In school settings, there are groups who set educational standards. In trades and professions, there can be standards for the certification of people who prepare to work in a field.

Typically, what we consider to be competent, knowledgeable, and skilled is less well-defined and often unexpressed. Literacy is a set of expectations for individual behavior (expression and action) among people who share a culture. The expectations are part of a social, workplace, or organizational culture – what any insider knows.

Bias Literacy is a timely construct because many individuals and organizations are engaged in understanding the problem of discrimination in society and in the workplace, but have not anchored their thinking in reflection and research on discrimination. When – in what contexts -- do we claim that someone is discriminating and is biased? How do we arrive at that assessment?

We also believe that literacy is the first step toward action on bias. This is not an intellectual exercise. Once we understand the dynamics and impacts of discrimination, we should understand what to do, and what others are doing successfully, in order to make bias transparent where it has been hidden or unacknowledged, and to control illegal bias. We are all victims of discrimination when our society or profession or group is built on a false sense of equity.

From the beginning of time, people have had to negotiate sharing resources in spite of their differences. Civilization is the process of organizing human activity into structures that allow us to flourish without mutual assassination or banishment, for the most part. Here, we use the enterprise of science and engineering as the social context from which to draw examples and research. We are concerned particularly with the extent to which women and minorities are treated with or without bias and discrimination in the American system of producing and employing scientists and engineers. We hope the dialog is improved by isolating the basics.

## The Vocabulary

There are a few key words and phrases that occur often in the discourse about discrimination.

**BIAS.** The definition of bias is inherently negative. It is to favor a view or group over others and to be unfair or partial to a view or a group. Regarding ethnicity, bias may be rooted in racism, which is to consider members of one race or group to be intrinsically superior to others. The *motive* for bias may be unconscious and unintended, however. Bias can be rooted in tradition or prejudice, such

that the socialization of children and new members encourages members of a group to be biased against members of another group. (“Asians are superior to whites.” “Women do not have a brain for math.”) Bias can also be unobservable. We discuss these dimensions in the next section.

**DISCRIMINATION.** “Discrimination” is a synonym for “discernment.” It is not inherently negative to analyze differences among things or people, and to make distinctions. It is negative when it is acted upon: treating an individual based on a class or category – such as a stereotype or statistical profile – to the detriment of the individual. (“A woman who becomes a mother will lose interest in her scientific work.”)

**PREJUDICE.** When a person holds or expresses an adverse, preconceived judgment or opinion about someone else, they are prejudiced. The meaning of the word emphasizes a lack of evidence, and a lack of interest in seeking evidence to sustain this attitude.

**BIGOTRY and MISOGYNY.** These two words are placed together because they both mean irrational suspicion or hatred of a particular group, race, or religion. The common aspect is hatred. Extreme prejudice and extreme discrimination are behind bigotry and misogyny. They imply not only a lack of information or a lack of sophistication, but deep emotional roots and conviction. (“No woman is going to get tenure here.”)

**INTOLERANCE.** Intolerance is a version of bias and discrimination. It stands for the unwillingness to recognize and respect differences in others. There is not necessarily a feeling of superiority on the part of the intolerant person, but possibly a feeling of impatience, discomfort, or dislike (lighter versions of bigotry and misogyny).

**TO BE FAIR.** What does it mean to be without bias and without prejudice, and to be fair? *Social tolerance is the capacity to recognize different beliefs, practices, and life experience in others, and to respect others in spite of their difference from you. It means holding stereotypes at bay. It means letting the merits of an individual trump preconceived, unsubstantiated negative assumptions about the individual’s group. It recognizes that an individual may not represent the group – especially not a gross statistical profile or reductionist view of a group.*

**SOCIAL JUSTICE.** The cause of social justice is about making society fair in its distribution of rewards and burdens. The “cause” is not necessarily rooted in some universal notion of what is fair, and how society should be made fair. Although everyone embarked on the mission of social justice feels a kinship and an affinity to a struggle, it pays to ask fellow-travelers which injustice is the target, and whether you agree on the methods for achieving a remedy. Sometimes the “movement” for equality on the basis of race is itself sexist, and the “movement” for equality on the basis of sex is racist. For example, our nation’s Founders implicitly excluded “women” and “slaves” when they established the principle that “all men are created equal.”

**RESEARCH.** Research is a systematic, controlled, and empirical investigation and process of inquiry. Its goal is to discover, interpret, or revise facts, events, behaviors, or theories, and to develop or contribute to credible, knowledge that can be generalized. A scientific method will often employ a hypothesis and the gathering of evidence to test or reject the hypothesis. Social science research may investigate the phenomenon of discrimination in society. Research on discrimination and characteristics of groups and their differences is *not the same as advocacy for social justice.*

**ADVOCACY and ACTIVISM.** Advocacy is the active support and promotion of an idea or a cause for the sake of changing public opinion, acceptance, and behavior, for example, the cause of social justice. Its methods of influence are wide and varied, ranging from public education, social marketing, and lobbying. Advocacy is inherently driven by values – notions of right and wrong.

Advocacy is not motivated by the same goals and constraints as research (that is, empirical investigation validated by expert judgment). Advocates may use research to make their case for an idea or a cause. (“Because X is true, Y is the right course of action.”) Conversely, researchers may advocate for social change. (“X is true, and it is socially wrong or bad.”) Advocates summarizing research may be biased (favoring a viewpoint) and selective (e.g., omitting contrary results) in making a “research-based” argument. Researchers may fail to be “scientific” in crossing the boundary toward advocacy for a particular social change. Many published articles on discrimination, especially in the media, confuse research and advocacy. A critical reader should ask themselves if a particular author is making a research case (“this is what we know about X”) or whether the author is offering a prescription (“this is the way things should be”). Sometimes both appear in the same piece of writing.

**POLICY.** Policy is a commitment to achieve a valued objective. It may suggest details as to delegated actors, stakeholders, processes, and timetables. Public policy is synonymous with federal legislation and investment. Outside government, policies are more community-specific. For example, a university may hold the policy that “the faculty will be more diverse in 20 years.” Leadership, resources, and detailed action plans are necessary to act on the policy. Since the objective is a subjective value, the process of deciding, supporting, and achieving the policy can be highly politicized.

**DIVERSITY.** The word represents the value on having the composition of a group, organization, or workforce reflect the distribution or composition of groups in the greater society and population, by race and ethnicity, gender, culture, disability, and other social differences. There are disputes about what constitutes sufficient diversity in a team, group, organization, etc. Diversity is a “problem” when groups are not represented to the extent that they “should be,” given the customer base, the population base, and the society in which they exist. Some regard diversity as a condition to be improved (that is, a starting point), while others consider it a solution to a problem retarding achievement of an organization’s goals (an end point).

**LAW.** A law is public policy that has been adopted as mandatory practice through a legislative process. It is a rule or body of rules of conduct given authority by a government. It is enforced by designated oversight or accountability agencies. For example, notions of “fairness” can be legislated, disputed and interpreted in courts, and enforced. Individuals or organizations that “break the law” can be punished.

### When Is Bias Illegal?

When a group of boys in school take over a scarce computer to engage their interests (educational or not), pushing girls aside, they are expressing a preference for each other’s company and for the pleasure of sharing a passion with like-minded friends. When a white, middle-aged engineer teams with his white male peers on a project he is expressing a preference for collegiality, friendship, and familiarity in tackling the complexities and risks of his project in a socially comfortable environment.

Preferences in both contexts have consequences beyond the immediate situation. In the school setting, the lack of access to a computer may mean that girls do not learn as much as the boys. They are put at a disadvantage. They may be discouraged from using certain tools. They may associate the tools with a select, narrowly defined group (computer=boy thing). They may not enroll in technology classes because they find them unpleasant and unwelcoming. They may fail to develop skills that are foundational to advanced study and preparation for certain careers.

In the second case, the elite team is choosing not to seek out or enlist younger researchers or researchers who are not in the personal network of the group, though they may be more appropriate

to the project or offer needed expertise. They are placing a higher value on social comfort and familiarity over wider brain power and intellectual inputs, over the development of new talent, and over the extension of their network to a broader community.

