Diversity in STEM: It is Past Time for Change

Bevlee Watford, Ph.D.

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Diversity in Engineering
It Is Past Time for Change

Bevlee A. Watford
Professor, Engineering Education
Associate Dean, Equity and Engagement
Executive Director, Center for the
Enhancement of Engineering Diversity
What is Diversity to You?

What is Equity?

What is Inclusion?

What is Justice?

What is Equality?
“Diversity is being invited to the party. Inclusion is being asked to dance.”

Verne Myers

Image from abc.go.com/dancing with the stars juniors
**Equality**  
The assumption is that everyone benefits from the same supports. This is equal treatment.

**Equity**  
Everyone gets the supports they need (this is the concept of “affirmative action”), thus producing equity.

**Justice**  
All 3 can see the game without supports or accommodations because the cause(s) of the inequity was addressed. The systemic barrier has been removed.

Image from https://imgur.com/gallery/RZ1HJtY
Educational Achievement

• Young people from high-wealth families (wealth above $223,500) are more than one and a half times more likely to complete at least two years of college than those from low-wealth families (wealth below $2,000).

• Among families in which parents did not graduate from college, young people from high-wealth families are roughly twice as likely to be upwardly mobile than those from low-wealth families.

https://www.urban.org/research/publication/wealth-inequality-barrier-education-and-social-mobility
Economic Disparity

Wealth by Race and Ethnicity, 2007-13

Median net worth of households, in 2013 dollars

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>2007</th>
<th>2010</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL HOUSEHOLDS</td>
<td></td>
<td></td>
<td>$81,400</td>
</tr>
<tr>
<td>WHITE</td>
<td>135,700</td>
<td>141,900</td>
<td>192,500</td>
</tr>
<tr>
<td>BLACK</td>
<td>16,600</td>
<td>19,200</td>
<td></td>
</tr>
<tr>
<td>HISPANIC</td>
<td>13,700</td>
<td>16,000</td>
<td>23,600</td>
</tr>
</tbody>
</table>

Note: Blacks and whites include only non-Hispanics. Hispanics are of any race. Source: Pew Research Center tabulations of Survey of Consumer Finances public-use data

PEW RESEARCH CENTER
Statement from NEA

We, the members of the National Education Association, acknowledge the existence in our country of institutional racism—the societal patterns and practices that have the net effect of imposing oppressive conditions and denying rights, opportunity, and equality based upon race. This inequity manifests itself in our schools and in the conditions our students face in their communities. In order to address institutional racism, the National Education Association shall lead by:
NEA con’t

1. spotlighting systemic patterns of inequity—racism and educational injustice—that impact our students; and

2. taking action to enhance access and opportunity for our students. NEA will use our collective voice to bring to light and demand change to policies, programs, and practices that condone or ignore unequal treatment and hinder student success by:

- Providing technical assistance to develop plans of action to address institutional racism.
- Partnering on campaigns and actions to eradicate policies that perpetuate institutional racism in education.
- Partnering on campaigns and actions on critical social justice issues impacting students and their communities.
- Convening high school students and young people
- Expanding the work of the Association on issues of institutional racism, including redirecting existing resources and providing grants to affiliates to lead and partner with us on site based projects, such as:
3. programs aimed at improving school climate and culture, particularly ending the school to prison pipeline
4. supporting campaigns to expand the development and implementation of community schools
5. expanding local affiliate-school district partnerships that expand educator-led professional development, particularly in areas of cultural competence, diversity, and social justice in order to address institutional racism
6. Researching implications for NEA’s Strategic Plan and Budget for 2016-2018.
It is not our differences that divide us. It is our inability to recognize, accept, and celebrate those differences.

— Audre Lorde —
SO WHAT?

