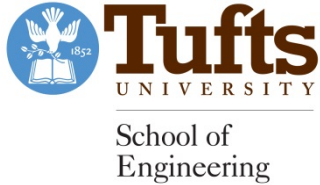


Attracting and Retaining Women in Engineering and the Physical Sciences: The Academic Experience

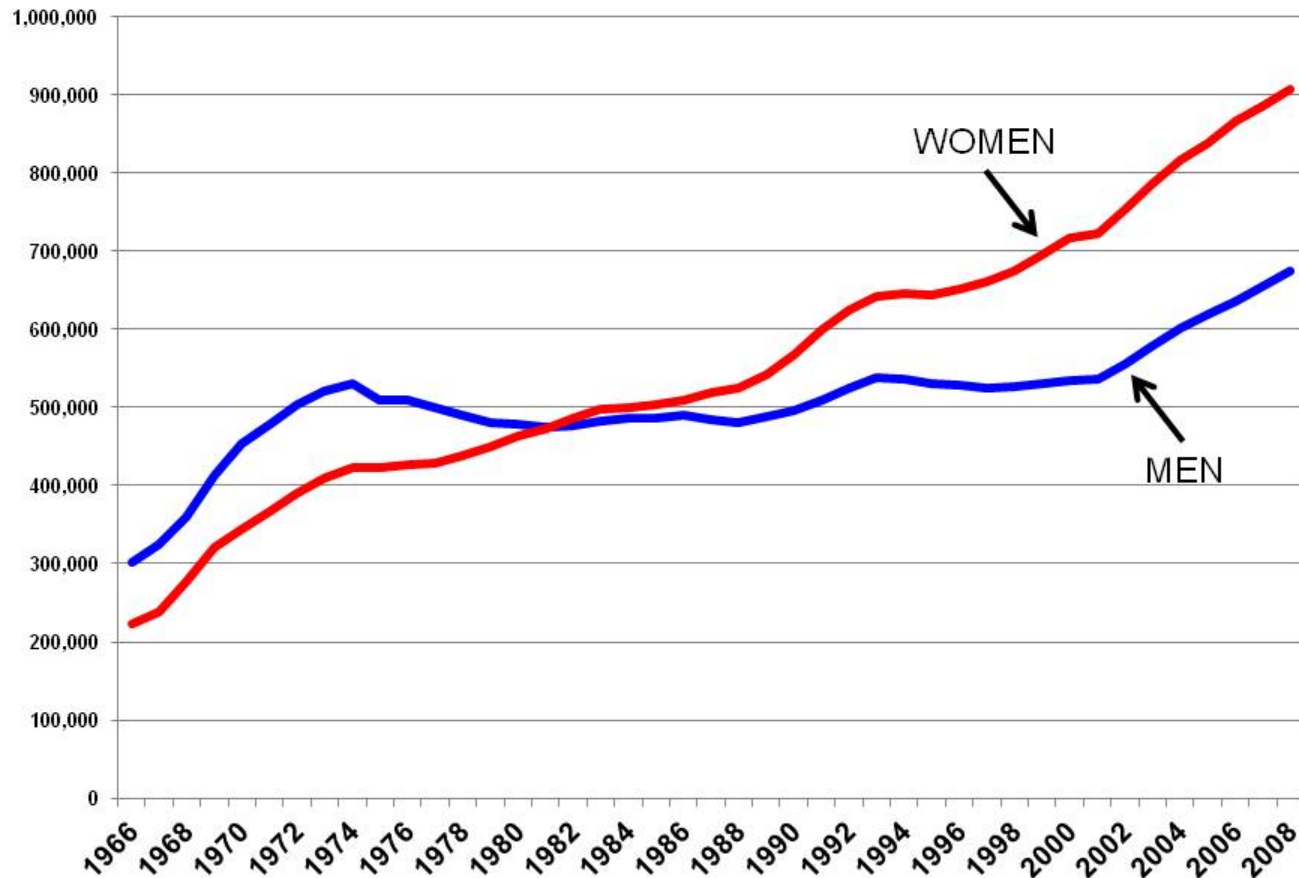


Linda M. Abriola
Tufts University

Presented at the First TMS Summit on Creating and Sustaining Diversity
Washington, DC
July 29, 2014

