ABET 2008 Annual Meeting

Organizing to Improve the Pipeline

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AAAS Capacity Center

American Association for the Advancement of Science

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ADVANCING SCIENCE, SERVING SOCIETY

Q: "Organizing . . . the pipeline."
Is engineering disorganized?

A: We are dissatisfied with our progress.
And frustrated by its sluggish pace.
Or are we?

Q: This session asks . . .

Should the engineering profession be more "organized" in the recruitment and/or retention of students?

A: Yes, but who should take the lead?

- **Engineering societies**
- **Universities**
- **Employers of engineers**
- ***ABET***

A Data-based Look at a National Problem—Aspects of Participation in Engineering

- Image
- Enrollments
- Degrees
- Workforce/Employers

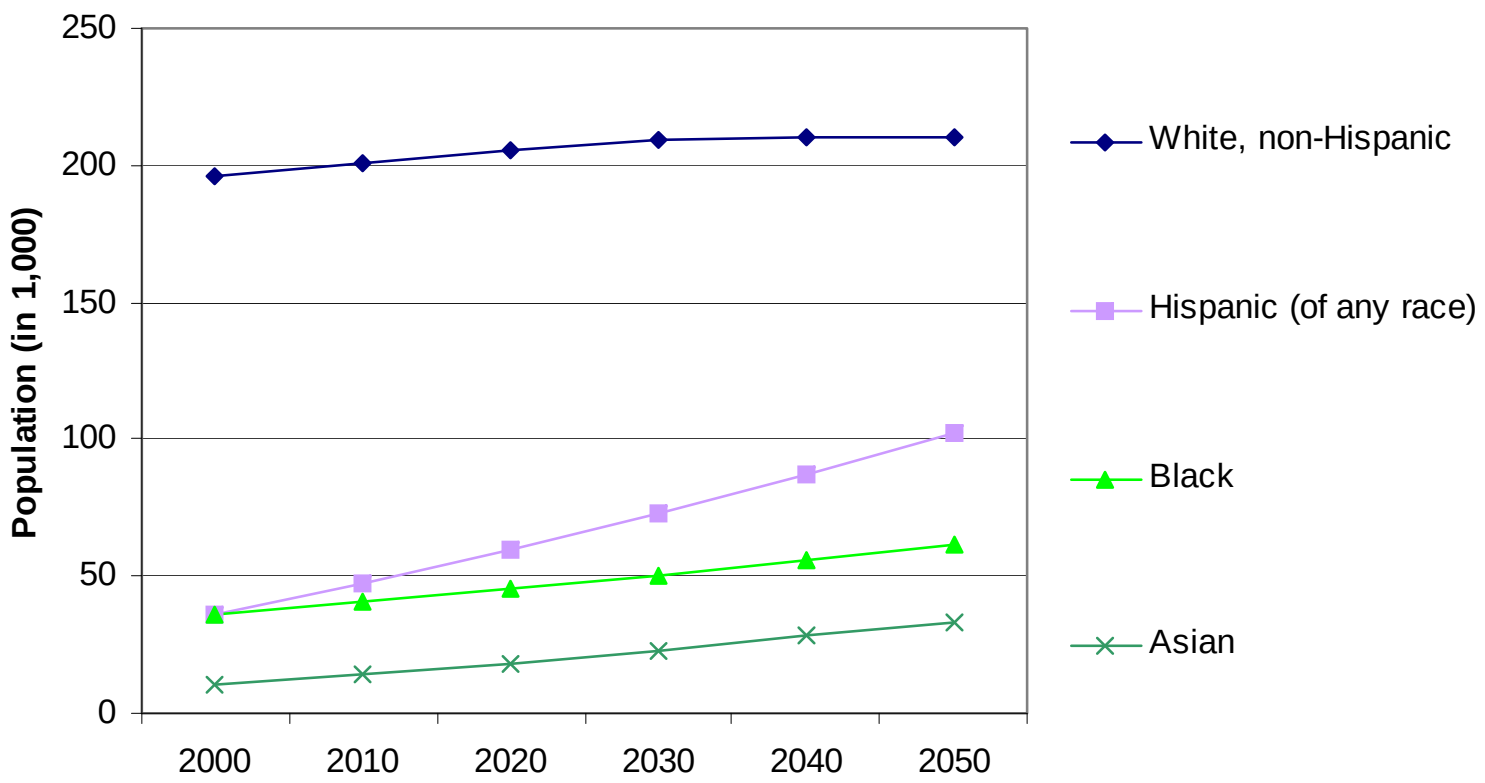
Image of Engineering

According to an NAE report* . . .

- K-12 teachers & students don't understand what engineers do as a career
- Survey of public shows engineers as competent in math/ science—and this as a barrier to engineering study
- Recommends 4 messages to reposition engineering as a satisfying profession, incl. helping to shape the future, being creative problem-solvers, & as essential to health and safety
- Need a coordinated communications strategy to strengthen image

*NAE, *Changing the Conversation*, National Academies Press, 2008

The numbers of non-Hispanic whites in the U.S. is projected to level off, with large increases in the Hispanic population.



Source: Commission on Professionals in Science and Technology, data derived from U.S. Census Bureau.

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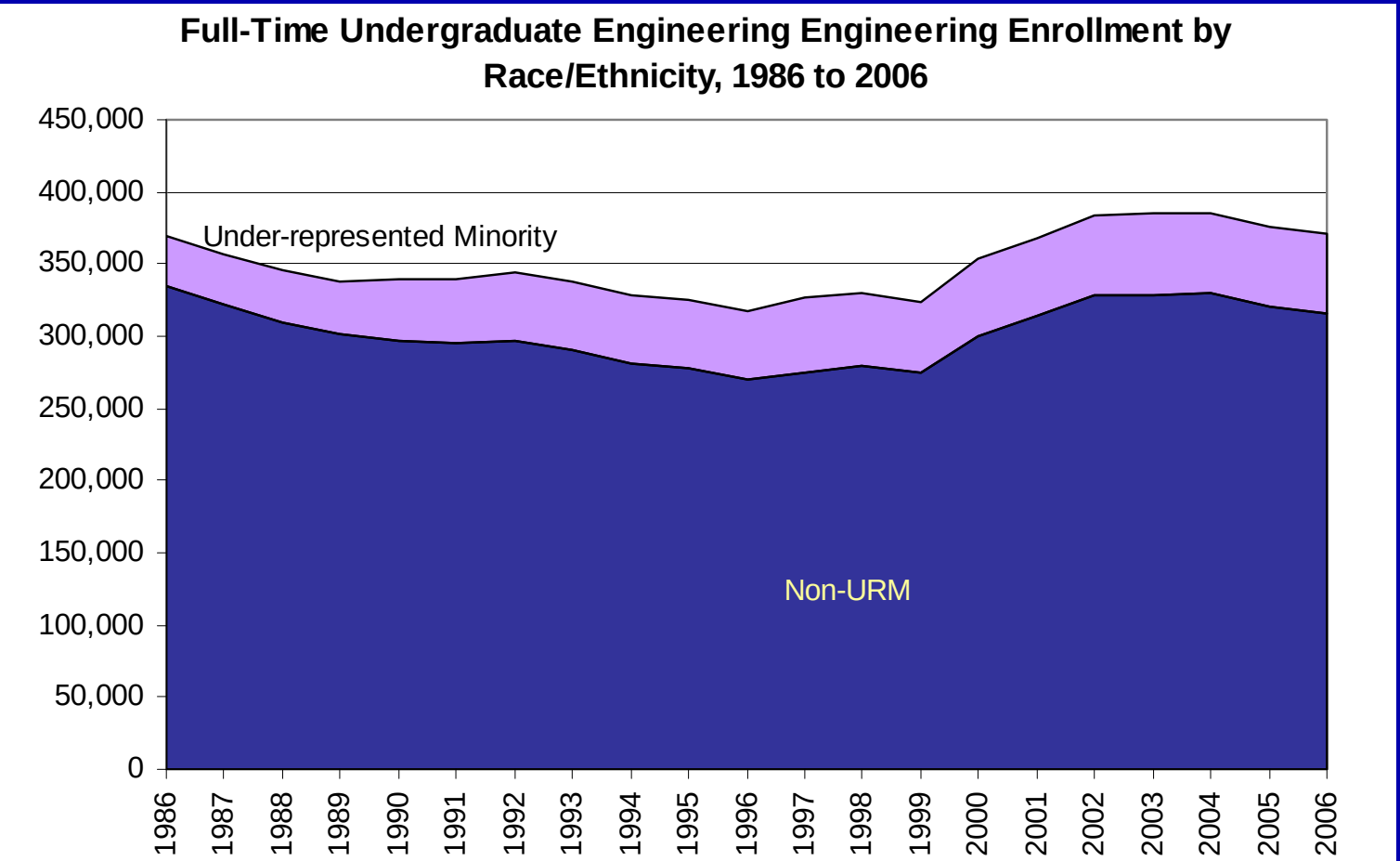
URM enrollment mirrors the general trend. The number of URMs enrolled in engineering has increased only modestly since 1980.