Generally, we may subscribe to the principles that schools should “leave no child behind,” that all kinds of students should be exposed to every feasible publicly funded educational experience, that the workforce needs the best minds and more people, especially in advanced science and engineering. The behaviors (on the part of the boys in school and their teachers; on the part of senior researchers and their administrators and funders) are not consistent with expressed values and national policy. The behaviors are unthinking, traditional, or uncontested. They are not technically illegal, unless they are part of a pattern of exclusion, and their impact adds up to measurable discrimination. They are merely unfortunate, lamentable, counter-productive – and maddening to the excluded.

**AMERICA’S CORE VALUES.** The United States Constitution expresses the fundamental values of our country. Use of the phrase “illegal bias or discrimination” is only meaningful with reference to our legal system. Other countries have not codified “fairness” to the same extent as the United States, nor in the same ways. Here is our statement of “truths we hold to be self-evident:”

“...all men are created equal.” Declaration of Independence, 1776

We should not assume that other countries share our definitions of rights and privileges, nor enforce them in the same ways as in the U.S.

Here are legal constraints to exclusion and discrimination, as contained in:

- **Equal Pay Act of 1963.** Abolishes differential pay based on sex.
- **Civil Rights Act of 1964.** Title IV outlaws racial segregation in schools. Title VI prohibits employment discrimination on the basis of race, color, religion, sex or national origin and establishes the **Equal Employment Opportunity Commission** as enforcer.
- **Title IX of the Education Amendments of 1972.** “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving Federal financial assistance.”
- **Americans With Disabilities Act of 1990.** Prohibits employers from discriminating against qualified individuals with disabilities in job application procedures, hiring, firing, advancement, compensation, job training, and other terms, conditions and privileges of employment.
- **Civil Rights Act of 1991.** Strengthens Federal civil rights laws. Title II set up the **Glass Ceiling Commission** to study discrimination (1991-1996).

Compliance with legal mandates can be soft. For 30 years, Title IX was applied mostly to the issues of inequitable provision of sports programs and sexual harassment in K-12 schools, though this law explicitly identifies neither “sports,” sexual harassment, nor primary and secondary schools as its focus. There is room for interpretation as to whether a program that has few girls enrolled is designed to keep them away. With sports, the improved availability of high school programs and the provision of programs designed to appeal to girls led to a ten-fold increase in participation over 30 years. At the college level, the increase was 5-fold. (National Coalition for Women and Girls in Education, 2002, pp. 14-20; Blumenthal, 2005) Could the same be achieved in engineering? Other

countries have shown that there is nothing inherently “male” about engineering, for example. Why, then, the gender imbalance in participation?

The U.S. Department of Education Office for Civil Rights bears the responsibility for monitoring compliance with Title IX for the nation’s schools, and the Office of Science and Technology Policy oversees the compliance among institutions funded by the federal research and development (R&D) agencies, including HHS (NIH), NASA, and NSF. In the case of compliance reviews in higher education, very little activity has been reported publicly.

There have been national policy initiatives to promote diversity and equity:

- **The Perkins Act of 1978** (reauthorization) required each state to hire a sex-equity coordinator to make the vocational training system more equitable. (However, it provided little funding and its reauthorization in 1998 eliminated endorsement of the position.)
- **The Equal Opportunities for Women and Minorities in Science and Technology Act of 1981.** States that it is U.S. policy and in the national interest to encourage all groups to participate in science and engineering. Mandated that the National Science Foundation report statistics on underrepresented groups and initiate a suite of programs to influence diversity in the science and engineering workforce. To this day, NSF is the only R&D agency with this mandate.
- **Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development 1998.** A two-year congressional commission created to research and recommend ways to improve the recruitment, retention, and representation of women, under-represented minorities (namely, African Americans, Hispanic Americans, and American Indians), and persons with disabilities in science, engineering, and technology (SET) education and employment. A follow-up to what became known as the Morella Commission was a public-private partnership, BEST (Building Engineering and Science Talent) that published several reports in 2002-2004.
- **U.S. Government Accountability Office Report on Gender Issues 2004.** Found Title IX enforcement inadequate, especially pertaining to higher education in science and engineering, including at institutions with research funded by the U.S. Department of Energy and NSF.

Bias is illegal when members of society are denied access to resources and opportunities on the basis of their membership in a group subject to discrimination. They are disadvantaged and cannot participate in the benefits of the society or contribute equally. America values equal opportunity in education and employment. America needs the participation and contribution of its best talent.

## Concepts

### *Tradition Versus Bias*

The first college in the United States, Harvard, was founded in 1636. Only elite young men attended college at that time. Women and people of color (of any class) were excluded. Oberlin College was the first to admit women, in 1833, and the first to admit students of all races. This means that *traditionally*, for nearly 200 years in America’s history, women and people of color did not have access to higher education. There was no legal mechanism in place to contest the tradition. The first women to get degrees found it hard to gain employment, as *traditionally*, they

were not welcome in the workplace. The early female and “colored” pioneers in higher education might have protested, but in those days, they did not sue in court.

Highly-rated institutions continued to exclude all women as late as 1970 (e.g., University of Virginia), to exclude them from certain fields of scientific study, and to deter them from graduate study in certain fields of science, such as physics and astronomy. Exclusion from certain fields of science in the 1960’s partially explains the low numbers of women available to be nominated to the National Academy of Sciences until recently.

Once women entered the workforce in great numbers, there was social acceptance for the break with the traditional idea that “a woman’s place is in the home.” However, some occupations were considered more appropriate than others. The “helping” roles of nurse, secretary, primary school teacher, and assistant were generously open to women, due to a number of traditional assumptions: women were not primary income providers for families and did not need high pay; their salaries were disposable income; they were not building careers; they were not interested in power and leadership. Both men and women commonly held these views. There was great social pressure to conform to tradition. There was little public debate about assumptions, and little support for women who had other ideas about work and career. It is true that many women did not feel that they suffered bias, because they found satisfaction in their traditional role and in their conformity with the majority.

Regarding ethnicity, class, and sexual orientation:

Until the 1960s, the great majority of American college and universities were overwhelmingly white. Minority students were rarely seen; their cultural traditions were almost entirely excluded from both the formal curriculum and the informal campus culture. Many institutions sustained quotas on specific religious groups. Other campuses either excluded or subordinately women while virtually every institution denigrated homosexuality. For students from less privileged economic and/or cultural backgrounds, class was--and remains still—a difficult and often painful issue. (Smith et al., 1997, p. 8)

The struggles to change tradition can be long and hard, especially when life styles of the advantaged classes are dependent on the free or cheap labor of a group. For example, slavery was abolished in America only in 1865, and women were given the right to vote only in 1920. Other countries were on a different timetable – some earlier and some later. Australia, for example, gave *women* the right to vote, but initially not *aboriginal* women. Discrimination dies hard and fades with much scrubbing. Legal milestones do not automatically bring about social acceptance and conformity with laws. We might ask historians how long it usually takes for new legal rights that challenge tradition to be assimilated – 100 years or more?

### ***Conscious Versus Unconscious Discrimination***

When the MIT Report on the Status of Women was issued in 1999, Dean Robert J. Birgeneau added among his introductory comments:

I believe that in no case was this discrimination conscious or deliberate. Indeed, it was usually totally unconscious and unknowing. Nevertheless, the effects were and are real. (Massachusetts Institute of Technology, 1999)

This is also called subtle prejudice. An in-group holds unconscious beliefs and associations about an out-group. In the minds of the in-group, their differences are exaggerated (linguistic, cultural, religious, sexual). Members of the out-group are portrayed as outsiders, worthy of avoidance and

exclusion or disadvantage. The in-group may justify the negative attitude and treatment by blaming the out-group for choosing to be deficient. If the in-group is a majority, in society, and in command of most of the resources (jobs, positions of authority, leadership, ownership), it might unconsciously favor its own members, and portray its own members more favorably in many contexts. For example, media portrayals of adventure heroes or doctors or heads of countries will show the in-group “in its element,” with the out-group invisible or in subordinate or negative roles.

