

Issues of Diversity in Engineering Education and a Path Forward for Action

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Abstract

This is the second of two invited papers for the special panel session on issues of diversity in engineering education. Whereas much work has already been done on the question of diversity and engineering education, many issues deserve attention and much work remains to be done in setting a path forward for real-world action. This paper focuses on why we need diversity for the national well-being – to promote economic and competitive advantage; to provide national benefits to the engineering profession; to leverage the good work that has been done so far; to confront the real, unspoken issues of diversity; and to recommend a path forward for action at the national level. The paper includes a “holistic diversity model” that applies to both education and industry. The model consists of four primary elements: 1) Diversity of Representation; 2) Valuing Diversity; 3) Managing Diversity and; 4) Marketplace Diversity.

Introduction

On May 17, 2004, America observed the 50th anniversary of the Brown vs. Board of Education Topeka U.S. Supreme Court decision. The Brown decision opened the doors of K-12 and higher education for people of color to pursue educational opportunities in previously segregated schools, colleges and universities across America, particularly in the South.

Ten years later, the 1964 Civil Rights Act-Title VII and President Johnson’s Executive Order 12246 served as two of the catalysts to provide racial minorities greater access to education, employment, public facilities and so forth, to eradicate all forms of discrimination, especially in education and employment. Moreover, these federal laws set the stages for higher education and

business to make paradigm shifts in the attitudes and behavior of people and for institutions to eradicate discriminatory practices in hiring, retention and promotion of all Americans.

The advent of the Affirmative Action Doctrine by the Johnson and Nixon administrations established the vision and mechanisms for under-represented ethnic groups and white women to demand through the courts, executive and legislative branches of government progressive inclusive policies and practices. That is, businesses, corporations, school districts, colleges and universities were required to develop and implement Affirmative Action plans that considered past discrimination in their history. This need for inclusive diversity plans, policies, and practices was paramount for America to move forward on race and gender issues.

Numerous court cases have since reaffirmed the practices of Affirmative Action and the need for diversity in the United States.

Clearly, higher education has been one of the battlegrounds in America for the Affirmative Action and Diversity Doctrines. In most cases, higher education has taken the lead to diversify the student body, and, to a lesser extent, its faculty and staff. Still it is clear and evident that more needs to be done to change our demographics and achieve full representation for all Americans. This point will be discussed later in the paper.

The intent of this paper is to explore new paradigms in higher education that will start a national debate and dialogue about implementing a holistic diversity model that progressive corporations, colleges and universities will deploy to recruit, retain and promote people of all ethnic groups, achieve gender balance and provide opportunities to persons with disabilities.

Corporate View

The changing demographics of the U.S. labor pool indicate that “people of color” and women each comprise more than one-half of the U.S. population. Corporate America is waking up to the basic fact that the changing demographics discussed in the 1987 ground-breaking Hudson Institute Report - “Workforce 2000: Work and Workers For the 21st Century” – are now becoming a reality. Recall, the report forecast that “85% of the entrants into the work force will be women, minorities and immigrants” by the year 2000. Corporate America is continuously trying to prepare itself for this new workforce paradigm. Some companies have taken the lead to make sure that diversity issues affect management decisions and are included in their corporate strategy.

For instance, Raytheon’s Diversity and University Relations Vision Statements have diversity as a strategic core:

Raytheon’s Diversity Vision Statement: We will build an inclusive culture that recognizes uniqueness, empowers each employee, and values all contributions and contributors - a culture that thrives on **diversity**.

Raytheon's University Relations Vision Statement: Raytheon builds world-class partnerships with schools, colleges, universities and employees that leverage technology, stimulate life-long learning, nurture **diversity** and make Raytheon an employer of choice.

Former Raytheon CEO Dan Burnham established the company's vision and philosophy by publishing and articulating these statements:

"To me, diversity is a requirement – an imperative of business survival in an era of increasingly tough competition. Why? Because diverse teams make better decisions, and better decisions make us more competitive." ...