Source: CPST, data derived from Engineering Workforce Commission, Engineering and Technology Enrollments, Fall 1984 - Fall 2006.

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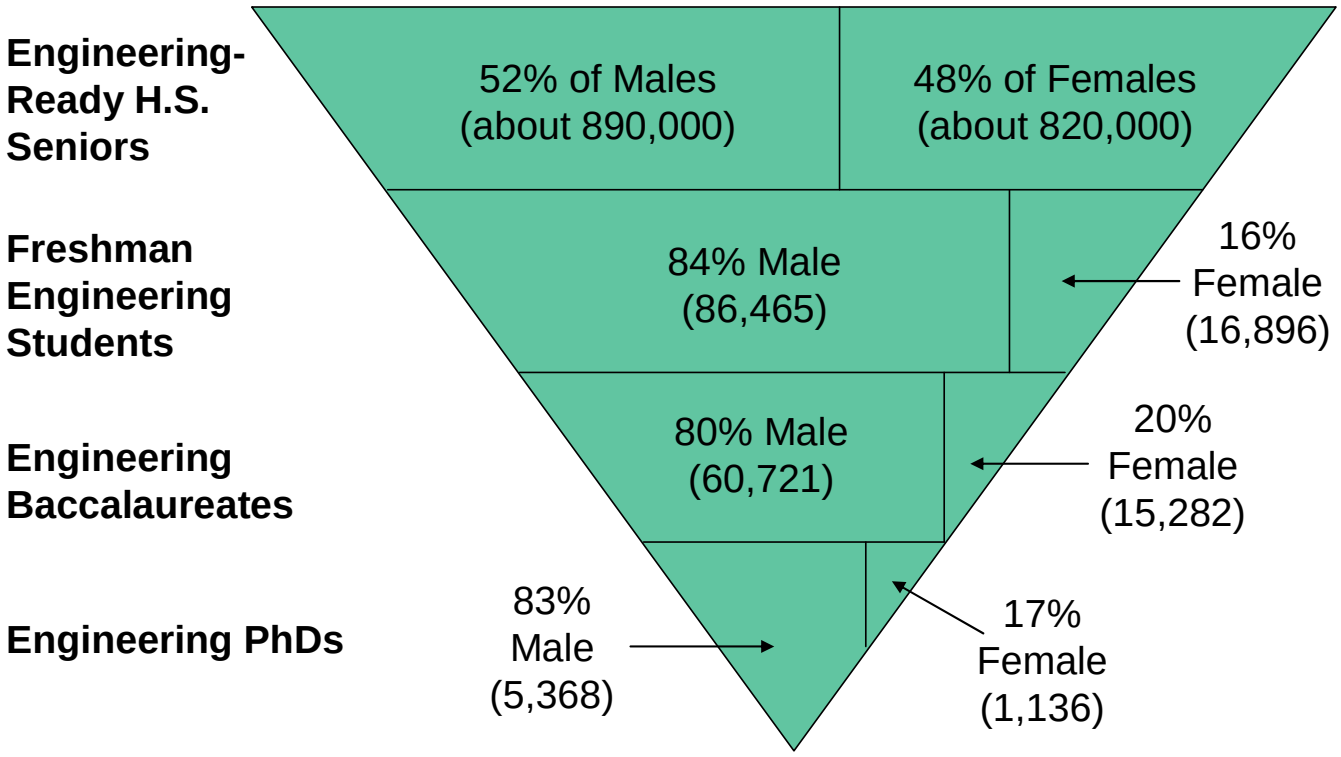
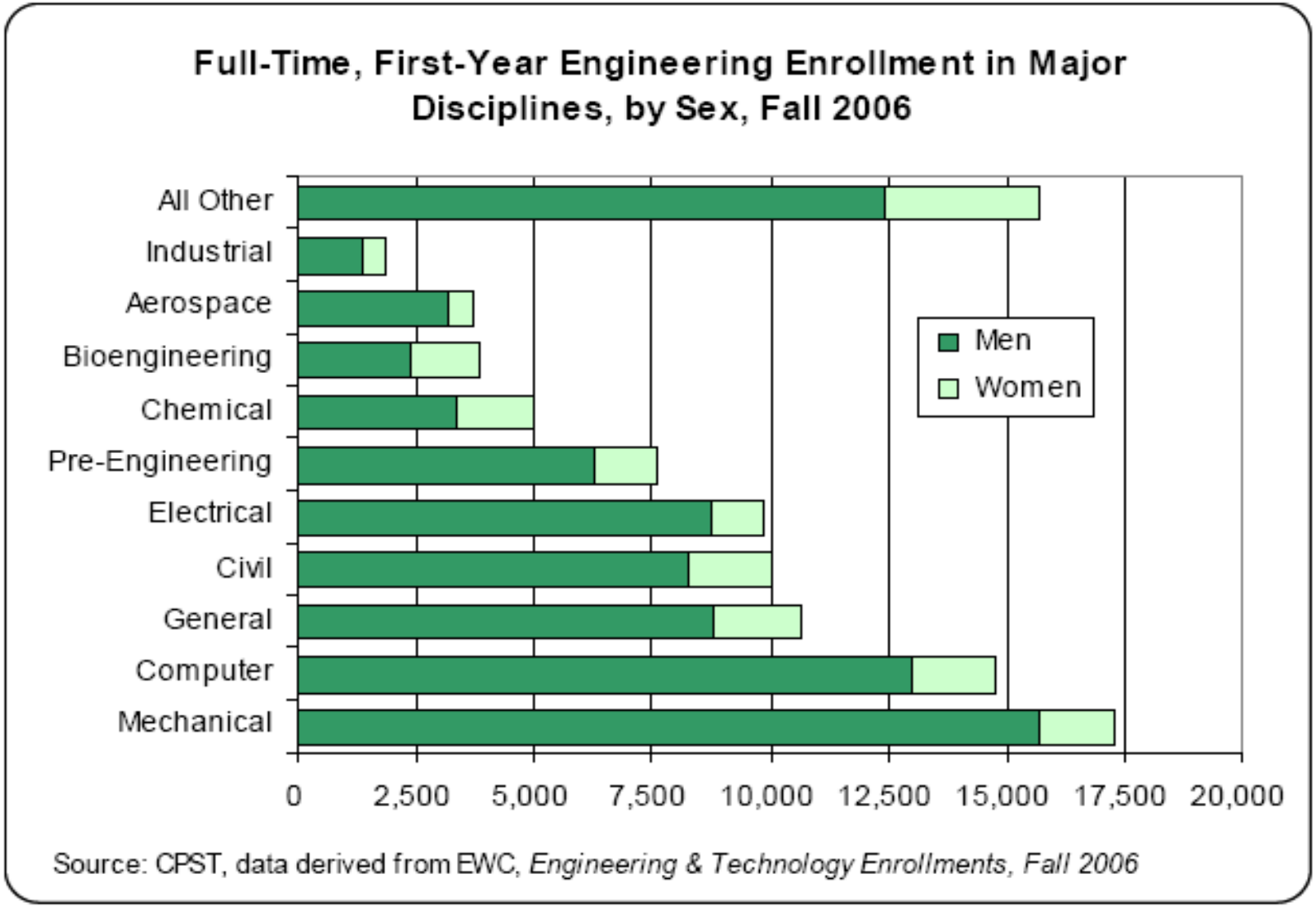
Percentage of First-Year Students Planning to Major in Science and Engineering, by Broad Field, 1996 to 2006