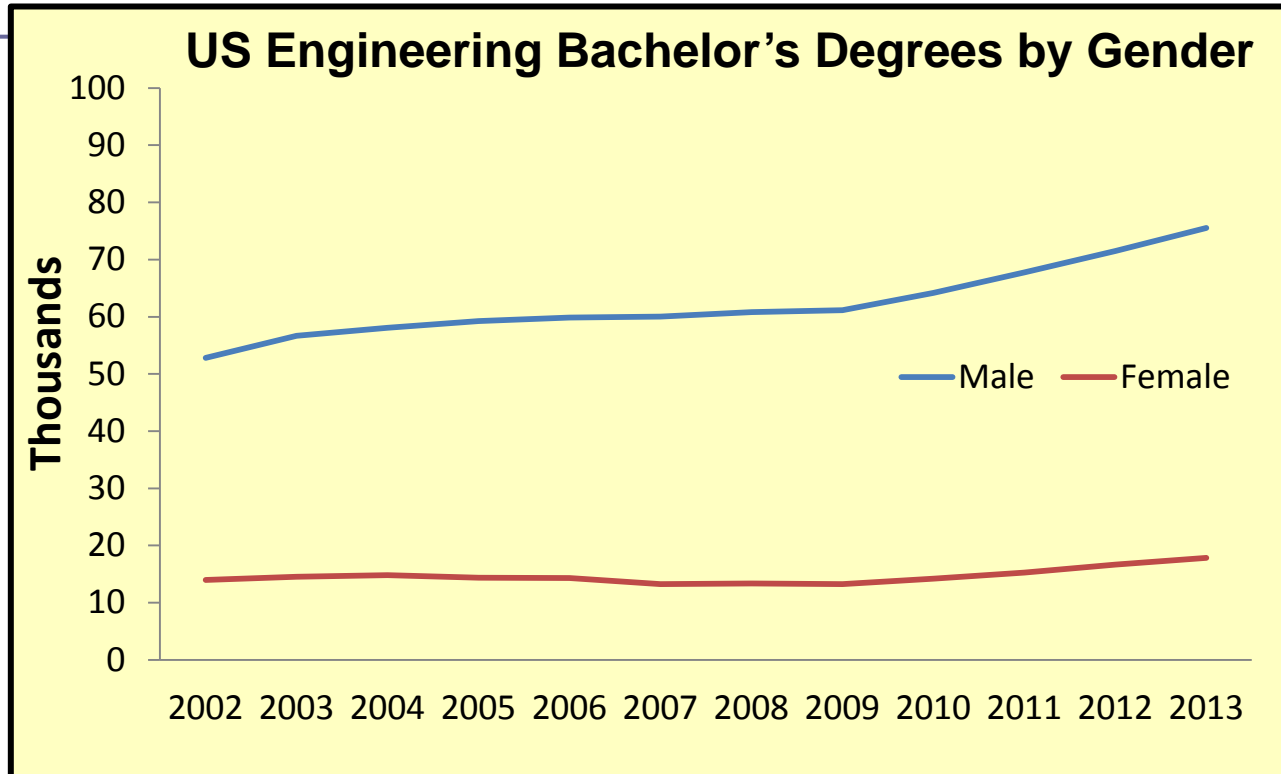
In the US, women have become an increasing percentage of our university graduates

**U.S. Bachelors Degrees Awarded
ALL FIELDS**



Source: S&E Degrees: 1966-2008, NSF 11-316, June 2011

But women are still greatly underrepresented in engineering...

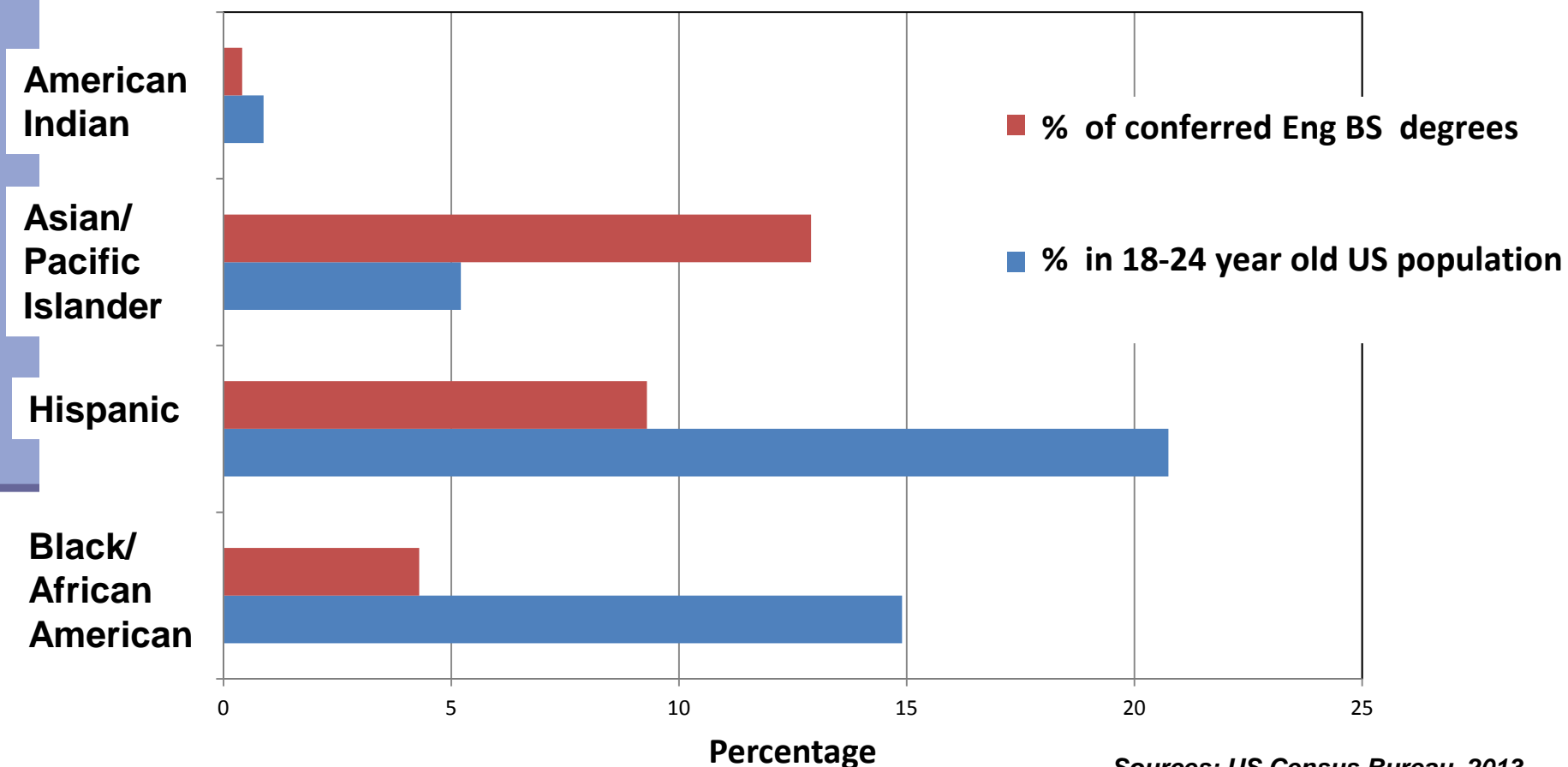


(ASEE, 2013)

The share of bachelor's degrees awarded to women reached a high of 20.9% in 2002 and then declined for most of the remainder of the decade. However, the declining trend has now reversed, with five years of growth, climbing from 17.8 percent in 2009 to 19.1 percent in 2013.