"Becoming an employer of choice for a diverse workforce is as important to me as any other aspirations. We will achieve this aspiration with the same intensity that we use to address any major challenge."... "Our EEO policy is based not only on our legal obligations, but also on our core values of respecting one another, fostering teamwork and collaboration."

Two years ago the ASEE Corporate Member Council also adopted diversity as one of its core initiatives. The CMC published the *Industry Speaks with One Voice: A Message for Colleges and Universities* Report, which identifies important key activities and groups for increasing diversity in engineering:

- Graduate School Enrollment - "People Of Color & Women"
- Pipeline Outreach
- Professional Organizations

Recently, the U.S. Bureau of Labor Statistics predicted that 68 percent of people entering the national labor force by 2005 will be members of ethnic groups and women. That statistic has far-reaching implications for U.S. industries, education and government agencies. Why? Because these groups have long been under-represented in science, technology, engineering and mathematics (STEM). Additionally, the U.S. Bureau of Labor 2000 Census predicts that engineering jobs will increase from the current level of 1.5 million to 1.75 million and Computer Science and Engineering jobs will increase from 1.5 million to 3.0 million by 2008. These job growth projections represent tremendous challenges for our K-12 and higher educational systems, as well as for industry and government. Supply and demand must match up.

Currently, there is a lack of a comprehensive plan and focused national strategy to address the trend of unfilled future STEM positions. Thus, the members of ASEE Corporate Member Council are partnering to support programs that have these foci:

- Target STEM Pipeline Outreach of our diverse population (all ethnic groups and both genders);
- Support Engineering, Science and Technology Graduate School enrollment of "people of color" and women;
- Work with professional organizations to encourage future STEM enrollment and graduation.

Since diversity refers to any collective mixture of persons characterized by differences and similarities, we plan to work with organizations and institutions that include all groups in attempting to meet the diversity need in the workforce, workplace and marketplace. Specifically, we plan to work with Historically Black Colleges and Universities (HBCU's), Hispanics Association of Colleges and Universities (HACUs) and Tribal Colleges and Universities (TCUs) and other institutions that recruit and graduate large numbers of ethnic minorities and women. We also plan to partner with professional organizations like ASEE, AISES, HENACC, SWE, NSBE, SHPE and others to achieve the lofty goal of increasing the enrollment and graduation rates of STEM under-represented and under-served students.

Specifically, we will work with programs like GEM, National Consortium for Graduate Degrees for Minorities in Engineering and Science, to increase the graduation rates of African Americans, Hispanics, and Native Americans receiving doctoral degrees in engineering and science. This initiative will serve as a means to increase the diversity of faculty, deans and other administrators at majority and minority institutions.

According to John McMasters, Engineering Fellow of The Boeing Company: "Agile, innovative companies need talent with diversity, including teams of different disciplines, linear and non-linear thinkers, working together...". The students of today are functioning in a continually more diverse world. The workforce, workplace and marketplace of today and tomorrow will require the leaders of tomorrow to understand and to implement diversity principles in all areas of their enterprises.

American industries need continuing intellectual capital to grow their businesses and sustain their competitive advantage. The old adage holds:" If not us who; If not now when."

Since the early 1990's, companies have begun to see diversity as a business issue – needed to sustain and to improve their competitive advantage.

Accreditation Board for Engineering and Technology Diversity Thrust Areas

On March 20, 2004, the ABET Board of Directors proposed and adopted the following policy statement on diversity:

ABET is committed to developing and using the talents of all qualified persons who study or work in the applied science, computing, engineering and technology professions. We respect the human qualities, both similarities and differences, present in the work and study environments of our constituencies as they are affected by our efforts to assure quality and stimulate innovation. The actions of ABET programs evaluators, commissions, staff and Board of Directors must demonstrate and confirm respect for each other and the contributions that each of us can make. Our professions benefit from the creativity and constructive improvements best informed and achieved by persons with varied perspectives, experiences and talents who work toward shared goals.