Year	Social Sci. & Psych.	Engi-neering	Biological Sciences	Physical Sciences	Computer Sciences	Math and Statistics
1996	9.2	8.2	7.0	1.8	2.6	0.5
1997	8.2	9.2	6.3	1.7	3.1	0.5
1998	8.4	8.2	5.6	1.6	3.5	0.5
1999	8.8	8.1	6.1	1.5	3.8	0.5
2000	10.0	8.7	6.6	1.9	3.7	0.7
2001	10.3	9.1	6.9	1.9	3.3	0.7
2002	10.4	9.5	7.2	2.0	2.2	0.7
2003	10.5	9.3	7.3	2.0	1.7	0.7
2004	10.2	9.6	7.7	2.3	1.4	0.7
2005	10.7	8.4	7.6	2.3	1.1	0.8
2006	11.2	8.0	8.3	2.3	1.1	0.8

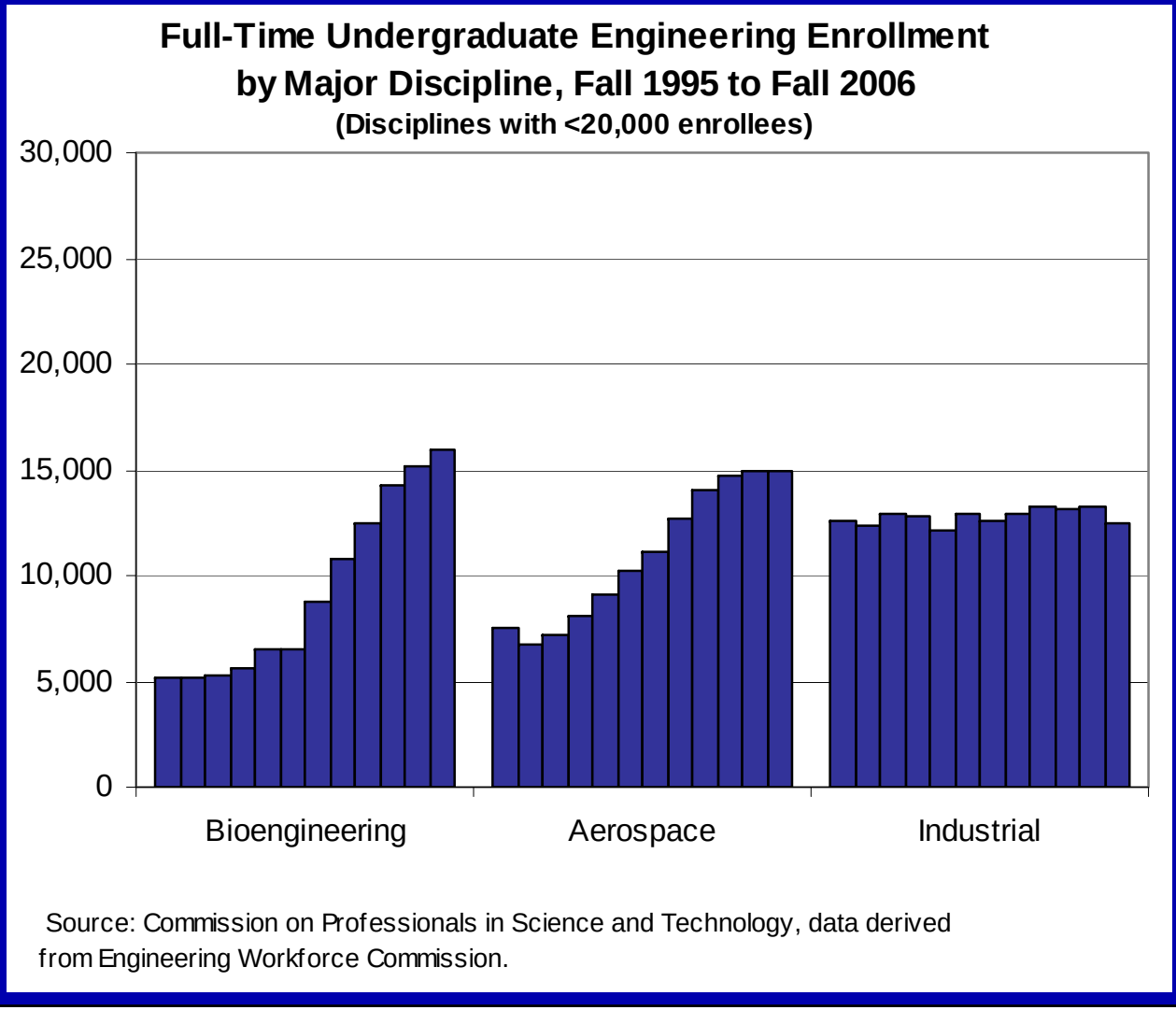
Source: CPST, data derived from *The American Freshman* , Higher Education Research Institute, University of California, Los Angeles

The Educational Pathway for Women in Engineering



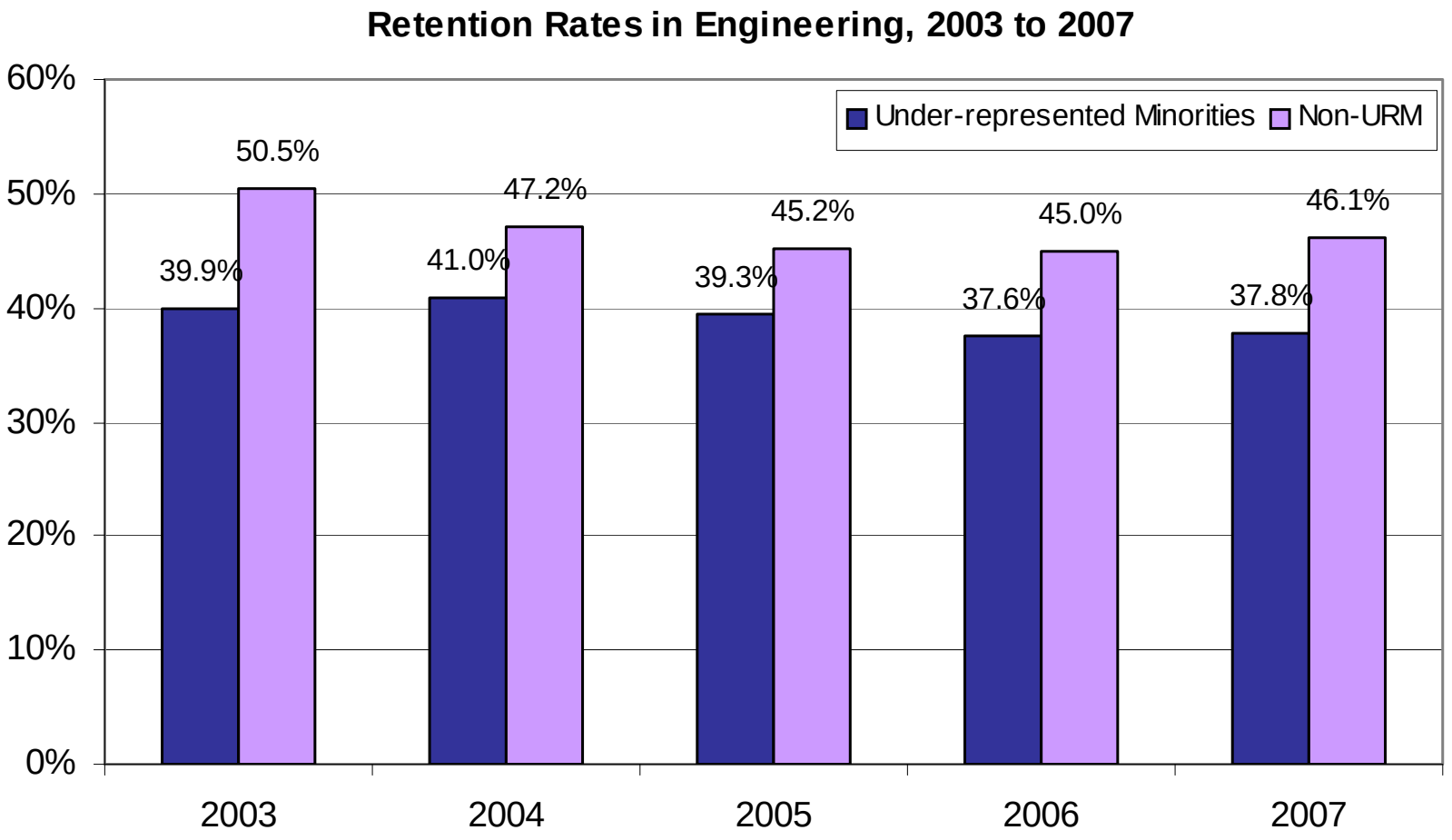

Full-Time, First-Year Engineering Enrollment in Major Disciplines, by Sex, Fall 2006
All Other
Industrial
Aerospace
Bioengineering
Chemical
Pre-Engineering
Electrical
Civil
General
Computer
Mechanical
Men
Women
0
2,500
5,000
7,500
10,000
12,500
15,000
17,500
20,000
Source: CPST, data derived from EWC, Engineering & Technology Enrollments, Fall 2006

While still smaller than other engineering disciplines, bioengineering and aerospace are on the rise.