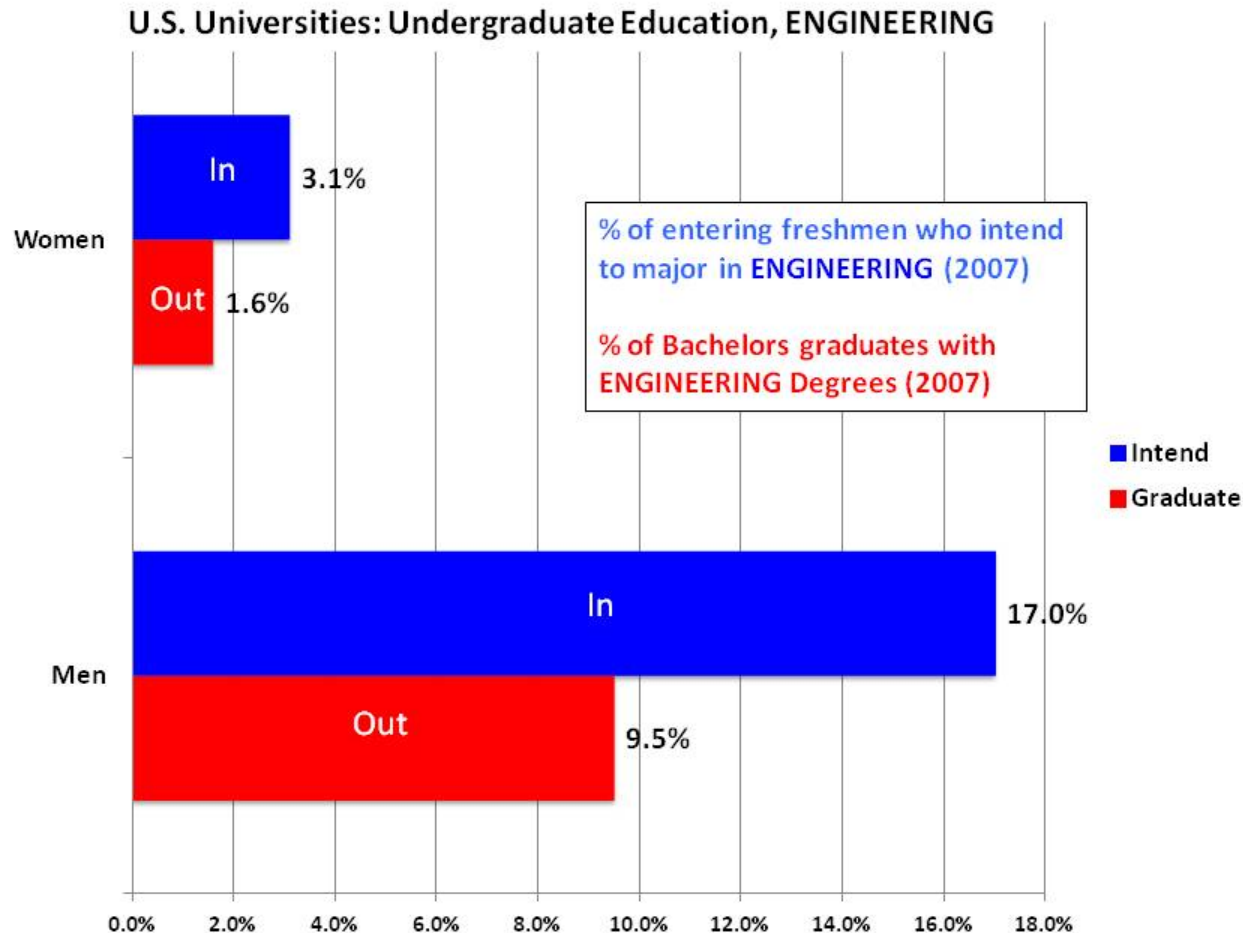
And the story is even more bleak for underrepresented minorities

BS Degree Recipient Ethnicity (2013)



Sources: US Census Bureau, 2013
ASEE, 2013

Perhaps we could do better if we managed to keep the students we attract...



source: NSF S&E Indicators 2010 and US Dept. of Education Digest of Educational Statistics 2008

In addition, a review of the literature reveals that studies have frequently found that women, underrepresented minorities, first-generation students, and those from low-income backgrounds leave STEM fields at higher rates than their counterparts

Chen (2013, NCES 2014-01)

Women are slightly better represented at the graduate level...

Percentage of Female Engineering Degree Recipients

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BS	20.9	20.4	18.2	19.5	19.3	18.1	18.0	17.8	18.1	18.4	18.9	19.1
MS	22.2	22.3	21.9	22.7	22.5	22.4	23.0	23.0	22.6	22.6	23.1	23.9
PhD	17.3	17.4	17.8	18.3	20.2	20.8	21.2	21.2	22.9	21.8	22.2	22.4

Source: ASEE, 2013

The percentage of female engineering master's degrees rose in 2013, with 23.9 percent awarded to women. While an all-time high, this represents just a two-percentage-point increase over 2004. Women received 22.4 percent of PhDs. In the last decade this share has increased substantially.

But the number of female engineering faculty is much less encouraging...

