Changing the face of physics

Sherry Yennello
Texas A&M University
7th graders view of scientists

The way I see a scientist is with brown hair, a beard, dorky glasses, a white lab coat, pens in his shirt, a blue polo shirt, khaki-colored pants, and a white-colored lab coat.
The Nations New Majority

• Women and under-represented groups make up a 1/2 to 2/3 of the population of the United States and comprise the nation’s New Majority.

• If the US is to maintain economic leadership and be able to sustain its share of high technology jobs, it must draw on all of the talents in our population . . . Innovation is the key.

Shirley Jackson,
President of Rensselaer
Percentage of BS Degrees for Women

Percentage of PhDs Earned by Women

National Science Foundation. Compiled by AIP Statistical Research Center.
<table>
<thead>
<tr>
<th>Academic Rank</th>
<th>1994 (%)</th>
<th>1998 (%)</th>
<th>2002 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Professor</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>8</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>12</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Other Ranks</td>
<td>8</td>
<td>13</td>
<td>29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Department</th>
<th>1994</th>
<th>1998</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Master’s</td>
<td>7</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Bachelor’s</td>
<td>7</td>
<td>11</td>
<td>14</td>
</tr>
</tbody>
</table>

Total 6 8 10

AIP Statistical Research Center: 2002 AWF Survey
Girls Enrollment in HS Physics

Figure 7. Percent of bachelor’s degrees and doctorates in physics earned by women, 1978-2000

Note: A form change occurred in 1994 resulting in a more accurate representation of women among physics bachelors. Some of the increase in 1994 only, may be a result of that change.

AIP Statistical Research Center, Enrollments and Degrees Report.
Women – compared to other fields

  - Chemistry 32.2
  - Computer science 18.7
  - Earth Science 31.1
  - Mathematics 26.9
  - Physics and Astronomy 15.0

## Parity of success in graduate school

<table>
<thead>
<tr>
<th></th>
<th>Physics</th>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>At Universities Ranked 1–10:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Ph.D. Yield</td>
<td>79.2 %</td>
<td>68.7 %</td>
</tr>
<tr>
<td>Male Ph.D. Yield</td>
<td>88.0 %</td>
<td>78.1 %</td>
</tr>
<tr>
<td>Parity Index</td>
<td>0.90</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>At Universities Ranked 11–25:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Ph.D. Yield</td>
<td>60.9 %</td>
<td>54.9 %</td>
</tr>
<tr>
<td>Male Ph.D. Yield</td>
<td>64.1 %</td>
<td>67.8 %</td>
</tr>
<tr>
<td>Parity Index</td>
<td>0.95</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Kuck
Gender Differences: Support

Primary SUPPORT

Primary SUPPORT of Women

Data from Survey of Earned Doctorates
Career Goal at Start of PhD

Men
- Bus., Gov., Other 40%
- Prof (resrch) 44%
- Prof (teach) 15%
- Other Acad. 1%

Women
- Bus., Gov., Other 30%
- Prof (resrch) 48%
- Prof (teach) 20%
- Other Acad. 2%

Current Goal

Men
- Bus., Gov., Other 53%
- Prof (resrch) 32%
- Prof (teach) 13%
- Other Acad. 2%

Women
- Bus., Gov., Other 54%
- Prof (resrch) 25%
- Prof (teach) 16%
- Other Acad. 5%

Changing Career Goals

- PTEM (Physical Sciences, Technology, Engineering, Mathematics)

The highest degrees obtained by the spouses or partners of postdoctoral fellows.

<table>
<thead>
<tr>
<th>Degree Level</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor’s</td>
<td>0%</td>
<td>30%</td>
</tr>
<tr>
<td>Master’s</td>
<td>22%</td>
<td>38%</td>
</tr>
<tr>
<td>Ph.D., M.D., or J.D.</td>
<td>78%</td>
<td>30%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Dual Career issues are very important to retaining women in physics.
The fields of spouses’ or partners’ education.

<table>
<thead>
<tr>
<th>Field</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Science</td>
<td>57%</td>
<td>10%</td>
</tr>
<tr>
<td>Other Natural Science</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Education</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Engineering</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>Fine Arts</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Humanities</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>Social or Behavioral Science</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>Business Management</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Law</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Medicine</td>
<td>4%</td>
<td>14%</td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Family Status of Tenured Faculty in the Sciences*

Women

- Married with Children**: 53%
- Married without Children: 14%
- Single without Children: 25%
- Single with Children**: 8%

Men

- Married with Children**: 73%
- Married without Children: 14%
- Single without Children: 9%
- Single with Children**: 4%

N=3109

N=19,074

*PhDs from 1978-1984 Who Are Tenured 12 Years out from PhD in STEM & Bio. Sciences.
**Had a child in the household at any point post PhD to 12 years out.