The ABET Industry Advisory Council (IAC) currently has a draft of a white paper titled *Issues of Accreditation in Higher Education Vol. III - Diversity* that will outline and discuss diversity from U.S. competitiveness, demographics and industry viewpoints.

Over the next decade, the National Academy of Engineering (NAE) in its report titled *Diversity By the Numbers*, by the National Academy of Engineering Forum on Diversity in the Engineering Workforce, projects the job growth in computer engineering/science, engineering and engineering technicians will provide nearly 2 million new employment opportunities in these disciplines. The source of the NAE data is the 2000 U.S. Census Bureau.

Higher Education and corporate America are using these data to develop strategic diversity plans and to focus their current and future recruiting and hiring practices to mirror the changing demographics trends. External forces, like globalization, are compelling highly competitive global U.S. institutions to attract and to utilize the talent, skills and creativity of all its human capital so they can grow and compete more efficiently and effectively. It has been proven by numerous studies that diverse teams serve to increase an institution's value.

Diversity by the Numbers

Finally, there appears to be a realization that the nation's demographics are changing rapidly. The census data support this assertion. Combining this fact with the "graying" of America and projected retirements of white males, America knows it must grow its talent pools in engineering and science to maintain and improve its technological leadership.

Currently, white males constitute seven (7) in ten (10) professionals employed in engineering and science. But percentages will change soon due to America's demographic evolution. Projected white males' retirements and the lack of a sustained pipeline will cause these percentages to change dramatically. Simply put, the people are not available to replenish the engineering and science professionals, given the projected retirements of white males currently in this workforce.

For example, NASA has estimated they will need to replace over half of their current workforce over the next decade or less. Pima County Colleges and other institutions of higher education have similar employment replacement projections.

The solution to the future engineering and science workforce problem is to educate, train and employ more women, underrepresented so-called minorities ("people of color") and persons with disabilities.

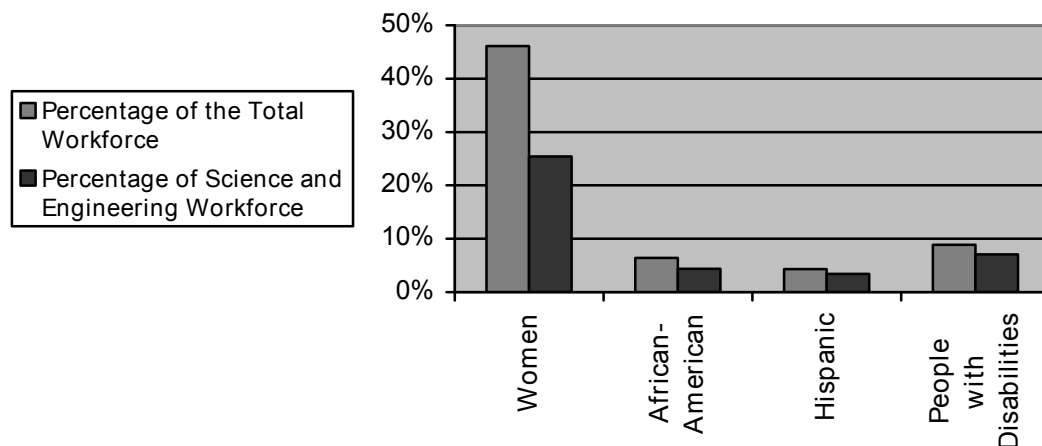
Figure 1 shows a comparison of the percentages of women, minorities and disabled persons employed in science and engineering versus the percentages in the total workforce.

Although white females represent 46 percent of the total American workforce, they represent only 25 percent of the engineering and science workforce.