Percentage of female faculty

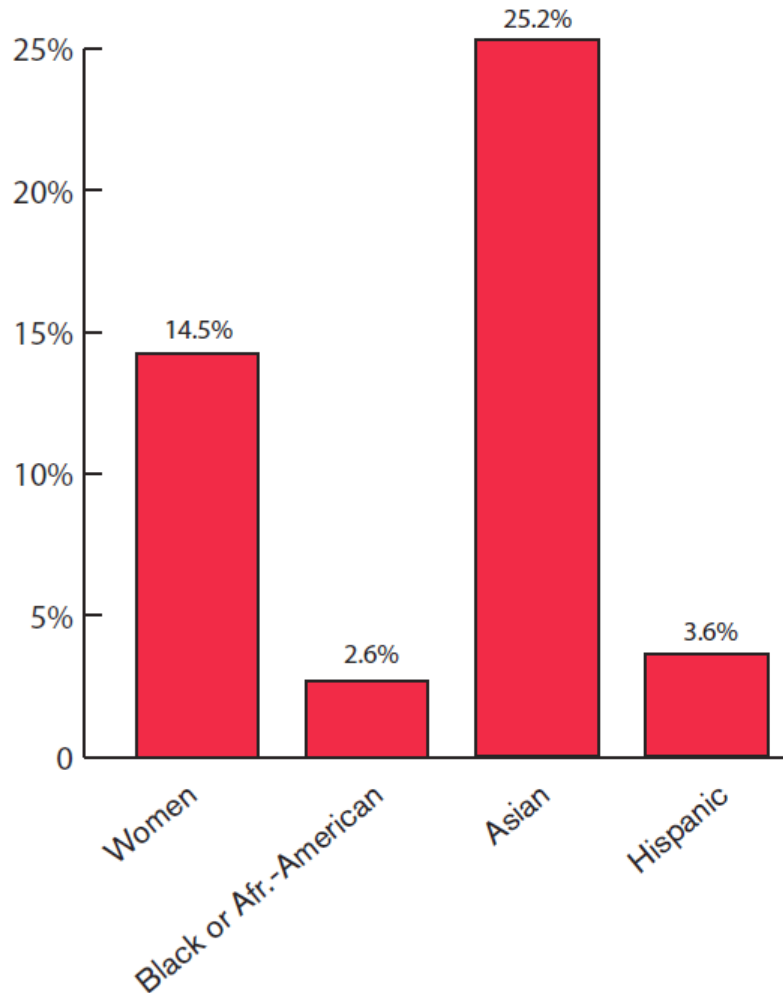
	Top 50 Departments in Selected Disciplines*			
	Asst Prof	Asso Prof	Full Prof	All Levels
ENGINEERING (all schools 2013)	22.8	17.0	9.4	14.5
Biomedical	n.a.	n.a.	n.a.	n.a.
Chemical	23.7	17.8	8.3	12.9
Civil	25.3	14.3	7.1	12.7
Electrical	14.5	14.1	6.2	9.7
Mechanical	18.2	12.0	4.9	9.0
COMPUTER SCIENCE	19.5	11.3	11.5	13.5

Sources:
Nelson and Brammer, 2010
ASEE, 2013

Women comprised 14.0 percent of tenured and tenure-track faculty as of the fall of 2012, continuing a slow but steady climb from 8.9 percent in 2001.

Although female faculty representation has made some gains, the same cannot be said for African-American and Hispanic faculty

PERCENTAGE OF WOMEN AND MINORITY FACULTY, 2004-2013*



	Women	African-American	Asian	Hispanic
2004	10.4%	2.3%	20.2%	3.2%
2005	10.6%	2.4%	20.9%	3.2%
2006	11.3%	2.4%	22.0%	3.3%
2007	11.8%	2.5%	22.6%	3.4%
2008	12.3%	2.5%	22.7%	3.5%
2009	12.7%	2.5%	23.3%	3.5%
2010	13.2%	2.5%	23.9%	3.6%
2011	13.8%	2.5%	24.1%	3.7%
2012	14.0%	2.7%	24.6%	3.9%
2013	14.5%	2.6%	25.2%	3.6%

**Note: Includes faculty data from University of Puerto Rico, Mayaguez, Polytechnic University of Puerto Rico and Turabo University*

(ASEE, 2013)

Why is this a concern?

- US competitiveness – shortages in scientific and technical labor force
- Quality – innovation through diversity of perspectives
- Equity – equal access to professions

Gender Differences at Critical Transitions in the Careers of Science, Engineering, and Mathematics Faculty (NRC, 2010)

Committee members

Claude R. Canizares, *Co-Chair*, Vice President for Research and Associate Provost and Bruno Rossi Professor of Experimental Physics, Massachusetts Institute of Technology

Sally E. Shaywitz, *Co-Chair*, Audrey G. Ratner Professor in Learning Development and Co-Director, Yale Center for Dyslexia and Creativity, School of Medicine, Yale University

Linda Abriola, Dean of Engineering, Tufts University

Jane Buikstra, Regents' Professor, Arizona State University School of Human Evolution and Social Change

Alicia Carriquiry, Professor of Statistics, Iowa State University

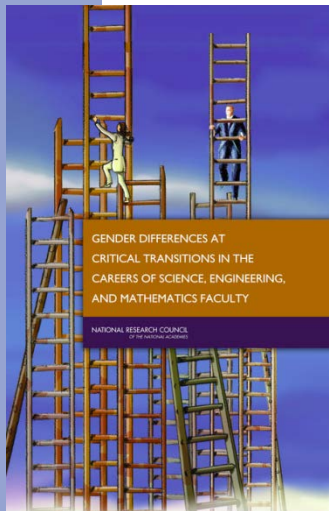
Ronald Ehrenberg, Director, Cornell Higher Education Research Institute and Irving M. Ives Professor of Industrial and Labor Relations and Economics, Cornell University