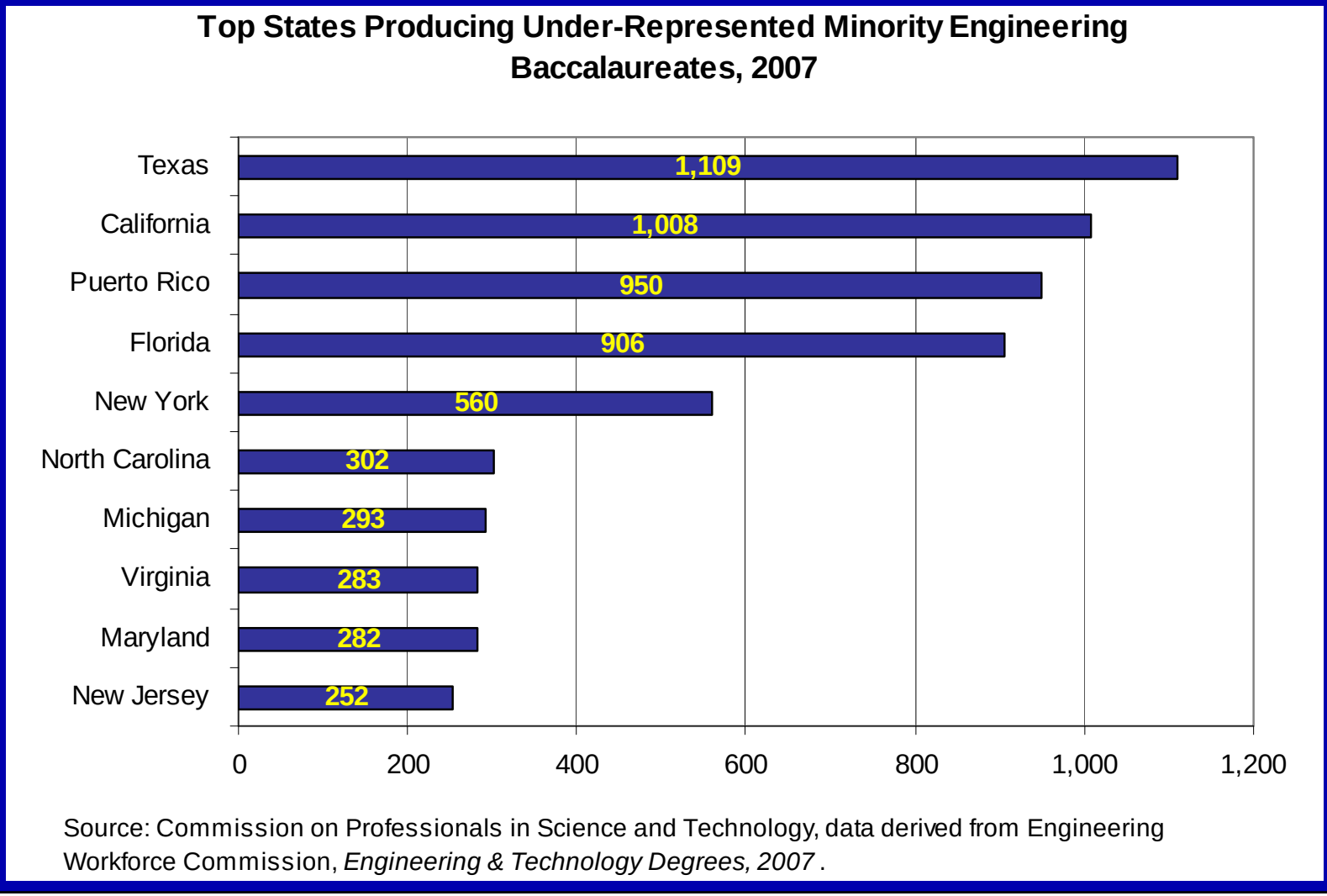
Source: Commission on Professionals in Science and Technology, data derived from Engineering Workforce Commission.

Undergraduate Retention in Engineering, 2003-2007



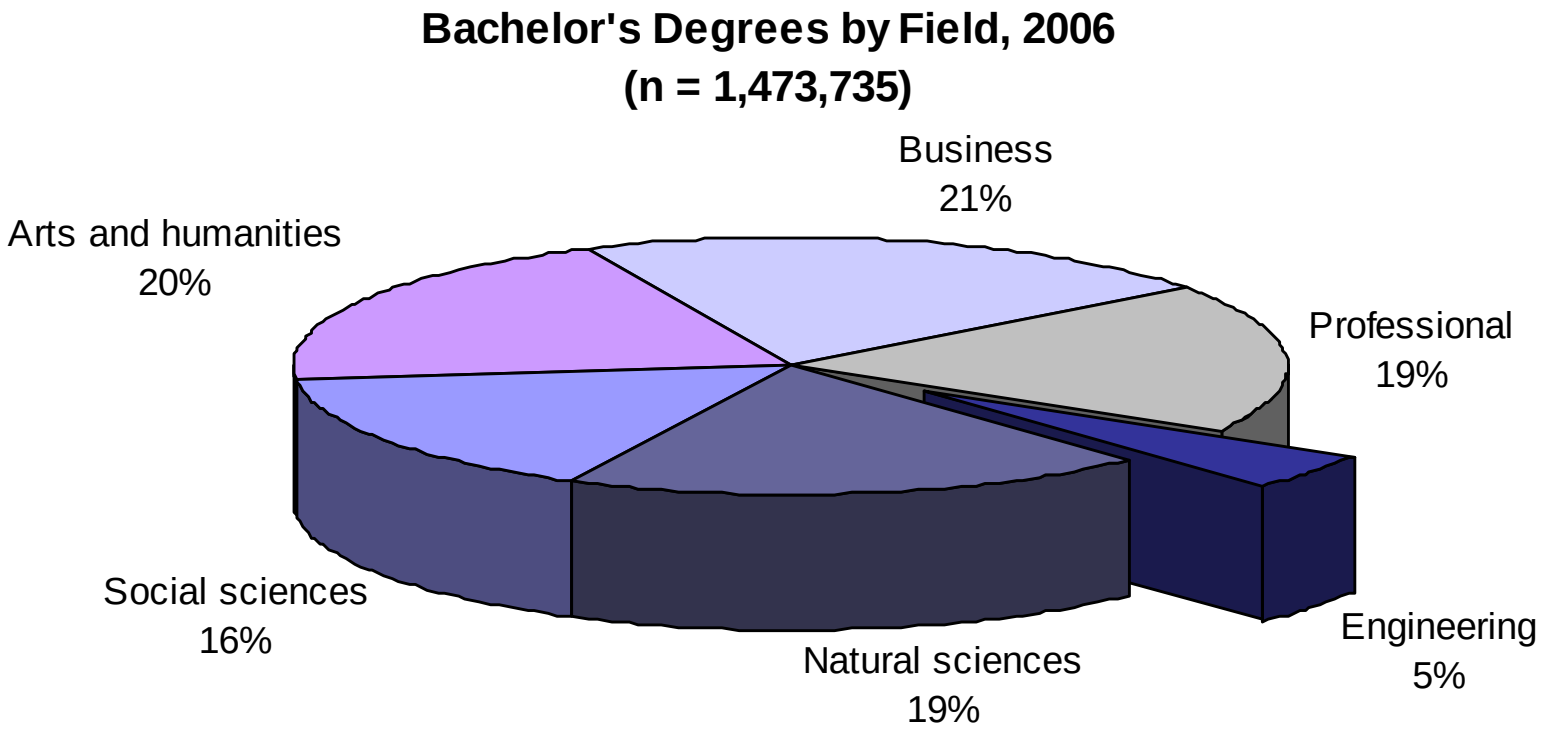
Source: Commission on Professionals in Science and Technology, analysis of data from Engineering Workforce Commission.