In 2000, African Americans, Asian Americans, Hispanics, Native American and Persons with Disabilities represented about 26.6 percent of the total degreed workforce. Asian Americans constitute 14 percent of engineers and scientists in the workforce although they constitute only 3.6 percent of U.S. population; African Americans constitute 6.4 percent of the nation's degreed workforce but represented 4.4 percent of engineering and science professionals; Hispanics constitute 4.4 percent of all the degree holders but Hispanics composed only 3.4 percent of the engineers and scientists; and Native Americans constituted 0.6 percent of the scientists and engineers in the workforce.

In 2000, physically and mentally disabled individuals comprised 8.9 percent of the American workforce; but only 7.1 percent of the 3.6 million people working as scientific and engineering professionals were disabled.

Figure 1. Employed Bachelor's or Higher Degree Recipients by Gender, Race/Ethnicity, and Disability Status in 2000



Source: ABET Diversity White Paper. Data represent Women, Minorities and Persons with Disabilities in Science and Engineering: 2004

Although some of the above disparities between the technical (science and engineering) degree percentages and total degrees earned by women, ethnic and disabilities groups may seem small, considerable improvement is needed to increase the technically educated and trained workforce to meet America's 21st century engineering and science workforce projections and needs. Diversity has emerged as an essential business and higher education strategy and practice to increase industry and education human capital.

Analysis of the Diversity Numbers

According to the American Association of Engineering Societies 2001 Workforce Commission data, women were awarded only 22 percent of the B.S. engineering degrees in 2000. Non-Hispanic White females received 66 percent of the total B.S. engineering degrees awarded to women in 2000; Asian American females received 16 percent, African American females

received 9.1 percent, Hispanic females received 8.5 percent, and Native American females received 0.7 percent of the B.S. engineering degrees awarded to women in 2000.

In 2000, a large percentage (33 percent) of the B.S. degrees in engineering awarded to African American and Hispanic women were earned at Historically Black Colleges and Universities (HBCUs) and Hispanics Serving Institutions. For instance, females make up nearly 45 percent of Prairie View A & M University College of Engineering enrollment and nearly 38 percent of the University of Puerto Rico at Mayaguez College of Engineering enrollment and graduates. Similar percentages are reported at the other nine HBCUs with accredited ABET programs and the University of Texas at El Paso.

Clearly, major universities need to do more to recruit, retain and graduate more women and people of color to meet our engineering and science workforce demands of 2 million projected jobs in these areas.

Past and Future Demographic Trends

Over the past decade, the U.S. African American population has risen by 16 percent and the Hispanic population by 58 percent. Data show U.S. population trends for persons under age 18 to be 33 percent for African-Americans, 34.4 percent for Hispanics, and only 22.8 percent for whites. Although the number of minorities pursuing degrees in higher education has increased considerably over the past two decades, the pool of minorities seeking degrees in science and engineering has leveled off or in some cases is on a steep decline. This is particularly troubling because the number of white males in scientific and engineering fields is dwindling.

According to the United Nations population growth forecast, the United States population will increase by 40 percent by 2050. But, as mentioned above, the forty and fifty “something” age groups will retire and leave a shortage that can’t be fully replaced by white males. Thus, industry and higher education will have to rely on women, people of color and people with disabilities to replicate their technical workforce.

Thus, diversity will become a more essential business imperative and business practice to keep companies competitive and able to grow and deal with the global economy. Simply put, it’s now basic macroeconomics supply and demand theory.

A Call for Diversity Visionary Leaders

Higher education and industry must lead the way to encourage an even larger percentage of the current and future U.S. population of white females, underrepresented minorities and persons with disabilities to pursue engineering and science careers. This can’t be achieved without holistic strategic diversity and implementation plans that encompass strategies on representation, valuing, managing and strategic diversity.

Diversity - Human Environmental Awareness Training (HEAT)

Before we briefly describe the attributes of a holistic diversity approach for the 21st century, let's explore diversity from some Human Environmental Awareness Training (HEAT) perspectives. HEAT should be the new diversity paradigm that will thrust higher education and industry to employ diversity principles more effectively.