Joan Girgus, Professor of Psychology and Special Assistant to the Dean of the Faculty, Princeton University

Arleen Leibowitz, Professor of Public Policy, School of Public Affairs, University of California at Los Angeles

Thomas N. Taylor, Distinguished Professor, Department of Ecology and Evolutionary Biology and Biodiversity Research Institute, University of Kansas

Lilian Wu, Program Executive, Global University Relations, IBM Technology Strategy and Innovation



Study Overview

- Conducted two original surveys of research-intensive institutions
- First: surveyed 500 departments, focusing on hiring, tenure, and promotion processes
- Second: gathered career-related information from more than 1,800 faculty full-time T/TT members
- Data present a snapshot in time (2004 and 2005), not a longitudinal view
- Six disciplines examined: biology, chemistry, civil engineering, electrical engineering, mathematics, and physics

Major (surprising) Finding

“For the most part, men and women faculty in science, engineering, and mathematics have enjoyed comparable opportunities within the university, and gender does not appear to have been a factor in a number of important career transitions and outcomes.”

Major Findings (cont)

- Women accounted for about 17 percent of applications for both tenure-track and tenured positions. In each discipline, the percentage of applications from women was lower than the percentage of PhDs awarded to women.
- The percentage of women who were interviewed was higher than the percentage of women who applied.
- The percentage of women who received the first job offer was higher than the percentage who were invited to interview.
- Departments have not generally been aggressive in using special strategies to increase the gender diversity of the applicant pool. However, the percentage of females on the search committee and whether a woman chaired the committee were both significantly and positively associated with the proportion of women in the applicant pool.

Major Findings (cont)

- In every field, women were underrepresented among candidates for tenure relative to the number of female assistant professors.
- Most strikingly, women were most likely to be underrepresented in the fields in which they accounted for the largest share of the faculty—biology and chemistry. (*This difference may suggest that female assistant professors were more likely than men to leave before being considered for tenure or could reflect the increased hiring of female assistant professors in recent years*)
- Women were more likely than men to receive tenure when they came up for tenure review.
- No significant gender disparity existed at the stage of promotion to full professor; women were proposed for promotion to full professor at approximately the same rates as they were represented among associate professors.



An in depth look at one institution:

TUFTS UNIVERSITY

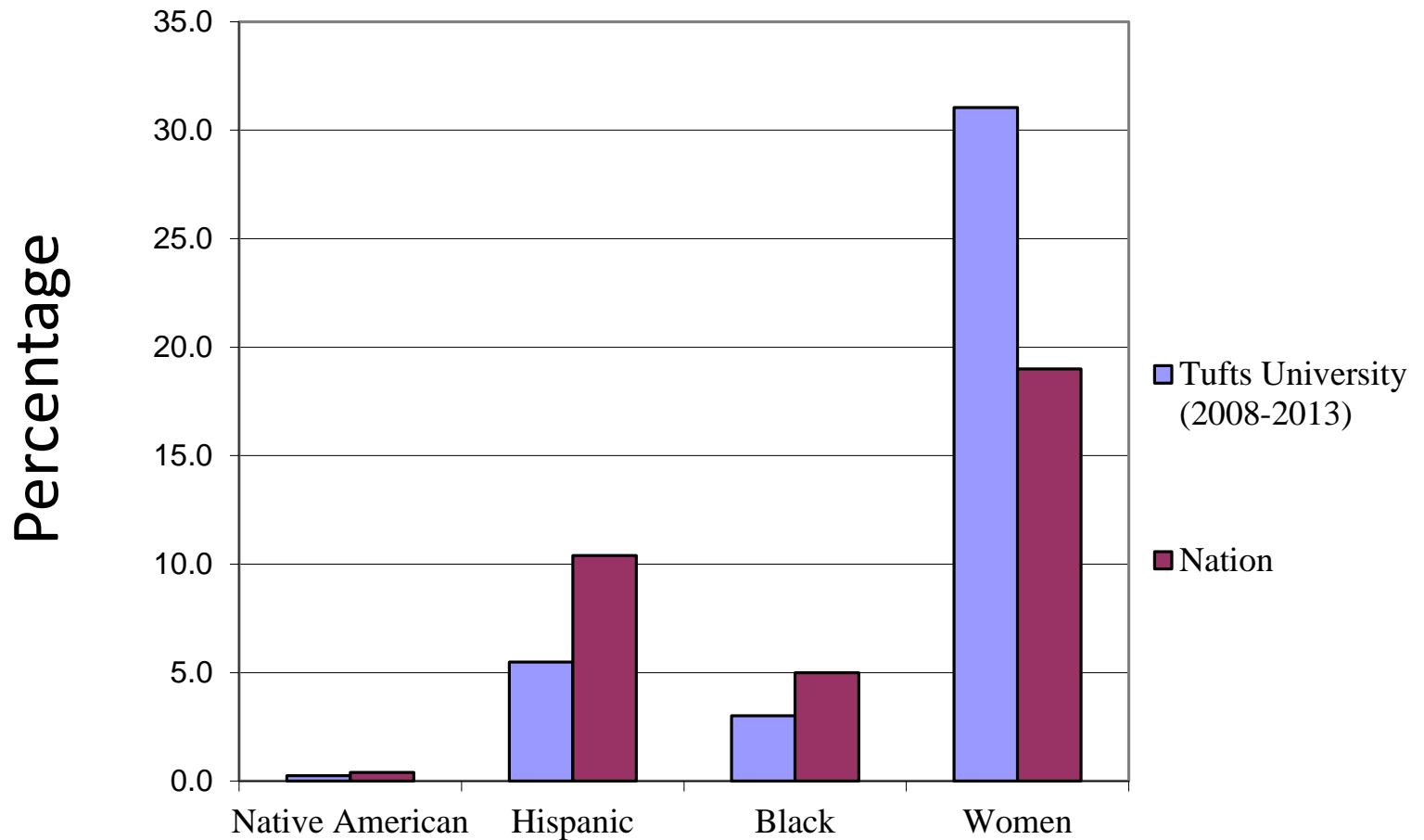
Total Engineering Degree Recipients – Tufts Comparison (2002-2012)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
TUFTS											
Bachelors	29.0 (193)	34.4 (195)	28.2 (220)	26.8 (164)	37.0 (200)	29.6 (159)	39.0 (141)	30.0 (170)	26.5 (166)	30.9 175	32.0 (197)
Masters	30.7 (114)	31.7 (123)	30.6 (160)	22.6 (155)	28.6 (154)	26.5 (132)	37.3 (118)	33.1 (133)	29.7 (101)	22.2 (117)	32.0 (169)
Doctoral	36.4 (11)	25.0 (8)	55.6 (9)	62.5 (8)	44.4 (9)	36.4 (11)	23.5 (17)	50.0 (14)	52.4 (21)	48.0 (25)	35.5 (31)
ALL ENGINEERING SCHOOLS											
BS	20.9	20.4	18.2	19.5	19.3	18.1	18.0	17.8	18.1	18.4	18.9
MS	22.2	22.3	21.9	22.7	22.5	22.4	23.0	23.0	22.6	22.6	23.1
PhD	17.3	17.4	17.8	18.3	20.2	20.8	21.2	21.2	22.9	21.8	22.2