For Engineering
Challenges Facing Engineering

• Ample supply for our future needs
• Rapidly changing K-12 population
• Women and minorities often don’t see engineering as a pathway
• Proportion of US College graduates in engineering is low and dropout rates are much higher in engineering than in other areas of college study
### Employment Growth

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Employment growth, projected 2012–22 (percent)</th>
<th>Employment</th>
<th>Median annual wage, May 2013</th>
<th>Typical entry-level education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information security analysts^2</td>
<td>37%</td>
<td>75,100</td>
<td>102,500</td>
<td>$88,590</td>
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<tr>
<td>Operations research analysts</td>
<td>27</td>
<td>73,200</td>
<td>92,700</td>
<td>Bachelor’s degree</td>
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<td>Statisticians</td>
<td>27</td>
<td>27,600</td>
<td>34,900</td>
<td>Master’s degree</td>
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<td>Biomedical engineers</td>
<td>27</td>
<td>19,400</td>
<td>24,600</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Actuaries^3</td>
<td>26</td>
<td>24,300</td>
<td>30,600</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Petroleum engineers</td>
<td>26</td>
<td>38,500</td>
<td>48,400</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Computer systems analysts</td>
<td>25</td>
<td>520,600</td>
<td>648,400</td>
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<tr>
<td>Software developers, applications</td>
<td>23</td>
<td>613,000</td>
<td>752,900</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Mathematicians</td>
<td>23</td>
<td>3,500</td>
<td>4,300</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Software developers, systems software</td>
<td>20</td>
<td>405,000</td>
<td>487,800</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Computer user support specialists^4</td>
<td>20</td>
<td>547,700</td>
<td>658,500</td>
<td>Some college, no degree</td>
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<tr>
<td>Web developers</td>
<td>20</td>
<td>141,400</td>
<td>169,900</td>
<td>Associate’s degree</td>
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<tr>
<td>Civil engineers</td>
<td>20</td>
<td>272,900</td>
<td>326,600</td>
<td>Bachelor’s degree</td>
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<tr>
<td>Biological science teachers, postsecondary</td>
<td>20</td>
<td>61,400</td>
<td>73,400</td>
<td>Doctoral or professional degree</td>
</tr>
<tr>
<td>Environmental science and protection technicians, including health</td>
<td>19</td>
<td>32,800</td>
<td>38,900</td>
<td>$41,700</td>
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</tbody>
</table>

Selected STEM occupations with fast employment growth, projected 2012–22
Employment Growth

Employment change and percentage employment change by type of STEM occupation, May 2009 to May 2015

- All STEM occupations
- Computer occupations
- Engineers
- STEM-related management
- Mathematical science occupations
- Life scientists
- Life and physical science technicians
- STEM-related postsecondary teachers
- Physical scientists
- Architects, surveyors, and cartographers
- Drafters, engineering technicians, and mapping technicians
- STEM-related sales

Employment Growth

Projected new jobs for types of STEM occupations, 2014 to 2024

- Computer occupations
- Engineers
- STEM-related management
- Mathematical science occupations
- STEM-related postsecondary teachers
- STEM-related sales
- Physical scientists
- Life and physical science technicians
- Life scientists
- Architects, surveyors, and cartographers
- Drafters, engineering technicians, and mapping technicians

Click legend items to change data display. Hover over chart to view data. Source: U.S. Bureau of Labor Statistics.
US K-12 Population

- White
- Hispanic
- Black/African American
- Asian/Pacific Islander
- Two or More
- American Indian/Alaska Native

Figure 1-4. High School Noncompletion Among 16-24 Year Olds, by Race/Ethnicity and Sex

Note: "White" and "African American" are non-Hispanics within those groups.
K-12 Men and Women

- Female students' achievement in mathematics and science is on par with their male peers.
- Female students participate in high level mathematics and science courses at similar rates as their male peers, with the exception of computer science and engineering.
- Male students were more likely than female students to
  - take engineering (21% versus 8%) a
  - enroll in AP computer science A (77% vs 23%)

(NSF, Science & Engineering Indicators, 2018)
High School graduates (n=3,014,670)
- White men: 30%
- Temporary resident men: 3%
- White women: 18%
- Temporary resident women: 3%
- Asian men: 16%
- Asian women: 3%

First-time, full-time freshmen in college overall (n=2,268,993)
- White men: 31%
- Temporary resident men: 1%
- White women: 18%
- Temporary resident women: 1%
- Asian men: 14%
- Asian women: 3%

Bachelor's degree in engineering or computing (n=121,310)
- White men: 55%
- Temporary resident men: 1%
- White women: 4%
- Temporary resident women: 2%
- Asian men: 11%
- Asian women: 1%