Consistent with population trends, Texas, California and Puerto Rico were the top producers of URM engineering bachelor's degrees in 2007.



Source: Commission on Professionals in Science and Technology, data derived from Engineering Workforce Commission, *Engineering & Technology Degrees, 2007* .

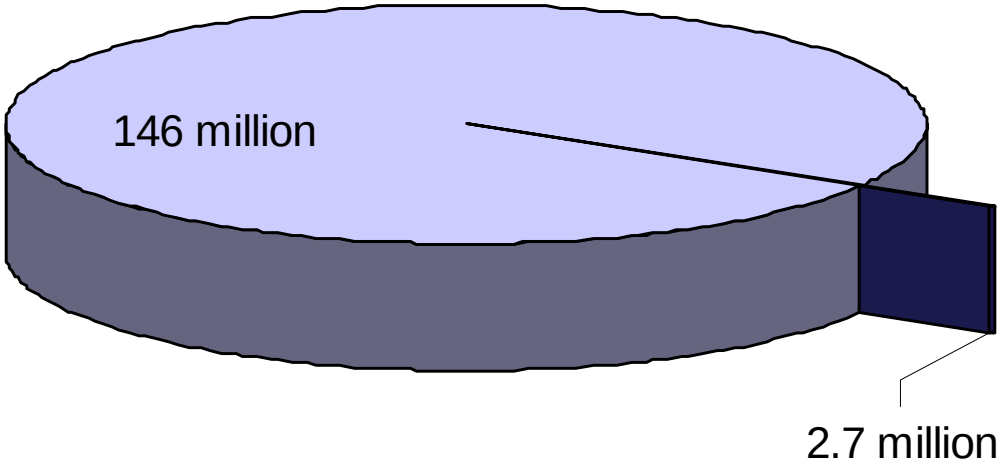
Engineering accounted for just 1 in 20 bachelor's degrees in 2006.



Note: "Natural sciences" includes "Science and engineering technologies."
Source: Commission on Professionals in Science and Technology analysis of IPEDS data accessed via National Science Foundation's WebCASPAR database, March 2008.

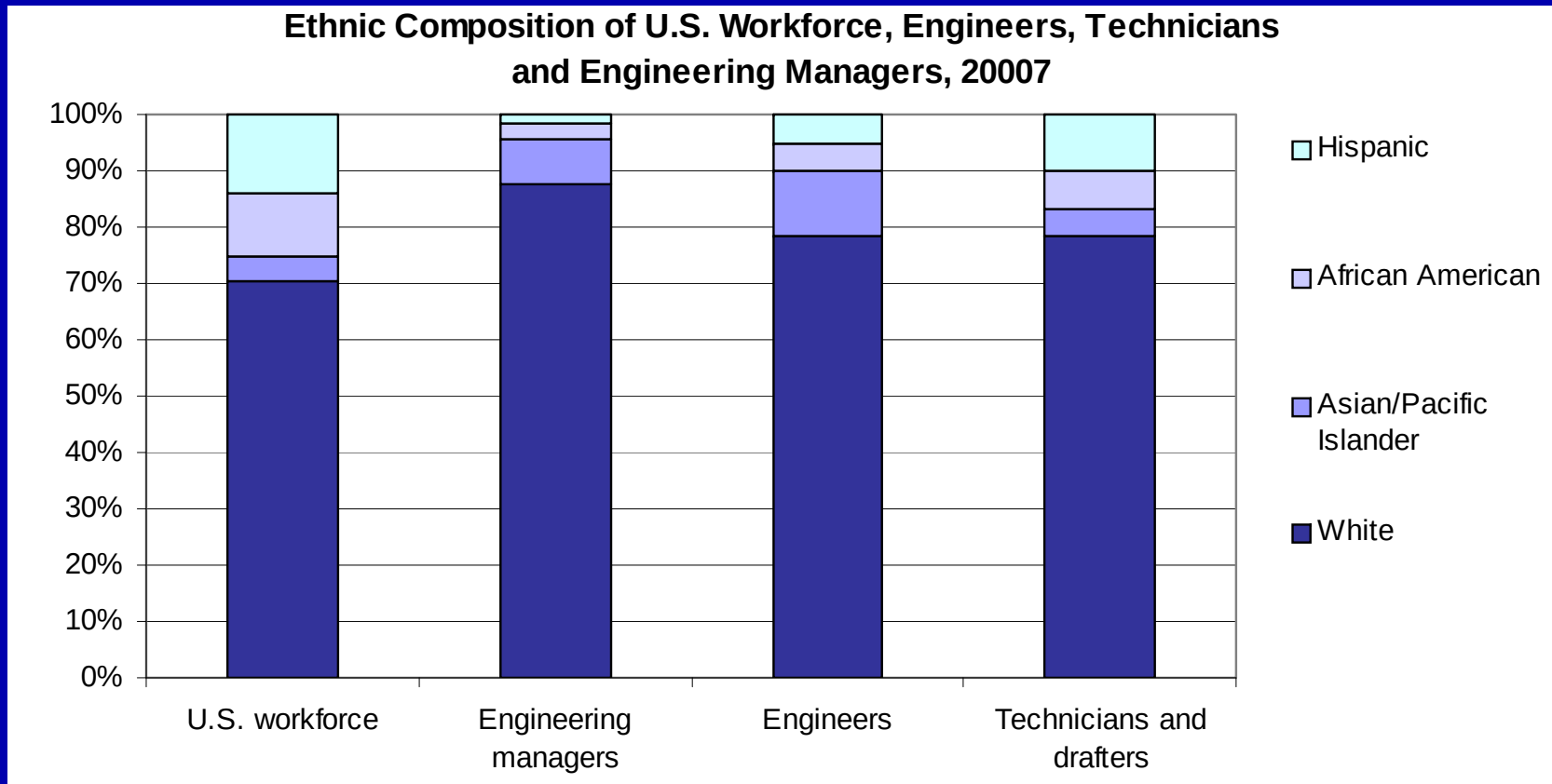
The U.S. engineering labor force accounts for 0.2% of all workers.

U.S. Engineering and Related Occupations Relative to the U.S. Labor Force, 2007



Source: Commission on Professionals in Science and Technology analysis of Bureau of Labor Statistics, Household Averages, aat11 data, 2007.