Basically, Human Environmental Awareness Training is designed to build relationships across lines of differences. Differences may include age, disability, gender, race, religion, sexual orientation and so forth. HEAT - operational or administrative - on a campus and in the workplace is based on the Human Diversity Successful Formula:

Fairness + Justice + Impartiality equal Effective Community Relations and Effective Employee and Student Relations

That is, $F + J + I = ECR \text{ and } EER$.

Additionally, the Human Diversity Successful Formula should consider these attributes:

Mutual Trust + Mutual Respect + Mutual Confidence equal Effective Community Relations and Effective Employee Relations

That is, $MT + MR + MC = ECR \text{ and } EER$.

In summary, Human Environmental Rights include:

- All People have a right to be treated fairly, justly and impartially.
- All people have a right to be treated with dignity and respect.
- All people have a right to visit, study, work or live in an environment that is free of hostility.

The roles and responsibilities of Human Environmental Awareness visionary leaders are:

1. Embrace a philosophy that values and respects diversity.
2. Communicate to faculty, students, staff, and employees your philosophy that values and respects diversity.
3. Set the example.
4. Establish appropriate policies, procedures and practices.
5. Be fair, just, and impartial in your interactions with students, staff, faculty members and internal and external customers.
6. Treat people, internally and externally, as individuals and not as a member of this or that group.
7. Assure that all personnel - students, faculty, staff and employees and customers - have an awareness, understanding and recognition of the impact of inappropriate actions based on differences.
8. Be alert to danger signs.

9. Support the recruiting, hiring, promotion, education, assignment of challenging tasks, and training of individuals from all groups and both genders.
10. Create multi-cultural teams and honor cultural perspectives different than your own.

These roles and responsibilities can best be achieved by developing an internal and external communication plan to articulate the department and institution diversity plans. Also, metrics, accountability systems and a balanced scorecard must be established to measure the effectiveness and progress and identify improvements in the organizational diversity processes. A corrective actions process is paramount in sustaining and keeping the team engaged and focused on diversity.

The Principles of Representation, Valuing, Managing and Strategic Diversity

Representation Diversity can best be defined in terms of Affirmative Action. It's about recruiting numbers and recruiting more women, minorities and persons with disabilities into an institution, either academic, governmental, or commercial.

Values Diversity focuses on the groups and individual differences, whether cultural differences or ethnicity. It also focuses on relationships - promoting harmony and respect and preventing the "isms" from being an issue.

Managing Diversity focuses on assessing talents and maximizing every employee's potential to achieve organizational goals.

Strategic Diversity focuses on the marketplace. Employees must understand, embrace and operate under the philosophy and charter of multiculturalism and differences in business cultures, laws, and diversity of opinions and background to achieve a company, business or institution effective in global marketing.

Next Steps

A national dialogue needs to occur in engineering education led by ASEE, the National Academy of Engineering and ABET. This dialogue needs to include elected officials, Presidents of ASEE member institutions, ASEE's Corporate Member, Engineering Deans, and Engineering Technology Councils, Engineering Societies, representatives of K-12 Education initiatives, and others. A nationwide diversity plan needs to be created, funded and implemented to attract, retain, graduate and employ more women, African Americans, Hispanics, Native Americans and Persons with Disabilities.

Conclusion

Diversity is an initiative the nation must act on because the inclusion of women, ethnic minorities, and persons with disabilities is a business necessity. To sustain our competitive advantage and survive economically, businesses and educators will have to change how they are

currently operating in the engineering education and employment arenas. They have to adopt different engineering education and employment paradigms that focus on implementing diversity programs that are inclusive of all groups. By using all its human capital, America will continue to be a technological leader and to improve its competitiveness on the global scale by pursuing diverse markets. Our economic and security survival depends on how we embrace diversity and how we will educate, train and utilize all our human capital to improve the quality of life for U.S. citizens.

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