It is very hard to detect and protest subtle, unconscious discrimination. It may be manifest in petty slights, nuanced visual clues, tone of voice, lack of eye contact, and so on. A TV show that omits the presence of women and minorities may seem normal. The victim’s claim that “You are not treating me as an equal” might be hard to substantiate (without a five-year MIT study by senior scientists!).

### ***Overt Versus Covert Discrimination***

It is possible for *intended* discrimination to be *covert*—unobservable and possibly uncontestable. For example, an academic committee may choose among candidates for a fellowship and discuss their belief that a woman should not take the place of a man, and they do not document their discussion, nor report it outside the meeting. If the committee members are unaware of their bias, for example assuming that a woman who just married or just had a child probably lost interest in graduate school, their discrimination is *unintended* and *covert*.

### ***Personal Versus Institutional Bias***

Sometimes it is not the personal behaviors of individuals that disadvantage a group, but *rules and policies* of an institution. This is also called “structural discrimination.” For example, a highly qualified couple may find that one is offered a position at a university in a remote small town. There are no other potential employers for the other spouse within a reasonable radius. Because the university’s nepotism rules preclude hiring the “trailing spouse,” that spouse must remain unemployed or under-employed, and usually out of their professed field. Another example are rules for qualification for tenure that are unforgiving of temporary leave-of-absence to bear a child, thus posing a disadvantage to a woman who chooses to have children in the first 7-10 years of her career, which are optimal years for childbearing.

Another example of a structural bias is to require a test as a qualification for a job (or other opportunity) that is known to disadvantage a certain group. An English language test – beyond the requirements of a job -- can be used to screen out immigrants. An aptitude test was used to prevent African Americans from obtaining jobs. Until the Civil Rights Act of 1964, flight attendants had to meet height, weight, age, and vision (no glasses) requirements, and be single -- all attributes irrelevant to their primary work function, which was passenger safety. Fire departments historically used excessively challenging physical tests to eliminate women from eligibility. “Women seeking admission to the New York State College of Agriculture in the 1970s needed SAT scores 30 to 40 points higher than those of men.” There were quotas for women in college admissions. (NCWGE, 2002)

Structural bias is impersonal – it is embedded in rules and procedures. It makes it easier for the insider to say “Sorry, I don’t make the rules” to the outsider. It may also be unintended—more tradition than policy. And it is sometimes hard to measure the effects, though we are learning how (see “Climate Study” below).

## ***Gender Schema***

All people are exposed to assumptions about gender from birth on. A girl and a boy will have different experiences in any society from the first minute their sex is known through the rest of their lives. They will be differentiated, and learn to differentiate, on aspects of appearance, activities, toys, roles in the family, and occupations. Like other cultural values and assumptions, assumptions about gender are internalized and are likely to become unconscious.

Gender schema theory (Martin & Haverson, 1981; Valian, 1998) holds that gender plays a major role in how children organize information. Gender provides a structure that constitutes an implicit theory. There are probably differences in how strongly gender typing acts between individuals. Younger children tend to have simpler constructs that they hold more rigidly. It is postulated that their initial simple and rigid constructs provide consistency and stability as they make sense of the world.

The gender labels that children learn can evolve into stereotypes. Stereotypes are not inherently bad. They simplify our world and offer rules of thumb about what to expect in social interactions. Gender schema theory is one of several psychological approaches to explaining how children develop identity, particularly gender identity.

Stereotypes across cultures for men and women are not uniform. A majority of cultures expect men to be dominant, competitive, and achieving, and women to be co-operative and supportive. However, expectations (especially implicit, unconscious expectations) and actual behavior may not be consistent. Our interpretations of the normal range of acceptable behavior will vary by culture and by individual, as will our tendency to assign a negative weight to deviations. One example of "gendering" is to consider the behaviors and clothing that are considered gay in America today. In some countries, men hold hands and use expressive gestures, and they are not labeled "gay."

According to Virginia Valian (1998), schemas are hypotheses and unconscious beliefs, shared by both men and women, that can skew our perceptions of their respective abilities. We tend to over-rate men, and under-rate women. In one study, people making a judgment about the height of a man and a woman of equal height, for example, perceived the man as taller. In a study of the peer review system of the Swedish Medical Research Council for post-doctoral fellowships, female applicants had to have more credentials than men to get the same competence rating from reviewers. (Wenneras & Wold, 1997) A study of the influence of gender in the review of curricula vitae for faculty found that both men and women favored male job applicants. One study took actual curricula vitae, created male and female versions, and sent them for review as candidates for faculty positions. It found that both men and women preferred male job applicants. (Steinpreis, Anders, & Ritzke, 1999) Another study compared letters of recommendation for medical faculty candidates and found that the letters differed "systematically" in preference toward men, in terms of length, "doubt-raising" language, and references to status. (Trix & Psenka, 2003)

Other studies show that we expect men to be capable of independent action, and that men do things for a reason (in contrast with women). We expect women to be more nurturing, expressive, and caring about the group or community than men. In situations where we evaluate the professional competence of men and women, and where there is much room for interpretation, men will have a significant advantage due to unconscious assumptions. Our schema for males is a better fit for professional success, and especially for high-intensity scientific and engineering careers. The theory of schemas explains the disparities between men and women in salary and advancement across professions.

### ***Accumulative Advantage***

Due to gender schema and other deep-rooted schemas about race, class, sexual orientation, there are many expressions of unconscious and undetected bias against excluded groups. Accumulative advantage is the idea that many small advantages cumulate over time and add up to a larger advantage. Disadvantages work the same way, negatively. The idea of cumulated disadvantage explains why even small disadvantages are important. They can over time grow into large disparities in salary, promotion, and status. “The rich get richer. . .” “Like interest on capital, advantages accrue, and . . . like interest on debt, disadvantages also accumulate.” (Valian, 1998, p. 3) A computer simulation postulated an organization staffed with equal numbers of men and women at the lowest level, having 8 levels of promotion potential. At each level of promotion in the simulation, men were given a mere 1% advantage over women. At the beginning, the starting group was comprised of 50% men and 50% women. After eight minutely advantaged moves, the top level of the organization was 65% male. (Martell, Lane & Emrich, 1996) Even small imbalances over time add up to major differences. When a woman or minority is denied access to a course, given a slightly lower grade, denied academic assistance, excluded from a study group, not encouraged, denied a fellowship, a job, or a promotion because of discrimination, they suffer an increasing gap in the competition for opportunity. The rich not only get richer, but the poor poorer. To recover competitive ground, the latter have to gain more than 1% in qualifications or opportunity to reach the same level as members of the advantaged group.

### ***Stereotype Threat***

Both men and women think and act according to gender schema automatically and unconsciously, for the most part. Children develop gendered stereotypes from early elementary school and by late elementary school show strong stereotypes. At these ages, girls and boys show equal primary abilities for mathematics. Sex differences in quantitative skills emerge after elementary school. (Steele, Reisz, Williams & Kawakami, 2007)

The theory of stereotype threat holds that when an individual is made aware of his or her identity in a group that is negatively stereotyped for an activity, their performance will be impaired (thus confirming the negative stereotype). For example, African Americans taking an IQ test who are told that their intelligence is being measured will do worse than those told it is not measuring their IQ. (Steele & Aronson, 1995) Another example is female students taking a math test and being made aware that “women are not as smart as men in math.” The effect is stronger in those who care about the domain. (Steele et al., 2007) The effect is triggered by raising awareness of negatives just prior to testing. When women are told that they usually do worse on a math test than men before the test, they tend to do worse than the men. When white men are told they usually do worse on a math test than Asian men, they tend to do worse than the Asians. The effect has been shown in African Americans, Latinos, low SES students, and the elderly (regarding memory), especially in testing environments. The effect can be triggered without *explicit* reference to the stereotype. For example, exposing individuals to strong cues about their group identity (gender, race, age, etc.) prior to the test can trigger the effect (e.g., filling out a form that asks subjects to identify their group).