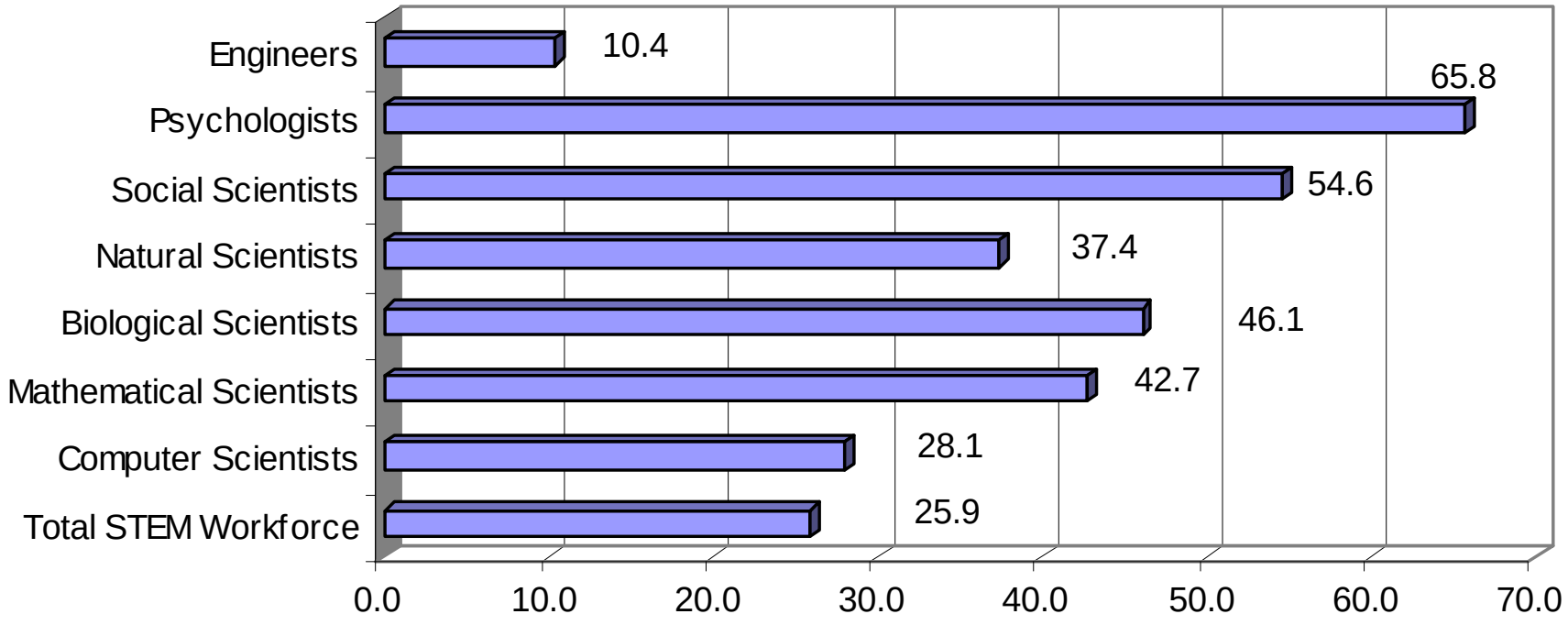
Asian/Pacific Islanders are under-represented as engineering managers vs. their representation as engineers. Hispanics and African Americans are under-represented in engineering and related fields.



Notes: Excludes engineering and technical occupations for which number of minorities was too small to permit analysis. Workforce includes only those aged 16 and older.

Source: Commission on Professionals in Science and Technology analysis of Bureau of Labor Statistics, Household

Proportion of Women in Selected STEM Occupations, 2003

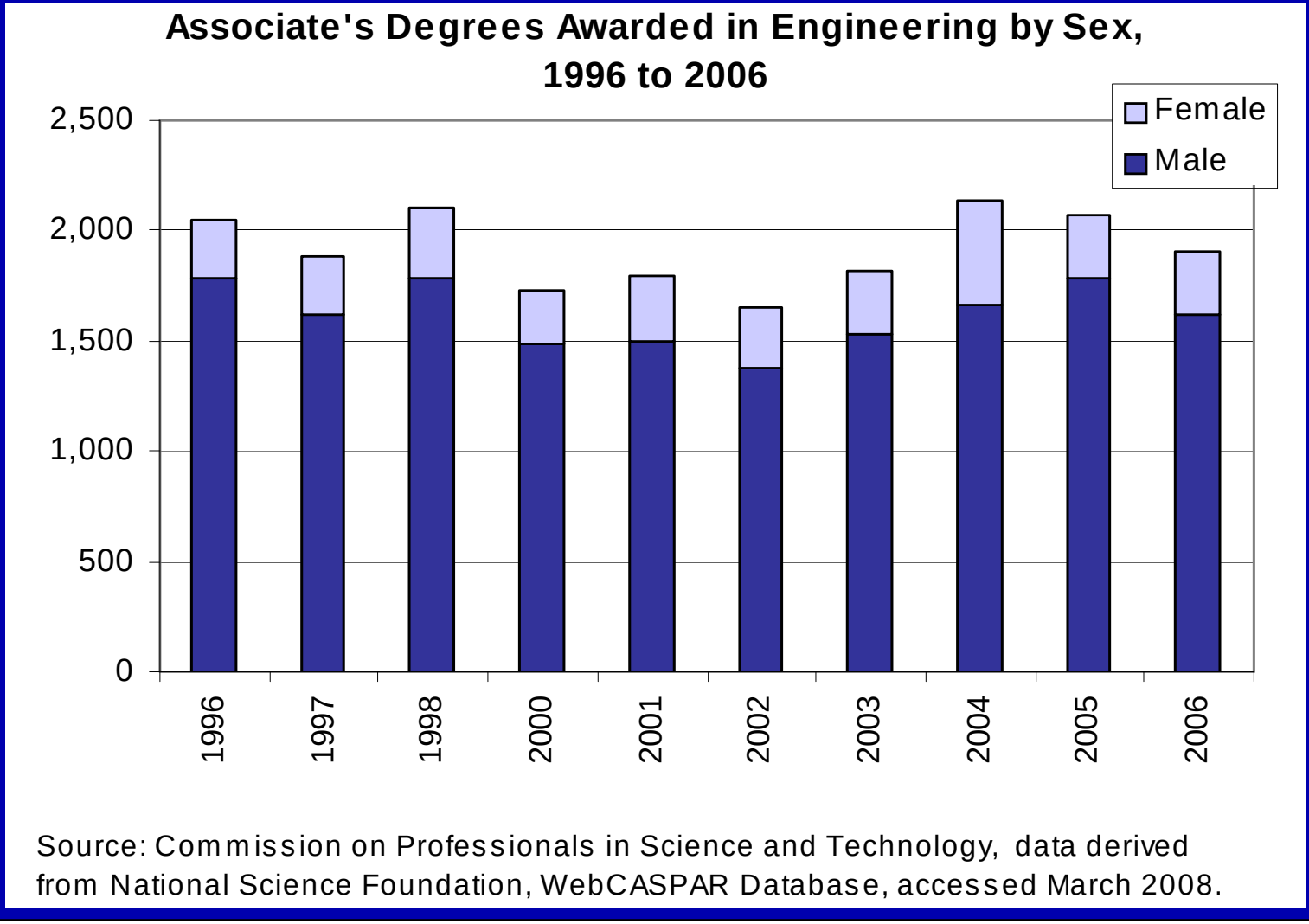


Source: CPST, data derived from Bureau of Labor Statistics, *Current Population Survey*

Missing Ingredients
(not explicit in the preceding)