Note: The use of NSF Data does not imply the endorsement of research methods or conclusions contained in this report.
Heads and Necks of Science PhD Recipients*

*PhDs from 1978-1984 Who Are Working in Academia 12 to 14 Years Out from PhD


Note: The use of NSF Data does not imply the endorsement of research methods or conclusions contained in this report.
Leaks in the Academic Pipeline for Women*

Graduate School Entry

PhD Receipt

Assistant Professor (Tenure Track)

Associate Professor (Tenured)

Full Professor (Tenured)

Leak!!

Women with Babies (28% less likely than women without babies to enter a tenure-track position)

Women, Married (21% less likely than single women to enter a tenure-track position)

Women (27% less likely than men to become an Associate Professor)

Women (20% less likely than men to become a Full Professor within a maximum of 16 years)

Mason
No Presentations at Conferences in the Last Year

- **Women Postdocs**
- **Men Postdocs**

<table>
<thead>
<tr>
<th>Category</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married with Children</td>
<td>45%</td>
<td>20%</td>
</tr>
<tr>
<td>Married without Children</td>
<td>31%</td>
<td>28%</td>
</tr>
<tr>
<td>Single without Children</td>
<td>21%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Unproductive Bias Avoidance by Gender, Research Universities

Productive Bias Avoidance by Gender, Research Universities

Employed S&E doctorate-holders, by race/ethnicity and field of doctorate: 2001

**Sciences**
- White: 82.3%
- Asian/Pacific Islander: 11.9%
- Black: 2.8%
- Hispanic: 2.7%
- American Indian/Alaskan Native: 0.3%

**Engineering**
- White: 64.4%
- Asian/Pacific Islander: 31.5%
- Black: 1.8%
- Hispanic: 2.0%
- American Indian/Alaskan Native: 0.3%

**SOURCE:** Women, Minorities and Persons With Disabilities in Science and Engineering-2004
The U.S. workforce

Science and Engineering Workforce

U.S. Workforce
Bureau of the Census Demographic predictions – 18-64 year olds
Percentage of nuclear science Ph.D.’s by ethnicity, compared with the percentage for physics and astronomy as a whole.

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Native American</td>
</tr>
<tr>
<td>Nuclear Science (91–02)</td>
<td>0.3</td>
</tr>
<tr>
<td>Nuclear Science (00–02)</td>
<td>3.3</td>
</tr>
<tr>
<td>Physics &amp; Astronomy (00–02)</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Family incomes for fulltime, full-year dependent undergraduates, by gender and race or ethnicity. (The table entries are in percentages.)

<table>
<thead>
<tr>
<th></th>
<th>Low: less than $30,000</th>
<th>Low middle: $30,000–$44,999</th>
<th>Middle: $45,000–$74,999</th>
<th>Upper middle: $75,000–$99,999</th>
<th>High: $100,000 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>21.6</td>
<td>15.2</td>
<td>29.9</td>
<td>15.4</td>
<td>17.9</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20.1</td>
<td>15.9</td>
<td>29.7</td>
<td>15.4</td>
<td>19.0</td>
</tr>
<tr>
<td>Female</td>
<td>22.9</td>
<td>14.6</td>
<td>30.1</td>
<td>15.4</td>
<td>17.0</td>
</tr>
<tr>
<td><strong>Race/ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>28.2</td>
<td>12.0</td>
<td>33.0</td>
<td>9.5</td>
<td>17.3</td>
</tr>
<tr>
<td>Asian</td>
<td>38.1</td>
<td>14.2</td>
<td>23.9</td>
<td>8.2</td>
<td>15.7</td>
</tr>
<tr>
<td>Black</td>
<td>45.9</td>
<td>17.9</td>
<td>17.9</td>
<td>9.4</td>
<td>8.9</td>
</tr>
<tr>
<td>Hispanic</td>
<td>44.4</td>
<td>17.7</td>
<td>21.0</td>
<td>7.8</td>
<td>9.1</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>15.3</td>
<td>23.5</td>
<td>16.4</td>
<td>22.7</td>
<td>22.2</td>
</tr>
<tr>
<td>White</td>
<td>14.6</td>
<td>14.6</td>
<td>33.0</td>
<td>17.5</td>
<td>20.3</td>
</tr>
<tr>
<td>Other</td>
<td>26.2</td>
<td>15.7</td>
<td>26.9</td>
<td>18.8</td>
<td>12.4</td>
</tr>
<tr>
<td>More than one race</td>
<td>36.8</td>
<td>12.6</td>
<td>24.9</td>
<td>13.4</td>
<td>12.3</td>
</tr>
</tbody>
</table>

1 American Indian includes Alaska Native, Black includes African American, Pacific Islander includes Native Hawaiian, and Hispanic includes Latino. Race categories exclude Hispanic origin unless specified.

2 Respondents were given the option of identifying their race as “other.”

Minorities ~50% more likely to earn Masters en route to PhD.
More institutional transitions.