Girls have often heard in school, from peers, teachers, and parents: “What are you doing in the physics class?” or “Do you think you can handle the material?” The effect can be mediated a number of ways. Strongly optimistic (and non-judgmental) relationships between students and teachers help. Making the negative stereotype conscious, and refuting it, helps. Awareness of positive role models – individuals from the group who counter the stereotype – helps. Individually, self-affirmation and raising a strong sense of self-adequacy can help foster psychological resistance. If the subject is made aware that they are possibly anxious about anticipated negative expectations,

and not really anxious about their ability, they tend to do better. “Teaching about stereotype threat inoculates against its effects.” (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007, pp. 46-47)

A related idea is the Pygmalion Effect. In studying the effect of teachers’ expectations on students, Robert Rosenthal and Jacobson (1968) found that high expectations can result in better performance. This is also known as a self-fulfilling prophecy, applied to many types of relationships such as doctor-patient or manager-employee. The dynamic is different than stereotype threat – it is interactive, between an authority figure and a student or subordinate, and, it usually refers to *positive* expectations. Yet, similarly, the student internalizes the expectation and changes to meet it.

In education literature, the phrase “soft tyranny of low expectations” is often used to blame schools for the poor performance of disadvantaged students. It is another variation on discrimination – the projection of not necessarily a stereotype but rather a negative, low expectation, which research shows will affect response.

### ***Implicit Bias***

Can we tell if we are prejudiced? Project Implicit at Harvard University recognized that people are either unwilling to report their attitudes and beliefs, or, unable to report them because those attitudes and beliefs are unconscious. (Project Implicit, 2007) They designed an online test designed to uncover unconscious thinking and feeling. The test prompts for associations between words. It measures not so much the patterns of associations that the subject makes, but rather the time (in milliseconds) it takes to respond to a sequence of rapid prompts. Longer times suggest a difficulty making an association automatically. Among the Implicit Association test suite of experiments are tests of a subject’s preference for young versus old people, preference for white versus black people, sexuality, gender and career, and gender and science. For example, it often reveals a an association between “liberal arts” and “females” and between “science” and “males.”

People taking the tests have been surprised at their implicit associations that indicate bias and discrimination. Some are shocked and dismayed at their scores because they have spent their careers and lives committed to fighting discrimination; their identity as a “fair” person is threatened. Subjects often want their results kept private because they consider them professionally damaging. The site warns: “If you are unprepared to encounter interpretations that you might find objectionable, please do not proceed further.” The Implicit Association tests are showing that that even the best *conscious* intentions and *conscious* reflection can cannot easily “undo” our *unconscious* schemas. The test can also measure change in attitudes and beliefs after a subject has learned to make different associations.

### ***Glass Ceiling***

Why can’t women and minorities “get to the top” or “move up the organization”? Because of the glass ceiling, which is a metaphor for an invisible barrier. It does not matter what the qualifications and ambitions of an individual who is “up against the ceiling,” if they are a member of certain groups, they will be blocked from advancement. It is possible to identify *where the ceiling is*, in an organization or in a profession. In an equal and fair system of promotion and advancement, every individual has an equal chance of getting ahead. If members of certain groups never or rarely advance, then their group membership is the variable that explains their lack of success. Statistics about the characteristics of people at each level of the organization can show that a

disproportionate number of the “disadvantaged” people drop off. *Why* they drop off can have many reasons and mechanisms.

Title II of the Civil Rights Act of 1991 created a 21-member, bipartisan Federal Glass Ceiling Commission. The Commission’s mandate was to study the barriers to the advancement of minorities and women within corporate hierarchies. Their definition was: “artificial barriers based on attitudinal or organizational bias that prevent qualified individuals from advancing upward in their organization into management-level positions.”(U.S. Glass Ceiling Commission, 1995)

The case of Asian Americans in science and engineering illustrates the glass ceiling effect. (Chen & Farr, 2007) Asian Americans are a population minority in the United States – about 5%. They are over-represented among students and professionals in the fields of science and engineering, that is, Asians are more likely than other groups to enroll and graduate. More than 15% of all doctorates in science and engineering are held by Asians. (National Science Foundation, 2003) As a group they have higher educational attainment than whites. Chen and Farr offer four criteria for a glass ceiling: the inequality represents a gender or racial difference that is not explained by other job-relevant characteristics of an employee (such as education, training, field, location), the inequality is greater at higher levels, it is an inequality of opportunity and not merely an inequality in numbers of people at high levels, and finally, the inequality increases over the trajectory of a career. The authors conducted statistical analyses of data crossing seven years, between 1993 and 1999. They found a glass ceiling effect for Asian Americans (both men and women) at all stages of their careers in science and engineering, and confirmed the effect for all women (regardless of race) in science and engineering.

A significant monograph on Asian Americans across all occupations, not just science and engineering, was produced for the Glass Ceiling Commission. (Woo, 1994) Other studies have found the effect for African Americans. Catalyst, Inc. updated the Commission report in 2000, with an emphasis on women in management. (Catalyst, 2000a)

### ***Mommy Track***

The “Mommy Track” is the socio-economic phenomenon that working women who get pregnant and have children experience lower expectations at work, lower opportunity, and lower pay than those who do not have children.

The “Mommy Track” is a complex dynamic. We cannot definitively say that it is the result of systematic discrimination against women who choose to raise children. If anything, it is structural discrimination in our society generally. The tremendous rise in the participation of women in the workforce over the 20<sup>th</sup> Century has collided with tradition that treasures women’s total dedication to the home. We cannot blame any single employer for traditions and stereotypes that make women our primary care-takers in the family. Nor can we expect any single employer to offer the ideal answer to staying competitive (i.e., having a workforce that works long and hard and at reasonable cost by competitive standards) and at the same time allowing for employees to “have a second job” at home in order to fulfill tradition’s ideal family scenario.<sup>1</sup> Instead, we tend to deny that the “second job at home” exists. Mothers returning from maternity leave (a “stolen time” of three days to three months) are supposed to “return to normal” and go back to “giving their soul” to work.(Crittenden, 2001, p. 35)

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<sup>1</sup> The tension is, in our opinion, behind the mommy wars played out in newspapers and blogs. Women who choose full time family care (mommies) feel maligned and guilty, and women who choose a career alongside family feel maligned and guilty. Most interesting is that women attack each other, vehemently and profusely, instead of attacking American societal structures that have not relieved the tension by offering better supports for sustenance of family and flexible work and career paths.

***The Job of family.*** The work of raising children and maintaining a family is significant. There is a large literature on the time spent on household work, showing the effects of education, marriage, ages of spouses, presence of children, and so on, and trends in the last century. Roughly, married partners together spend about 53-55 hours per week. Working women do two-thirds of the household chores, and spend 25-30 hours a week. In a study of business school graduates, “the presence of children adds from three to ten hours per week to the workload of male graduates and from ten to 20 hours per week to the workload of female graduates.” (Bujaki & McKeen, 1998), p. 114) Since children are not as easily ignored as laundry and cleaning, the workload constitutes as *at least the equivalent of a part-time job.*

***The Family and home is women’s work.*** “American culture generally stereotypes care-giving as feminine work.” (Committee on Maximizing, 2007, p. 174) Tasks and responsibilities at home have not shifted significantly to men, in America. The pressure to maintain the family and the home falls unequally on women.

***Changing expectations.*** Our expectations for how to raise children and how much time to spend raising them have increased. Although there are more supports for child care than there used to be, such as child care centers, pre-school, kindergarten, after-school programs, and community centers, there is a greater expectation that children need constant enrichment and attention in order to thrive. Popular media feature the importance of reading to children every night, exposing them to varied experiences, food, people, and providing much close physical contact. Research shows that children who are not stimulated at home are disadvantaged when they enter school. The research is behind programs like Head Start to provide enrichment in early years to disadvantaged populations. The cost-benefit to society of rich early family environments have been calculated. (Heckman, 2006) In disadvantaged children, early stimulation of cognitive, linguistic, social and emotional competencies reduce the need for later social programs and interventions such as reduced pupil-teacher ratios, public job training, convict rehabilitation programs, tuition subsidies, or expenditure on police. We don’t think we should compromise parenting and child care, we don’t want to, and we recognize the later costs of early neglect. Old authoritarian approaches to child raising – “stay out of sight and out of mind” and “play amongst yourselves” – are out of vogue.