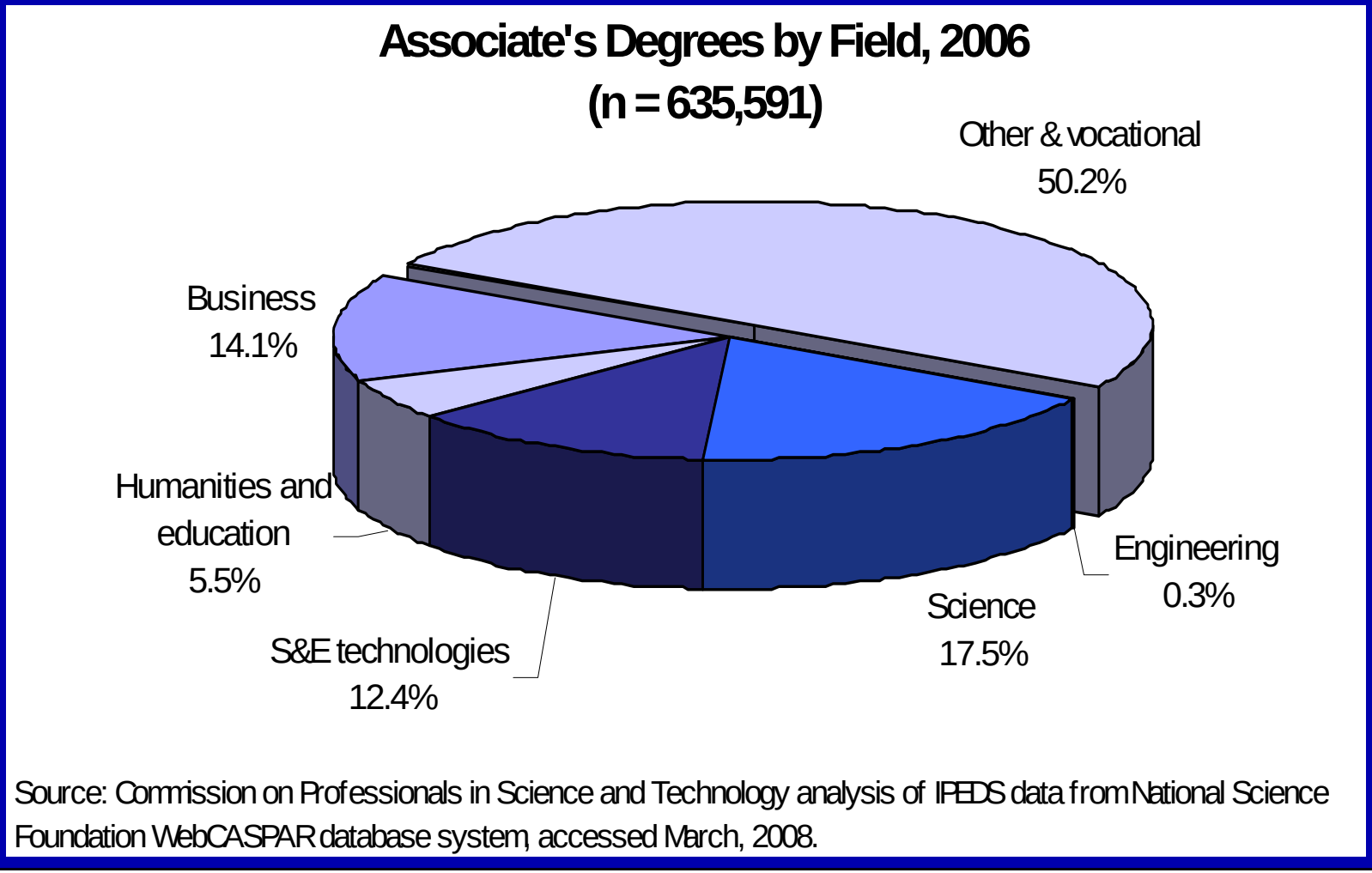
- Community colleges
- Faculty
- Strategies
- Policy

Women earned a small but varying proportion of associate's degrees in engineering between 1996-2006.



Source: Commission on Professionals in Science and Technology, data derived from National Science Foundation, WebCASPAR Database, accessed March 2008.

Engineering accounted for a small portion of the 635,591 associate's degrees awarded in 2006, but 1 in 8 were awarded in science and engineering technologies.

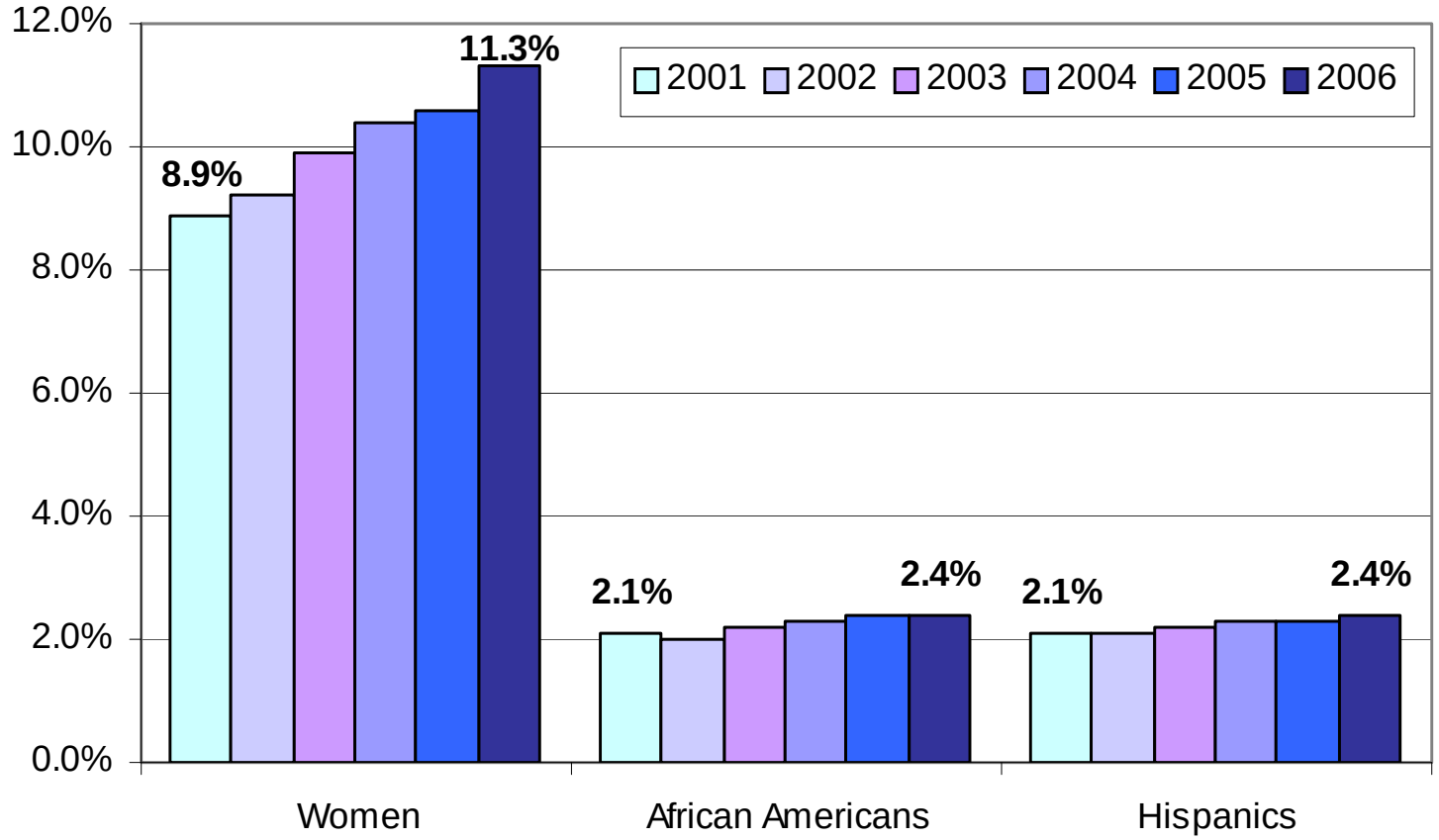


Source: Commission on Professionals in Science and Technology analysis of IPEDS data from National Science Foundation WebCASPAR database system, accessed March, 2008.

Faculty—What Matters

- Rewards for academic performance (promotion, tenure, bonus, advancement), including metrics of student success (recruitment/outreach, retention, mentoring)
- Recognition of “champions of diversity” institution-wide as scholarly role models
- Appointment by a department/program of a woman or minority faculty member
- Addition of an undergraduate to a faculty member’s research team/laboratory

Underrepresentation in the Engineering Faculty



Source: Commission on Professionals in Science and Technology, data derived from American Society for Engineering Education

Strategies for Reducing Underrepresentation: Fix the Students, Pathways, or College?

- **Students:**
  - Demographic composition (*Is Generation Net, b. 1982-91, different from predecessors in notable ways?)*
  - Pre-college academic preparation
- **Pathways:**
  - Intervention programs—add-on to formal education
  - Access to higher education—cost reduces diversity
- **College Environment:**
  - "Cultural competence" of faculty—teaching diverse students
  - Structural support—climate, career information, mentoring

What Do We Do Now (A Sample of Interventions)

- Opportunities for undergrad research experiences
- Faculty networking in MSIs
- Links to special programs
- Advertising through professional societies
- Talent scouting among own undergrads
- Financial support
- Learning communities
- Mentoring, etc.