Master's degree in engineering or computing (n=59,952)
- White men: 30%
- Temporary resident men: 6%
- White women: 3%
- Temporary resident women: 2%
- Asian men: 33%
- Asian women: 7%

PhD degree in engineering or computing (n=10,084)
- White men: 24%
- Temporary resident men: 5%
- White women: 2%
- Temporary resident women: 3%
- Asian men: 46%
- Asian women: 7%
Share of full-time undergraduate enrollment among U.S. citizens and permanent residents, by race and ethnicity: 2000–15

- White
- Asian American
- Black
- Mexican American/Chicano/Puerto Rican/other Latino
- American Indian/Alaska Native
Undergraduates

- In 2015, women received over half of bachelor’s degrees awarded in the biological sciences, they received far fewer in the computer sciences (18%), engineering (20%), physical sciences (39%) and mathematics (43%).

- In 2016, 12.6% of bachelor’s degrees in science and engineering, 7.8% of master’s degrees in science and engineering, and 5.0% of doctorate degrees in science and engineering were awarded to minority women.

- URM women have increasing and strong shares of bachelor’s degrees in psychology, social sciences, and biological sciences. Representation in these fields by underrepresented minority women is increasing and is near or above their representation in the labor force.
Presence vs. Population

- US Population
- College Graduates
- Degreed S&E

- URM
- Asian/Pacific Islanders
Women's share of S&E bachelor's degrees, by field: 2000–15
### Undergraduate Enrollment in Engineering

- **American Indian/Native American:** 0.008% (1973) vs. 0.4% (2015)
- **African American:** 3.30% (1973) vs. 4.6% (2015)
- **Hispanic American:** 1% (1973) vs. 11.20% (2015)

### BS Degrees in Engineering

- **American Indian/Native American:** 0.07% (1972/73) vs. 0.4% (2015)
- **African American:** 1.5% (1972/73) vs. 1.3% (2015)
- **Hispanic American:** 3.6% (1972/73) vs. 11% (2015)

### PhDs Produced in Engineering

- **American Indian/Native American:** 0 (1973) vs. 42 (2015)
- **African American:** 19 (1973) vs. 374 (2015)
- **Hispanic American:** 10 (1973) vs. 714 (2015)
Where we need to be!!

Parity line: 31% of U.S. 18-24 year olds are URM

Source: CPST analysis of NSF WebCASPAR data. Life Sciences includes biological and agricultural sciences; Physical sciences includes the earth, atmospheric and ocean sciences disciplines. URM = Under-represented minority and includes African American, American Indian and Hispanics.
Workforce

- Women make up half of the total U.S. college-educated workforce, but only 28% of the science and engineering workforce.
- Female scientists and engineers are concentrated in different occupations than are men, with relatively high shares of women in the social sciences (60%) and biological, agricultural, and environmental life sciences (48%) and relatively low shares in engineering (15%) and computer and mathematical sciences (26%).
- In 2015, 67% of workers in science and engineering occupations were white.
- Hispanics, blacks, and American Indians/Alaska Natives make up a smaller share of the science and engineering workforce (11%) than their proportion in the general population (27% of U.S. working age population).
- Asians work in science and engineering occupations at higher rates (20.6%) than their representation in the U.S. working-age population (5.5%) particularly in computer and information science occupations.
- The increase in female participation in science and engineering over the past two decades includes increasing participation by members of all racial and ethnic groups, especially Hispanic and Asian women.
Issues Impacting the Underserved

Center for the Enhancement of Engineering Diversity

2019-2020
Center for the Enhancement of Engineering Diversity

• Founded 1992 as the Office of Minority Engineering Programs
• Increase numbers of UR/US students earning engineering degrees from VT
• Programs targeted for
  – African Americans
  – Women
  – Hispanic/Latina/o
CEED

• 2019 - Suite of Programs
  – Middle school (Imagination, BLAST, inVenTs Outreach, SPARK, JROTC STEM Leadership, Pathways)
  – High school (C-Tech², PCI, RISE, Women’s Preview Weekend)
  – Pre-freshman (STEP Bridge)
  – Undergraduate (Mentoring, Hypatia, Galileo, IT)
• 4 Full Time Team Members
  – Director, *Undergraduate Programs*
    • Susan Arnold Christian
  – Director, *Pre-college Programs*
    • Kim Lester
  – Director, Research
    • Walter Lee
  – Office Manager
    • Becky Shelor
  – Assistant to the Executive Director
    • Kristy Morrill