***Family-Friendly workplace?*** The definition of a family-friendly workplace is one where an employer acknowledges the demands of family responsibilities and adopts policies that allow for flexibility, particularly in the time and location of work, absence from work, and allowances for family care. In spite of the Family and Medical Leave Act of 1993, the United States “lags far behind all wealthy countries” with regard to family-oriented policies, and lands in a group with Lesotho, Liberia, Swaziland and Papua New Guinea in not guaranteeing some form of paid maternity leave. (The Associated Press, 2007) Among established policies are paid maternity and paternity leave, paid sick days, support for breast-feeding, child care facilities, and limits on the maximum work week. The U.S. is a leader in providing equal opportunity to work, but has not helped the family. We can only speculate why American society, relatively, has “left the family behind.” An enormous literature in the late 20<sup>th</sup> Century explores the problem, identifies solutions, and offers model implementation plans and policies. Good employer behavior is frequently highlighted and recognized via national awards and media exposure. An example is the Sloan Work and Family Research Network (2007). A common intervention for improving on retention of female faculty in science and engineering is to provide relief from the traditional tenure process which coincides with prime child-bearing years. (NSF, 2007a)

***Women and career interest.*** Women’s expectations that they will work and have careers have risen phenomenally and rapidly. In 2006, adult women with B.A.s held 52% of those degrees, 53% of Masters degrees, 36.5% of professional degrees, and 31.5% of Ph.Ds. (U.S. Department of Education, 2006, Table 9) Women with degrees are more likely to work than women without

them. (Coontz, 2007) Over the last century, the participation of women in the workforce has gone from 18.4% to 46.4%. (Rutgers University Center for Women and Work, 2002)

**Higher expectation for advancement in career.** Legal challenges to discrimination have opened more positions, more kinds of positions, and higher positions, than ever before, as well as more equal pay. Young women graduate from college now perceiving no barrier to their ambitions based on gender. Research reports monitor the changes in opportunity for women in business, closely, and are encouraging. (Catalyst, 2007)

**Opting out.** The tension between working (typically full time) and raising a family has led more women to opt out of careers in spite of investing in long and intensive career preparation - confirming old stereotypes that "women just want to get married and have a baby." Early in the 20<sup>th</sup> Century, "the first group of American women to receive a higher education - those graduating around 1910 - virtually had to renounce motherhood and family life if they wanted a career. More than half of the female college graduates of that generation never had children. There was a clear-cut either-or choice: *career or family*." (Crittenden, 2001 quoting Goldin, 1995, p. 33) The next generation, graduating around 1933, had a "*job then family*" pattern. The graduates in the 1950s (the post WW II decade) "had substantially higher marriage and fertility rates than their predecessors" and went to work after their children were older. Their pattern was *family then job*, for almost all the doors to the professions were still closed to them with the exception of teaching." (Crittenden, 2001, p. 33) "Fewer than 20 percent of college-educated baby-boomer women [graduating between 1966 and 1979] managed to achieve both motherhood and a career by their late thirties or forties. ... Women without children have been *twice* as successful in achieving a career as the women with children. Fully *half* of the women who had attained a career by midlife were childless." (Crittenden, 2001, p. 32) A study of female M.B.A.'s in high management positions found that fewer than half have children, compared with 84 percent of male peers. (Crittenden, 2001 quoting Catalyst, 2000b, p. 35)

Many statistics show that women are disproportionately concentrated in less pressured career positions - lower levels of management, community and four-year colleges rather than research universities, non-profit associations, and staff jobs. Did they opt out?

**Or pushed out?** Employers are in the position of pressure to hire without bias regarding family status (single or married, children or no children) and to invest in professional development fully, regardless. At the same time, they may find prized employees walk away from the investment because of family pressure. (It is a joke for politicians - "I quit in order to spend more time with my family.") Some of this experience may reinforce old biases against committing to women and making allowances for their "home distractions." A study of high-achieving women - graduates of Harvard's professional schools between 1971 and 1981 - found that 25 percent of the M.B.A.s, who were "some of the most expensively trained and highly motivated people in the country, had left the workplace entirely by the early 1990s. Many said they had been forced out of the best jobs once they became mothers." (Crittenden, 2001, p. 36 quoting Walker & Swiss, 1993, p. 34) According to the study, the women were taken by surprise at falling in love with the new baby, and, at the inflexibility and even hostility they encountered in the workplace.

Studies of the female brain drain found that the cost of replacing professionals could exceed the cost of a year's salary. Some employers respond by providing flexible schedules and other allowances, and not punishing women who elect to enjoy them. (Crittenden, 2001, p. 36) Inevitably, some male managers and supervisors will consider these benefits unfair advantages, and unconsciously shy away from hiring or promoting women. When a woman has a child, she signals a choice to be available to family over career. Very few people would question her new priority of responding to family needs (sick child?) over work demands (critical presentation?). Peer perception in the workplace is likely to expect the woman to stay home with a sick child rather than a man. A

1992 study of government executives found that “women with children have received fewer promotions than women without children and than men, even after controlling for length of service, education, and other factors.” (Crittenden, 2001, p. 41 quoting Merit Systems Protection Board, 1992)

**Parents and productivity.** There are a few studies that show that people who have children and no one at home full time *devote a few hours less to work per week* than those who do not. (Committee on Maximizing, 2007; Crittenden, 2001) Employers and peers can exaggerate the negatives associated with “family distractions.” Some states have laws prohibiting discrimination against parents. In academics, there are studies that show a gender gap in the number of papers published, but they tend not to isolate the effect of parenthood. (Committee on Maximizing, 2007, pp. 117-123) Even so, the practice of counting papers as a measure of productivity is controversial. Measuring work productivity across all types of work is problematic, so the question of whether parents are less productive cannot be answered objectively. That is unfortunate, because the assumption is common.

**The Dilemma persists.** It is hard to separate out how much the Mommy Track is due to women’s withdrawal from intensive career pressures, and how much it is due to being “pushed out” or “parked” by employers. There are signs that the conflict is a taboo subject in professional life. Crittenden (2001) calls it a “conspiracy of silence.” Academics are even reluctant to fill out questionnaires about their needs for accommodation for family life, lest it have repercussions on their career advancement. Meanwhile the subtle effects of workplace marginalization and the female brain drain cumulate, reducing the income and status of women, and wasting everyone’s investment in the development of human capital. There is a joke that Ginger Rogers did everything Fred Astaire did, only backwards and wearing high heels. There is research evidence that a baby on a woman’s psychological hip can be a career drain and a career buster.

### **Occupational Segregation**

Occupational segregation is a sociological label for the phenomenon whereby certain groups are concentrated in certain jobs. In the United States, the Census data currently identifies 449 broad occupations. (Bureau of Labor Statistics, 2007) The distribution of men and women across such a wide spectrum is, however, surprisingly uneven. In 1997, 75% of women were concentrated in mainly ten occupations: secretary, cashier, administrator, nurse, sales supervisor, nursing aide, bookkeeper, elementary school teacher, waitress, and retail sales clerk. (Fain, 2007a) There are many, many more jobs where there are a few women, but mostly not: specifically, 66 occupations in which they are less than 25% of the workers in the occupation category. (Fain, 2007b) These are often called non-traditional occupations.

Affirmative action has opened many job opportunities that were formerly closed cues to blatant exclusion or special rules that screened applicants by gender. For example, now there are more males among nurses, secretaries, and airline stewards. There are more females among police officers, carpenters, construction workers, and security officers.