Lange 2006
Minority-Serving Institutions

- Historically Black Colleges & Universities (HBCUs)
  - 2% of all US college enrollment
  - 25% of all African-American bachelor’s degrees
  - 50% of Af-Am bachelor’s in science/engineering
- Hispanic Serving Institutions (HSIs)
- Tribal Colleges & Universities (TCUs)
- Community colleges
  - 50% of minorities start here
Fisk-Vanderbilt Masters-to-PhD Bridge Program

• *Preparation needed to earn a PhD*
  1. Earn a Masters degree in physics at Fisk, with full funding support.
  2. Get valuable, paid research experience.
  3. Receive preparation for the GRE.
  4. Get fast-track admission to the Vanderbilt PhD program, with full funding support.
• Astronomy, astrophysics, cosmology
• Biophysics
• Materials science, nanophysics, detector development
• Imaging science
Facilitating successful transitions:

- Joint advising committees: Involvement of potential PhD advisors from the start, enhanced communication and tracking of progress
- Requirement of coursework at Vanderbilt: Become known to Vanderbilt faculty, complete PhD requirements
- Requirement of research at Vanderbilt: Demonstrate ability in the lab, develop faculty advocates
- Ancillary support: Identify problems early on, provide tutoring where necessary
- “Professionalization”: Seminar on academic culture, participate in professional meetings
- Social networks: Orientation, “Bridge Club”
APS / CSWP & COM

• Gender Equity Workshop
• Site Visits
• M Hildred Blewett Scholarship
• APS Scholarship for minority undergraduate physics majors
• Best Practices for recruiting and retaining women in physics
• Gazette
• Physics in you Future
• Women Speakers List
• Minority speakers list
• Travel grants for women/minority speakers
• Female friendly physics graduate programs list
• Professional development workshops for women physicists
• Programming at National meetings
The Golden Rules - Best Practices

What should departments do? (The Golden Rules - Best Practices)

• Increase the number of female/URM faculty, postdocs and students

• Actively recruit female/URM students

• Make sure they get good mentoring - create climate for success

• Do not tolerate discrimination - pay, space, $$ research (data!!!)

• For much more, see
  http://www.aps.org/programs/women/reports/bestpractices/index.cfm
  Murnane
Common Weaknesses in Departments
(from observation)

- Senior female faculty are marginalized, paid less, have less space, and sometimes discriminated against
- Students have no recourse when faculty misbehave
- Often there is poor accountability for hostile actions
- Male faculty are passive, happy to benefit from existing system
- Sometimes senior university administration are passive, unable or unwilling to help or intervene
- Students and junior male faculty learn to accept flawed system
- Lack of ethics, fairness, respect, accountability to society
- Denial of all of the above
- No pressure to change - system works for male faculty in power
Laudable Strengths - Dream Dept.!

- Senior and junior female faculty are present and leading aggressive research groups
- Critical mass of female postdocs and students also present
- Female postdocs and students have high career aspirations
- Talented department chair builds trust and broad, open, hiring plan within the department
- Male faculty accept, support and mentor female students/faculty
- Senior university administration willing to fund targeted diversity hires
- Attention to ethics, respect, fairness, accountability to society
CSWP Site Visits - What Matters

• Critical mass
• Role models
• Family issues
• Community
• Leadership
• Respect

http://www.physics.unc.edu/~mcneil/MM04_files/frame.htm
CSWP Site Visits - What Matters

• Critical mass
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http://www.physics.unc.edu/~mcneil/MM04_files/frame.htm
General Observations

Major issues

• The overall demographic situation
  – Slowly declining PhD production
  – Low, slowly increasing percentage of women
  – Abnormally low percentage of ethnic minorities

• Inadequate career advice/overall mentoring
  – Poor preparation for careers outside of academia / national labs
  – Serious dual career issues

• Major importance of undergraduate research

• Necessity to improve K-12 and public education
Change culture of field

Only by exposing the underlying assumptions will we address the cultural issues
• Is the model of how scientists work (hours, places, groupings) the only one that can support “good” science
• Does the initiation into the field really need to be primarily a filter
• Is domination the approach that best opens us to discovery
• Does conformity in the initiation phases assure the emergence of genius – either because they conform or are they the few who manage not to conform
• Are scientists elite or the norm
Some possible underlying assumptions

• You must love doing science more than anything else in order to be a good scientist
  – It’s not possible to be an excellent scientist part-time, or if you have other absorbing interests
• Diversity can introduce a lack of excellence
• Spirited confrontation is the only way to achieve true peer review and therefore excellence
  – Collaborative, cooperative approaches are inherently suspect
• We are the smartest elite
  – We are more critical of ourselves than others are of themselves
• You have to be like one of “the boys” to succeed
• “Excellence” is obvious and well-defined, we all agree what it looks like, and it is the most important thing
• If you are not a university professor you are a failure
• There is one and only one natural career pathway for success
• The “best” students will make the best scientists