Recruitment and Attrition

- 59% increase in applications to the SOE in the past five years, 102% increase in the last 10 years
- Over the past ten years, female enrollment has increased from 26% for the class of 2009 to 33% for the class of 2018
- We graduate as many engineers as we matriculate – ZERO NET ATTRITION
- 99% of our freshmen in engineering graduate in 4 years
- Women are performing as well as the men – average GPA (combined grads 2001-05) :
 - females: 3.30/4.0 (29.1% of 973 grads)
 - males: 3.24/4.0

But we are not doing as well in terms of other underrepresented minorities...




Percentage of Female Faculty: Tufts Comparison

	Top 50 Departments in Selected Disciplines*				School of Engineering Tufts University (AY 2013-14)		
	Asst Prof	Asso Prof	Full Prof	All Levels	Asst Prof	Asso Prof	Full Prof
ENGINEERING ** (all schools 2013)	22.8	17.0	9.4	14.5	23.5 (4 of 17)	20.0 (6 of 30)	25.0 (8 of 32)
Biomedical	n.a.	n.a.	n.a.	n.a.	33.3 (1 of 3)	100.0 (1 of 1)	0 (0 of 4)
Chemical	23.7	17.8	8.3	12.9	33.3 (1 of 3)	0 (0 of 5)	50.0 (1 of 2)
Civil	25.3	14.3	7.1	12.7	33.3 (1 of 3)	12.5 (1 of 8)	25.0 (2 of 8)
Electrical	14.5	14.1	6.2	9.7	0 (0 of 3)	50.0 (2 of 4)	16.7 (1 of 6)
Mechanical	18.2	12.0	4.9	9.0	50.0 (1 of 2)	0 (0 of 6)	0 (0 of 5)
COMPUTER SCIENCE	19.5	11.3	11.5	13.5	0 (0 of 3)	33.3 (2 of 6)	57.1 (4 of 7)

* Nelson and Brammer, 2010; ** ASEE, 2013

At 22.8% female, Tufts ranks 12th out of 242 institutions in 2013



Although we can still do much better, why have we had this level of success?

It may be the result of many factors.....

Leading by example



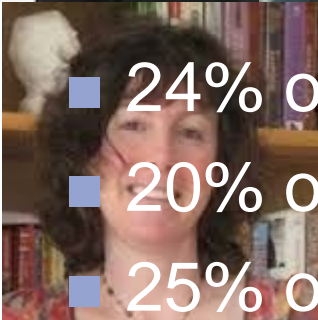
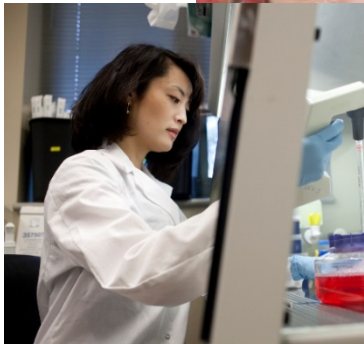
■ Six of Tufts' top administrators (including the Senior Vice President for Finance, the Vice Provost for Research, and the Vice President for Operations) and four of its eight school deans are women; two of this leadership group are African Americans

■ The Dean of Engineering's leadership team is 59% female and underrepresented minority

Faculty Role Models

At Tufts, 23% of the Engineering tenure-track/tenured faculty are women:

- 24% of 17 Assistant Professors
- 20% of 30 Associate Professors
- 25% of 32 Full Professors



Integration of the SOE

- There is a close historic relationship between the Schools of Engineering and Arts & Sciences
- Collaboration between the schools is institutionalized at all levels - by joint majors, shared students services and academic administrative structures, and integrated faculty governance
- The two schools cohabit the same campus – no physical isolation of SOE