Vocational education in the United States before Title IX restricted women’s access to non-traditional careers such as automotive, aviation, food, and maritime trades, all normally higher-paying than the careers open to women, such as health services, teaching, graphic arts, office technology, and cosmetology. Efforts to open vocational programs are still ineffective. (NCWGE, 2002) The National Alliance for Partnerships in Equity (2006) tracks annually the statistics on non-traditional careers, showing those in which males or females are more than 75% of the current occupation group. Collapsing classifications of jobs from multiple sources, they list 204 jobs that are *non-traditional for women* (women comprise less than 25% of workers), and 62 jobs that are

*non-traditional for men* (men comprise less than 25%). Many reports have observed that, generally, women are still concentrated in the lowest paying jobs, and in relatively few “pink” jobs.

There is horizontal segregation or uneven distribution across types of work specializations. There is also vertical segregation, which is the concentration of one gender in higher, more advanced positions in a given occupation.

As the gender gaps in university attendance narrow, and as more women enter the workforce than ever before, and more egalitarian views enter the public consciousness, and legal barriers to discrimination are assimilated – is there less sexual segregation in the workforce, especially in developed countries? Not really. “Occupational ghettos” persist, because of deeply rooted cultural assumptions across many cultures that men and women are fundamentally different. (Charles & Grusky, 2004) Women are considered suited to provide service and nurturing, and men are considered suited to do physical labor, technical tasks, and abstract calculation or analysis. Thus women cluster in service-oriented occupations that don’t involve manual labor, and men are clustered in physically demanding occupations often involved with manual labor. When both participate in occupations that do not require manual labor, there is still vertical segregation due to views that men are more competent and status-worthy than women. The segregation is perpetuated, especially in affluent economies in which a wide variety of careers and occupations are available, as males and females adapt their interests to conform to traditional models, and employers project their fundamental assumptions about differences.

Occupational segregation by gender is a self-fulfilling prophecy on a societal level. Gradually, as men work as nurses, administrative assistants, and in care-taking professions, and as women work as soldiers, security guards, economists, CEOs, and civil engineers, the public may adjust its view of differences from real experience and allow for a less segregated profile. During World War II, women were called to take on jobs normally excluding them, and showed they were quite capable of performing them well much to the surprise of many. This demonstrates that strong biases about differences can be suspended.

### ***Statistical Profiling***

Statistical profiling is a legitimate and powerful technique made possible by the availability of huge banks of electronic data (such as the national census), ubiquitous computing, and software that put it feasibly in the hands of anyone who knew statistics. It made it possible in marketing to analyze and target consumer behavior – “if a person with a median income likes to barbeque they will probably buy lawn care products.” Statistics made it possible to analyze voter behavior, and the characterization of highly refined subsets of population such as soccer moms and their likelihood of holding certain positions on issues. Unfortunately, it also can promote simplistic, and reductionist thinking: “women don’t want demanding jobs.” The logical fallacy is to mistake an individual who shares characteristics with a profiled group as having all the characteristics, and attributing a determinism to the profile. For example, “Soccer moms will support investment in education.”

Statistical profiling can thus create and reinforce false stereotypes and assumptions by making them appear to be a truth about individuals.

### ***Climate Study***

Sociologists have characterized the culture of organizations. Universities promote themselves on the basis of unique traditions and constellation of values. Professions such as physics, geology, and mathematics develop a pride of professional identity. Accordingly, academic departments which are

a microcosm of a disciplinary field can reverberate and reinforce characteristic identity as they bring new students into the profession. Unfortunately, certain fields (electrical engineering), like certain occupations (airline pilot) are gendered -- especially strongly associated with male dominance, and thus women are not perceived by themselves or others as a "good fit."

There is no wide consensus about the definition of organizational or professional culture. (Powell, Bagilhole, & Dainty, 2007) Cultural life encompasses psychological predispositions, beliefs, values, and learned ways of behaving. Organizations can be characterized as hierarchical, patriarchal, sexist, resistant to change, or competitive as well as collaborative, egalitarian, open, and dynamic. "Historically, the image of engineering has been tough, heavy and dirty, and to do with machinery." (Powell, Bagilhole, Dainty, 2007, p. 50) When women go against cultural dictates and undertake "male work," everyone is uncomfortable. They can experience a hostile environment of bullying, stalling, sabotage, harassment, and spite. The behaviors can be small instances of conscious or unconscious, intended or unintended, overt or covert bias and resentment. A culture can also be simply indifferent, uninteresting, or uninviting.

There is a research literature devoted to climate study -- the challenge of determining whether a culture is experienced as friendly by women and whether it has embedded structural, or institutional barriers. The subject of a climate study is the atmosphere and environment for students or professionals, both intellectual and social, and interactions between individuals, the community, and the system of the institution. The survey tool typically addresses perceptions and experiences of individuals in various roles (e.g., students, faculty, teaching and lab assistants, peers), perceptions of typical experiences (classroom, laboratory, advising, tutoring, conferences), and personal characteristics (confidence, perception of the field, preparation for the field). Data can be disaggregated by gender, ethnicity, year in school or year in profession, and citizenship status. Most climate studies focus on an educational institution or a department.

Two major studies of students found that aspects of a negative climate explain the loss of qualified students in their first years of college study. An ethnographic study about students leaving science and engineering was conducted by Elaine Seymour and Nancy Hewitt (1997). They conducted a three-year, multi-institutional qualitative survey to identify the reasons why undergraduate students, with an emphasis on females, leave S&E majors for non-science fields. With no significant differences in academic preparation or performance between leavers and non-leavers, it was found that leavers: lose interest in S&E; are drawn to a non- S&E major; recognize poor teaching; and feel overwhelmed by the fast pace and workload of their coursework. Women were more likely than men to be discouraged by the competition in S&E departments. Seymour and Hewitt also found that, for many women, experiencing engineering education as a distinct minority automatically puts them at a psychological disadvantage, eroding their confidence.

In another large-scale effort, the *Women's Experiences in College Engineering Project* (WECE) conducted a cross-institutional, longitudinal examination of undergraduate women's experiences and persistence in engineering majors at 53 universities. (Goodman & Cunningham, 2002) Consistent with Seymour and Hewitt, over 30 percent of the exiting students cited *school climate factors* as a reason for leaving. WECE also noted losing interest and attraction to another field as key factors for leavers.

Brainard and Carlin (1997) conducted a six-year longitudinal survey of female students in science and engineering at the University of Washington. Factors that influenced the decisions of women to persist in, or switch out of, degree programs in engineering and science were: a significant loss of self confidence in their first year of study; a loss of interest, discouragement, lack of confidence, poor advising, and an attraction to another field. Persisters continued because they had a positive view of their coursework, understood career opportunities, and had positive experiences with faculty and with a Women-In-Engineering program.

Hartman and Hartman (2006) conducted a longitudinal survey of engineering students to determine characteristics of stayers and leavers at Rowan University. Involvement in student activities was a major factor in student retention. Leavers were less likely to be involved in discipline-specific professional societies, academic enrichment programs, and interactions with faculty.

Three case studies of physics departments yielded a set of characteristics that produce a high percentage of female graduates in physics. (Whitten, 2003; Whitten, 2004; Whitten, 2007)

- Faculty support structure
  - More women on the faculty
  - Family-friendly policies, addressing child care, family leave, and the “two-body” problem
  - A tolerant atmosphere (no sexist remarks, invited speakers include females)
  - Good team work
  - Support for junior faculty, especially in the first year
- Recruiting and outreach
  - An inviting departmental web site
  - Community presence at science fairs, summer programs, school visits
  - Department and admissions office work together
  - Offer bridge programs
- Role of alumni and alumnae
  - Department maintains relationships with former students
  - Use alums to illustrate career options
  - Highlight alum accomplishments
  - Bring alums back to give talks as role models and career awareness
- Departmental culture
  - Students have an active role in maintaining supports for others
  - Strong sense of community
- Introductory courses and early course experience
  - Courses are interactive
  - There is a value and use of team work
  - Courses include learning “the culture of the profession”
  - Offer special math skills development, such as 3-D spatial skills
  - Courses convey applications of the field to the environment and to social issues
  - Students participate in research with faculty
  - Safe labs
- Student care
  - Mentoring for four years
  - Student lounge
  - Tutorial service
  - Lab assistants
  - Seminars on career aspects
  - Club and social activities

A climate study can be one stage in an institutional process to change its culture in order to recruit and retain more diverse students in science and engineering. Data and discussion about a local context is more persuasive to faculty than national statistics on the issues. An example of such an intervention is the University of Wisconsin-Madison Climate Workshops for Department Chairs. (Committee on Maximizing, 2007, pp. 224-225)

### ***Value of Diversity in Learning***

Many people dismiss the pressure to diversify as rampant political correctness. Personally, they assume that their profession or group's system of recruitment and advancement is fair, and that members who are brought into the group are evaluated objectively. They consider the pressure to include individuals from under-represented groups as an effort to favor less qualified people and to compromise standards. The research evidence for discrimination is not usually considered, in their argument, nor is the evidence for *the value of diversity in learning and work*.