• 15 Graduate Assistants
• ~200 undergraduate students
• Serving over 2000 students annually
CEED Pre-College Programs

### Summer Programs
- Take place weekdays late June through the end of July
- Typically include a camp-long design project with culminating showcase as well as 1 – 3 hour hands on activities, lab tours, lunch with faculty
- Participants are usually divided into 4 groups of 15 – 20 students

### Academic Year Programs
- Weekends and weekdays
- Lab tours, 1-2 hour hands on activities, dinner with faculty

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<table>
<thead>
<tr>
<th>K - 5th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
<th>11th</th>
<th>12th</th>
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<tr>
<td>SPARK (250)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Green = academic year</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Galipatia (~1000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange = summer</td>
<td></td>
<td></td>
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<tr>
<td>Imagination (120)</td>
<td></td>
<td></td>
<td>BLAST (80-160)</td>
<td>C-Tech^2 (60)</td>
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<td>TechGirls (64)</td>
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<td>JROTC STEM Leadership (300 - 400)</td>
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<td>Pathways (180)</td>
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<td>PCI (200?)</td>
<td>RISE (80)</td>
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<td>Women's Preview Weekend (150)</td>
<td></td>
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</tr>
</tbody>
</table>
Undergraduate

• STEP – Summer Bridge Program
• Hypatia & Galileo Living Learning Communities
  – Information Technology LLC
• Peer Mentoring
• Research/Scienceering Seminar
STEP Summer Bridge

• “bridging” the transition from high school to college (5 weeks)
• Academic Development
  – Chemistry, intro to engineering, precalculus
• Professional Development
  – Leadership development, interviewing
• Personal Development
  – Etiquette dinner, mentoring, team building
Fall Welcome “O Show”
Peer Mentoring

- Peer Leaders (6)
- Peer Mentors (79)
- 8-10 freshman (832/125)
  - BEST (Black Engineering Support Teams)
  - WEST (Women in Engineering Support Teams)
  - AHORA (Academic Hispanic OutReach Alliance)
  - GUEST (General Engineering Support Teams)
- Monthly dinners
- After test socials
- Weekly Meetings to assist with transition to VT
Galipatia

- “living, learning community”
  - Fall Seminar
  - Block Scheduling
  - Leadership Development
    - Academic, Community Service, Social Committees
    - Peer Mentoring
Number of Students Served

• 38 Galipatia Leadership Team Members
• 20 RA’s
• 124 Upper Class Mentors & Committee Members
• 693 Freshmen
  – 403 Galileans
  – 290 Hypatians
• Total = 875 students
## Impact on Retention

<table>
<thead>
<tr>
<th>Residency</th>
<th>Entering Cohort</th>
<th>% Continued to 2nd Year</th>
<th>% Continued to 3rd Year</th>
<th>% Continued to 4th Year</th>
<th>% Graduated in 4 Years</th>
<th>% Continued to 5th Year</th>
<th>% Graduated in 5 Years</th>
<th>% Continued to 6th Year</th>
<th>% Graduated in 6 Years</th>
<th>% Continued to 7th Year</th>
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</thead>
<tbody>
<tr>
<td>2008</td>
<td>1391</td>
<td>90.6</td>
<td>85.3</td>
<td>83.2</td>
<td>46.9</td>
<td>37.1</td>
<td>75.7</td>
<td>6.7</td>
<td>79.9</td>
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<td>1208</td>
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<td>89.7</td>
<td>86.0</td>
<td>49.6</td>
<td>35.0</td>
<td>77.3</td>
<td>6.0</td>
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<td>85.6</td>
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<td>87.3</td>
<td>52.8</td>
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<td>1435</td>
<td>94.6</td>
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<td>30.9</td>
<td>84.3</td>
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<td>1739</td>
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<td>2016</td>
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</table>
TIME

PAST

change
SO WHAT?

For Engineering Education