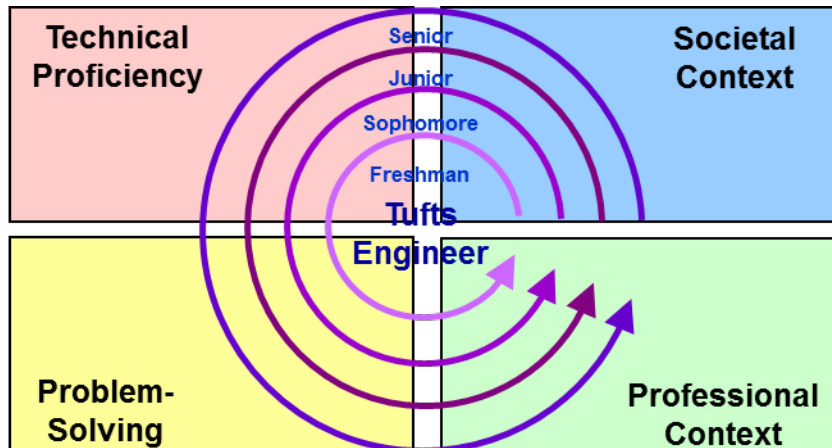
Student Advising

- Full time Associate Dean for Undergraduate Advising
- Faculty assigned for both pre-major and major advising
- Fulltime internship coordinator
- Targeted Programs for support of first generation and underrepresented students through Center for STEM Diversity



Educational Innovation

- New first year courses
- Project-based learning and design experiences throughout the curriculum
- Multigenerational teaching and mentoring
- Team leadership experiences
- An understanding of engineering in its societal context



Service Learning

- Student Teacher Outreach Mentorship Program

- NERD Girls

- Engineers Without Borders

- Tisch Scholars



The Center for STEM Diversity

- Created in 2008 to help Tufts University better recruit and retain underrepresented students in the STEM disciplines
- Helps coordinate efforts around STEM diversity on the Tufts Medford Campus
- Advise undergraduates and grad students, and work with faculty and staff on creating a more inclusive, supportive STEM community
- Programs include cohort weekly meetings and workshops, science study groups, and a bridge program



Why Bridge Programs?

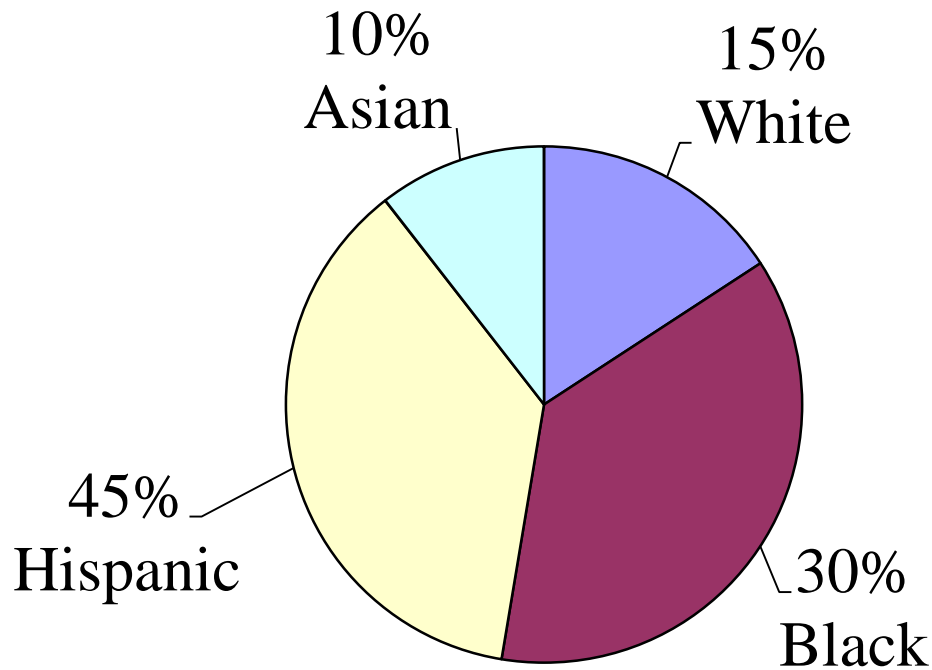
- In an effort to expand recruitment and increase diversity, many universities have begun recruiting a wider variety of students
- Universities must address the reality of unequal college preparation of high school students (access to AP courses, quality of instruction, etc.)
- Bridge programs allow schools to identify students with high potential but less college-prep, and successfully transition them to college life and academics

Bridge to Engineering Success at Tufts (BEST)

- Six-week summer bridge program for incoming engineering students, primarily first generation college-goers <http://stemdiversity.tufts.edu/>
- Students must participate in the program to matriculate into SOE in the fall
- Opportunity to take two Tufts University courses for credit; participate in academic/college life workshops
- First cohort of 8 participated in summer 2010 and graduated in spring 2014