The question gained critical importance in 2003 in the Supreme Court's deliberation of a suit against the University of Michigan for using race-sensitive criteria in admitting students to law school and to its college. (University of Michigan, 2003) The University's intention was to ensure that it had a racially diverse student body in order to provide the best possible learning environment for students. It was exercising affirmative action by artificially reversing a historical trend of low enrollments by African American students. The Court found for the University's procedures in the law school but against them in the college. (Alger, 2003)

Many organizations supported the University's position by submitting briefs summarizing substantial research on the educational benefits of diversity. One brief represented 34 associations in higher education. (American Council on Education et al., 2003) The summary of a key brief reads:

Research studies show that student body diversity can promote learning outcomes, democratic values and civic engagement, and preparation for a diverse society and workforce—goals that fall squarely within the basic mission of most universities. Several studies demonstrate that student body diversity broadens the range of intellectual opinions on university campuses and improves classroom learning environments, that diverse learning environments promote thinking skills, and that cross-racial interaction has positive effects on retention, college satisfaction, self-confidence, interpersonal skills, and leadership. Diverse learning environments challenge students to consider alternative viewpoints and to develop tolerance for differences, and can promote participation in civic activities. Studies further show that student diversity better prepares students for an increasingly diverse workforce and society. (American Educational Research Association et al., 2003)

Within the briefs were hundreds of citations for research studies and policies behind the value. Some verified empirically positive learning outcomes for students exposed to diversity, such as thinking ability, sophistication of opinions, higher self-confidence, and improved interpersonal and leadership skills. A special case for the value of diversity in science and engineering was among them. (Massachusetts Institute of Technology et al., 2003) Prior events, especially California's Proposition 209 and the legal decision in Hopwood versus University of Texas, prompted an earlier published literature review (Smith, 1997) and the development of a web site to consolidate and update knowledge on diversity. (Association of American Colleges and Universities & University of Maryland, 2007) Findings are generally that "environmental and experiential components of a diverse campus have positive affects on retention, overall college satisfaction, college grade point average, and intellectual and social self-confidence." (Smith, 1997, p. 28)

### **How Is Bias/Discrimination/Unfairness Measured?**

Most countries gather data about their population through a census. The type of data gathered and its ability to show social and economic trends depends on the theories behind the design of the survey. Disaggregation by sex is common for census data, but not always common for data about

occupations or education and other domains of life that are assumed to be neutral and independent of differences due to sex.

International comparisons are problematic due to uneven investments in data collection, lack of infrastructure to gather data, and no universal conceptualization of the issue, for example, women's empowerment. Nevertheless, the international development community has worked to adopt and refine measures related to discrimination and inequity. The United Nations uses a Human Development Index to measure a country's achievements in longevity (life expectancy at birth), knowledge (adult literacy rate and education enrollments), and a decent standard of living (GDP per capita). A **Gender Development Index** is based on the Human Development Index and measures disparities in achievement between men and women. Following an international conference on sustainable development in 1994 and the 1995 Beijing conference on women, the use of a **Gender Empowerment Measure** was introduced. The Gender Empowerment Measure also estimates gender inequality in economic and political spheres of activity. Economic participation and decision making is measured by the percentage of female administrators and managers, and professional and technical workers. Political participation and decision making are measured by the percentage of seats in parliament held by women. Power over economic resources is measured by Women's GDP per capita (PPP US\$). (United Nations Economic Commission for Europe, 2007) Extensive studies have scrutinized the measure and its implementation (Malhotra, Schuler, & Boender, 2002) and refined it. (Williams, 2005; Beteta, 2006)

In the United States, the U.S. Department of Labor, Bureau of Labor Statistics provides Occupational Employment Statistics (2007) which provides extensive, detailed information about employment by occupation, and wages, with analyses down to state and local levels. The web site used to offer breakdowns by sex, but those reports were removed under the George W. Bush administration and the information must now be specially retrieved or requested. Other organizations have made the effort to retrieve the data from BLS and present it for the analysis of occupational segregation by sex. (NAPE, 2007)

The Equal Opportunities for Women and Minorities in Science and Technology Act of 1981 mandated that the National Science Foundation report statistics on under-represented groups in science and engineering. The agency publishes **Science and Engineering Indicators** biannually, and a more detailed volume **Women, Minorities and Persons With Disabilities**. (NSF, 2007) The reports give statistics on enrollments in higher education by field at the undergraduate and graduate levels, disaggregated by race/ethnicity, disability status, and sex, as well as employment in science and engineering. From time to time, the National Science Board issues special reports with greater depth of analysis of statistical trends, for example, **Broadening Participation in Science and Engineering Faculty**. (National Science Board, 2004)

The most detailed statistics on education at the K-12 level are available from the National Center for Education Statistics. Indicators on learning with breakdowns by race/ethnicity and gender are given in the publication of national statistics, for example, the National Assessment of Education Progress (NAEP). Also, special publications such as **Trends in Educational Equity of Girls & Women: 2004** assemble a series of indicators that examine the extent to which males and females have access to the same educational opportunities, avail themselves equally of these opportunities, perform at similar levels throughout schooling, succeed at similar rates, and reap the same benefits from their educational experiences. (U.S. Department of Education, 2004) It shows, for example, the rates of enrollment in Advanced Placement courses, and compares median scores on national mathematics and science tests.

The Commission on Professionals in Science and Engineering monitors national statistics on human resources in science, engineering and technology. (2007) CPST regularly publishes **Professional Women and Minorities**, which is a detailed reference book of data on human resources presented in

over 300 tables with breakouts by sex and minority status. **Professional Women and Minorities** is widely regarded as an authoritative source of data and trends in science and technology. Data on enrollments, degrees, and the general, academic, and federal workforce by field and subfield are included. It has been published biennially for nearly three decades.

A special project reported looked at the top fifty research departments in universities in science and engineering. It compared statistics on graduation rates, by sex and race/ethnicity and with profiles of the faculty. (Nelson & Rogers, 2004; Beutel & Nelson, 2005) Comparing these two datasets showed that leading departments were not hiring women and minorities at nearly the rate as they were graduating. It also showed that less than 15% of full professors in top research departments are women or non-Whites. In the fields of biological sciences, psychology and social sciences, women were up to 15%, but they were much lower in physical sciences and engineering. In addition, Blacks and Hispanics made up 4.1% of faculty, with female Blacks and Hispanics at only 1%.