Table 2

BEST Evaluation Criteria for Assessing Higher Education Programs/Practices

Questions/Criteria	Exemplary – actionable now	Promising	Not ready to adapt/scale
1. Were expected outcomes defined before program launch?	Yes	Soon after	Sort of/vague
2. Are outcome data attributable to the program intervention?	Far exceeded original expectations	Exceeded original expectations	Failed to meet expectations
3. Does it demonstrate excellence, which requires equity? – i.e., did it increase the diversity of the target population?	Chief outcome achieved and documented (positive trend)	Chief outcome implied (no monotonic trend)	Equity at core of program design, not an add-on
4. What was the value-add of the experience to the target population?	Related outcomes that move treatment group to next competitive level	Majority (but not most) of individuals in treatment popula-tion enhanced	Gains for some individuals that can be attributed to treatment
5. Is there evidence of adaptation/ institutionalization, i.e., multiple sites?	Explicit scale-up strategy w/evidence	Attempt to implement strategy and evaluate	Confined to a single site
6. Is there evidence of effectiveness with a population different from that originally targeted?	Planned and executed	Planned	Serendipitous
7. How long has it been in place?	Self-sustaining (10+ years)	Majority soft money (3-10 years)	New (<3 years)
8.Were there unexpected consequences?	Positive in intensity or extent (and measured)	Identification of possible/probable consequences	Evidence for systematic rather than random effect

Source: BEST Blue Ribbon Panel on Higher Education, 2002

What Fortune 1000 STEM Executives Say about STEM Education—Survey Findings*

- More than half believe precollege system is failing to engage girls & minorities to pursue STEM careers
- More than half are experiencing a shortage of STEM talent
- Two-thirds are concerned that other countries' access to STEM talent is impacting US competitiveness
- Two-thirds believe the presidential candidates should be concerned
- Eight in 10 recognize underrepresentation as an issue for their industry & company
- Nearly 9 in 10 claim their companies participate in precollege outreach programs (seeing this as corporate responsibility)
- Only half say they are effectively communicating to students that there are myriad job opportunities in STEM fields
- Half are frustrated by their companies' inability to hire adequate numbers of women & minority STEM workers
- Companies split almost 50-50 in rating how well they mentor & provide role models to younger workers

***Bayer Facts of Science Education Survey XIII, Sept. 2008 (includes chemical, pharmaceutical, aerospace, & semiconductor companies)**

Educating the U.S. S&E Workforce—Challenges & Opportunities Post 9/11

- **Challenges:**
  - Declining *interest*/Increased *competition* for talent
  - Lack of student & faculty *diversity*—unlike general population
  - Demand for new workplace *skills*
  - *Constraints* on affirmative action, esp. in public universities
  - No shortage of PhDs, but who's *left out*?
- **Opportunities:**
  - Campus- & company-wide outreach/recruitment/internships
  - Improved retention to degree & on-the-job
  - Growing our own while welcoming foreign talent

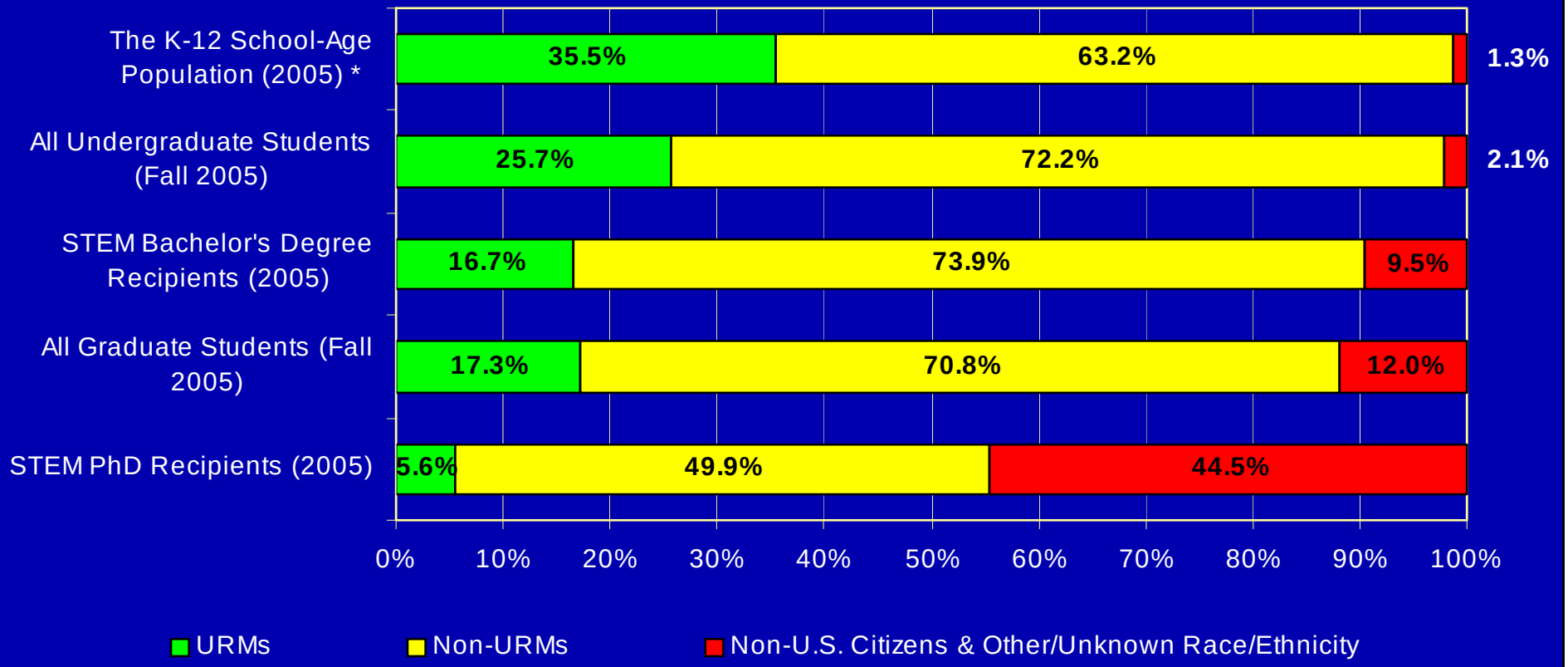
What Leaders & Decisionmakers Need to Do: Connect the Dots

- Set an overall tone
- Make expectations explicit
- Be transparent & ensure fairness in processes
- Create a mix of talent to maximize individual & group contributions
- Recognize & reward exemplary practices
- Celebrate & utilize alumni—as mentors, fund-raisers—who help you achieve your goals for engineering

What ABET Can Do

- Host forums like this one that provide a *"safe place"* for candid discussion
- Consider policy changes, e.g., *accreditation criteria*, that could influence who participates in engineering
- Use its moral authority to engage engineering educators to *effect change* back home
- Connect *engineering leaders* with other stakeholders in the broader community, K-12 to workforce

Under-represented minorities (URMs) and non-URMs as a percent of . . .



Note: Data for the K-12 population were not available by citizenship, so non-U.S. citizens are included in all percentages.
Source: CPST, data derived from National Science Foundation, WebCASPAR Database, National Center for Education Statisics, Digest of Education Statistics, 2006, and U.S. Census Bureau, Population Division

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Commission on Professionals in Science and Technology

Closing Thoughts—
What It Takes to Invite Students to Engineering

- Linkage: Recognize the precursors of undergrad talent—reach out to precollege *and* to those in the workforce
- Capitalize on community/campus leaders: employers, trustees/regents, provosts, department chairs
- Geographic & comparative advantage of your institution: What is it?
- Policy & Practice: Use federal/state laws strategically—target & measure improvements beyond baseline

Recent Sources—My Personal Involvement

- "Making a Case for Diversity in STEM Fields," *Inside Higher Ed*, Oct. 6, 2008 http://www.insidehighered.com/views/2008/10/06/chubin (with S.M. Malcom).
- "Educating Generation Net—Can U.S. Engineering Woo and Win the Competition for Talent?" *Journal of Engineering Education*, v. 97, July 2008: 245-257 (with K. Donaldson, L. Fleming, and B. Olds).
- "Federal Agencies" (249-258) and "Professional Societies" (263-272) in S. Rosser, ed., *Women, Science, and Myth: Gender Beliefs from Antiquity to the Present,* ABC-CLIO, 2008.
- *NACME Data Book—2008 Update*. Commission on Professionals in Science and Technology, http://www.nacme.org/databook/ (with L. Frehill).
- "Voices of the Future: African American PhDs in the Sciences," In R.J. Burke and M.C. Mattis, eds., *Women and Minorities in Science, Technology, Engineering and Mathematics: Upping the Numbers*. Edward Elgar, 2007: 91-100.
- "The New Backlash on Campus," *College and University Journal*, v. 81, Fall 2006: 65-68 (with S.M. Malcom).

Thank you! To continue the conversation. . .

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