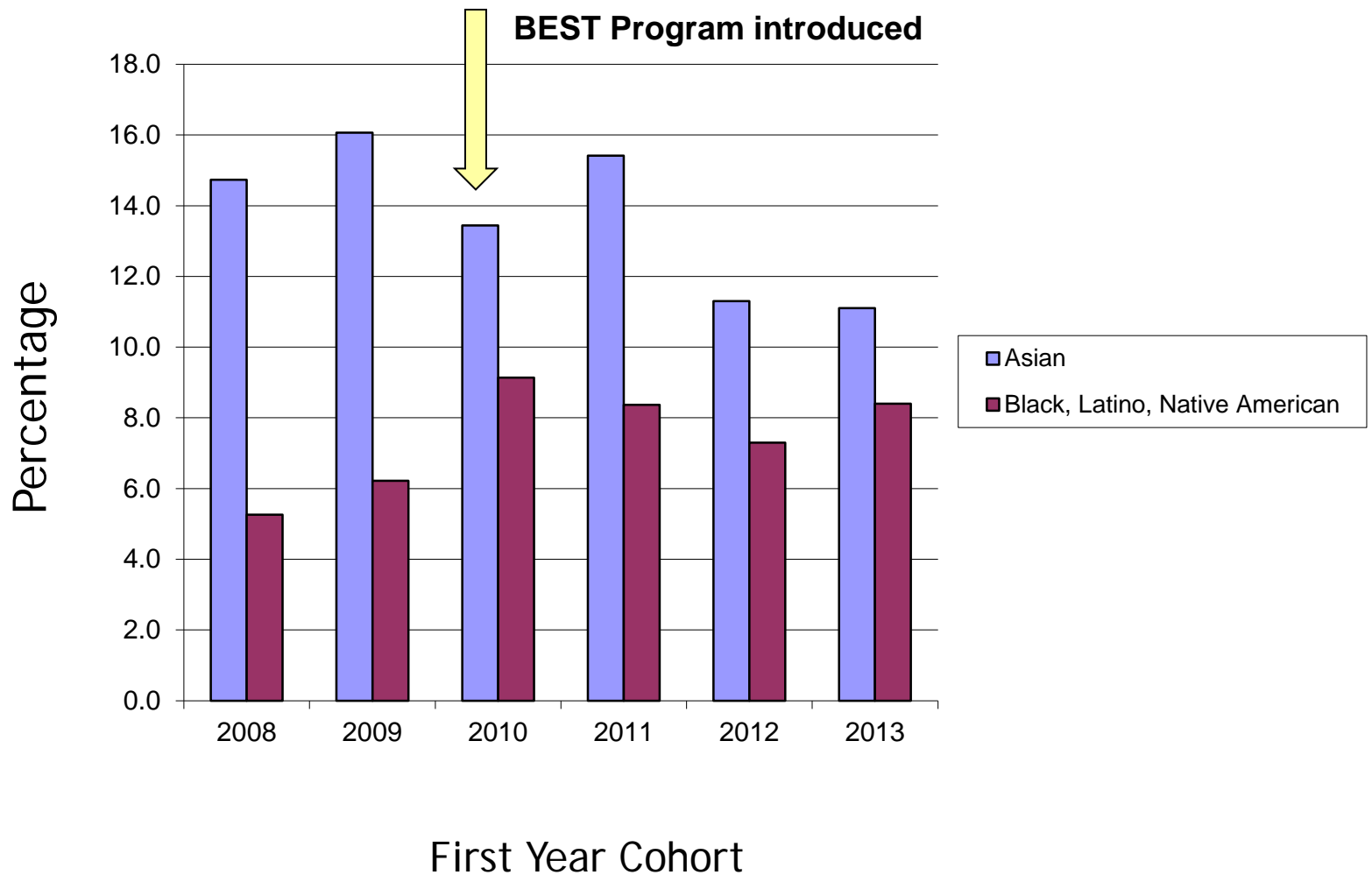
BEST Demographics

All cohorts combined



- 43% women
- Average HS class rank top 5%
- Vast majority are first-generation college-goers
- All receive financial aid (average financial need approx \$50K out of a Tufts budget of \$61K) (2103 cohort)
- Residents of: Massachusetts, Texas, Maryland, New York, Florida, California, Illinois, Connecticut, Washington, Washington, DC, Idaho, New Mexico, Michigan, New Jersey, Rhode Island, West Virginia

Tufts School of Engineering – Undergraduate Students of Color



Bridge to Engineering Success at Tufts



Faculty Recruitment and Retention

- Of tenure-stream faculty hired from AY 03-04 through AY 12-13, 26% (12 out of 46) were women
- For the hire cohort years AY 03-04 through AY 12-13, 92% (11 out of 12) of the women have been retained (compared with 94% (32 out of 34) of the men)
- In AY 13-14, 50% (2 out of 4) of the tenure-stream hires were women

It is informative to compare with statistics of previous 15 years:

- Of tenure-track faculty hired from AY 90-91 to AY 04-05, 40.5% were women
- For the hire cohort years AY 90-91 through AY 98-99, 50% of the women were retained (compared with 64% of the men)



Faculty Hiring Process

The Dean and Associate Dean for Faculty Affairs monitor all searches very carefully:

- Review/approve membership of search committee and text of position announcement
- Encourage extensive outreach, including outside of academia
- Review/approve demographics of total pool and those who survive the “first cut”
- Review/approve candidates proposed for on-campus interviews, the “second cut”
- Encourage welcoming interview climate
- Dean meets all interview candidates
- Review/approve candidate proposed for hire
- Dean makes position offer personally

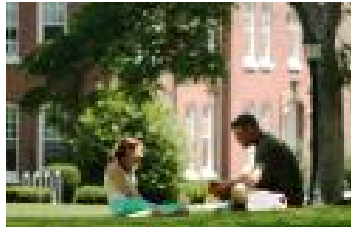
Faculty Mentoring

- Reduced course load for new faculty – 2 courses/year
- Junior faculty research leave (one semester) for all junior faculty
- Formal mentoring program – junior faculty paired with one senior faculty from within department, one senior faculty from outside department
- Regular junior faculty social luncheons
- Informal support from faculty/administrators in both SOE and A&S, thanks to integration of schools
- Regular, formal reviews (2nd and 4th years) with written feedback
- Opt out tenure clock stoppage of one year for primary caregiver

Conclusions

- Attracting and retaining women and underrepresented minorities in the academic sector is a complex problem that admits no easy solution
- Role models, community, and the development and adoption of certain policies/programs may help explain why some institutions are more successful than others
- The adoption of new institutional policies/programs have improved the climate/learning environment for ALL groups
- Recruit well and invest in people
- Personal relationships and individual leadership matter!

Questions???



Tufts
UNIVERSITY

School of
Engineering