The American Association of University Professors (2006) looked at **four indicators for “faculty gender equity”** (across all fields in higher education, not just science and engineering):

1. Employment status (are women employed as faculty full-time tenure-track or other?)
2. Tenure status (non-tenure track, tenure-track, tenured; by type of institution)
3. Full professor rank (percentage of women by type of institution)
4. Average salary (salaries by rank and across all academic ranks)

The National Science Foundation’s ADVANCE program (NSF, 2007a) funded a number of institutions with the aim of institutional transformation in advancing female faculty. A number of projects have developed very detailed measurements to quantify progress. One evaluation (De Cohen & Clewell, 2006) for example, employed the following measures:

- Faculty in science and engineering by gender
- Faculty in tenured/tenure-track positions by gender and rank
- Faculty in non-tenure-track positions by gender and rank
- Faculty in administrative positions by gender
- Faculty in endowed/named chairs/professorships by gender
- Faculty on promotion and tenure committees by gender
- Tenure promotion outcomes (baseline and during grant) by gender
- Years in rank by gender
- Time at institution and differential attrition by gender
- Salaries of scientists and engineers (faculty) by gender (with controls)
- Space allocation by gender (with controls)
- Start-up packages of newly hired S&E faculty by gender (with controls)

## **Changing the Status Quo**

### ***Agents for Change***

There are many motivations for working against bias and discrimination. Individuals and organizations may find themselves lumped together when their agendas are truly different, and actually narrowly intended:

- **Fairness and social justice** – harkening back to America’s purest principles of equality and legal mandates

- **Wider educational opportunity** for the purpose of greater literacy in a complex society
- **Empowerment of women and minorities** to redress historical disadvantage
- **Rational human resource development** to stay responsive to demographic trends, a global economy, and diverse customers
- **National economic and technological competitiveness** – recruiting more good talent to build intellectual and economic capacities to maintain America’s lead in productivity and growth

A growing constellation of organizations is engaged in promoting diversity:

- **Federal agencies** have diversity policies and programs. The National Science Foundation requires every grant application to address “broader societal impacts,” (NSF, 2007b) which means pushing science to people it does not reach as well as it should. NSF has a division for human resource development, (NSF, 2007c) and special initiatives. The National Institutes for Health in the U.S. Department of Health and Human Services asks grant applicants to include a “Recruitment and Retention Plan to Enhance Diversity.” (2007)
- **The National Academy of Science (Committee for Women) and the National Academy for Engineering**
- **Professional associations** specializing in the issue:
  - American Association for Women in Science (AWIS)
  - American Association of University Women (AAUW)
  - Commission on Professionals in Science and Technology (CPST)
  - National Action Council for Minorities in Engineering (NACME)
  - National Alliance for Partnerships in Equity (NAPE)
  - National Association of Diversity Officers in Higher Education (NADOHE)
  - National Society of Black Engineers (NSBE)
  - Society of Hispanic Professional Engineers (SHPE)
  - Society of Women Engineers (SWE)
  - Women in Engineering Professional Advocates Network (WEPAN)
- **Professional associations with a specializing unit:**
  - American Association for the Advancement of Science (AAAS), Center for Advancing Science and Engineering Capacity
  - American Association of Physics Teachers (AAPT), Committee on Women
  - American Council on Education (ACE), Office of Women in Higher Education
  - American Educational Research Association (AERA), Research on Women and Education Special Interest Group
  - American Institute of Physics (AIP)
  - American Physical Society (APS), Committee on the Status of Women in Physics
  - American Society for Engineering Education (ASEE), Women in Engineering Division
  - Association for Computing Machinery (ACM), Committee on Women in Computing
  - Association of American Colleges and Universities (AACU), Program on the Status and Education of Women
- **Centers and institutes**
  - Anita Borg Institute
  - National Center for Women in Information Technology (NCWIT)
  - Building Engineering and Science Talent (BEST)
- **Programs and centers embedded in universities**, for example:

- Georgia Tech, ADVANCE Program<sup>2</sup>
  - University of Washington, Office of Minority Affairs and Diversity
  - Arizona State University, Women in Applied Science and Engineering and Minorities in Engineering
- **Corporations** investing in diversity, for example:
    - L'Oreal
    - IBM
    - HP
    - Dupont

There are many **published reports and compendia of best practices or model programs**:

- Beyond Bias and Barriers, from the National Academy of Sciences
- Land of Plenty, A Bridge for All, The Talent Imperative, Quiet Crisis from BEST
- New Formulas for America's Workforce, New Formulas for America's Workforce 2, and New Tools for America's Workforce from the National Science Foundation

And **rich web sites**:

- [www.diversityweb.org](http://www.diversityweb.org)
- [www.swe.org](http://www.swe.org)
- [www.umbc.edu/cwit/](http://www.umbc.edu/cwit/)
- [www.aip.org](http://www.aip.org)

### ***Accountability***

There are many ways organizations are held accountable for good and bad performance regarding discrimination: publicity, awards, individual and class action lawsuits, and oversight by government organizations that are required, in their programs, contracts, and funding, to comply with the law.

Recently there was movement to use the provisions of Title IX to put pressure on universities to address inequities in science and engineering higher education. Senators Ron Wyden (D-OR) and Barbara Boxer (D-CA) sponsored legislation that mandated the General Accounting Office to audit Federal science agencies' oversight of Title IX in 2004. (Title IX applies to any organization receiving Federal funding; grantees are obligated to assure equal educational opportunity.) The GAO Report (2004) found that Title IX could provide the basis for reviewing research institutions and assessing whether they are discriminating in the treatment of students and faculty. They could look at universities where, for example, a relatively low number of women go on to graduate study or where relatively few qualified women are hired even though they are available in the national candidate pool. National statistics reveal problem areas, and local statistics can show where universities are not making an effort to address and eliminate discriminatory policies and practices. There was little follow-up on the GAO Report. The potential for action does not go away as long as Title IX is the law.

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<sup>2</sup> The Georgia Tech ADVANCE program developed the ADEPT (Awareness of Decisions in Evaluating Promotion and Tenure) tool. It is a software application for candidates coming up for promotion and tenure and for members of evaluation committees, presenting case studies, simulations of discussion, and activities that help identify forms of bias often encountered during the process of review. See <http://www.adept.gatech.edu>

## Conclusion

The history of democracy and education in the United States illustrates a progression toward truer realization of equality. We have moved from a country run by a small handful of upper-class white men to one that gradually shared education and power with other groups. The abolishment of slavery, the vote to women, opening of education, and the myriad of laws and practices that these movements represent are not clean jumps over a transom.

Early philosophical assumptions about the inferiority of women and of other races are embedded in our religions and folklore and still persist. Now modern brain research is finding differences in cognitive preferences and in brain processing patterns between men and women. The differences that they identify do not indicate that men and women, or particular races, are determined from birth in capacity and interest for learning, work, and particular careers. The spectrum of interest and ability by sex and by race is not so different that it determines who should be in certain careers and who should be in power. From cross-cultural comparisons, we see that innate genetic differences do not explain global variations in who does what kind of work and who holds power. For example, we have evidence that Japanese girls can outperform Caucasian American boys in mathematics. That does not mean that we should direct Japanese girls into our advanced mathematics professions, and steer Caucasian American boys away, nor do we need to, in order to achieve excellence.

It is not easy to change our minds. It may be a function of our brains to resist locking on schema and stereotypes once they are learned:

Neuroscientists have recently shown that biases in thinking are built into the very way the brain processes information – all brains, regardless of their owner’s political affiliation. In a study of people who were being monitored by magnetic resonance imaging while they were trying to process dissonant or consonant information about George Bush or John Kerry, researchers found that the reasoning areas of the brain virtually shut down when participants were confronted with dissonant information, and the emotion circuits of the brain lit up happily when consonance was restored. Researchers also showed that reading information that goes against your point of view can make you all the more convinced you are right. So there is a neurological basis for the observation that once our minds are made up, it is hard to change them. (Tavris & Aronson, 2007)

For profound personal change, we may have to depend on real-life, personal experiences that confront our bias. White soldiers in World War II who were rescued or saved by African American or Japanese conscripts saw them as valued peers for the first time. An older white male whose life was saved by a Black female physician changed his mind about his assumptions.

An advice columnist captured the problem of attitude, talking about a father who showed no interest in a daughter:

If he continues to put girls and boys in neat little unequal boxes ... then it’s time to ask why. Pick any reason, that he’s ignorant, ‘old school,’ controlling, angry, in a rut ... you still have the same common denominator. Fear. The clearer we draw our distinctions, the less gray we need to navigate, the fewer unknowns we need to face, the less we need to learn about ourselves or others, and the less we have to try. Trying, on the other hand, is scary. (Hax, 2007)

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