Women in Science, Mathematics, Engineering and Technology: Implications for National Security

- Prepared by Ruta Sevo, NSF
- for Women in Defense Conference
- October, 2005

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ARKANSAS DEMOCRAT-GAZETTE © Jon Chambers Syndicate
DERING
TO THE TALIBAN:
GIVE US
OSAMA BIN LADEN
OR WE'LL
SEND YOUR
WOMEN TO
COLLEGE

THE U.N.'s GENDER EMPOWERMENT MEASURE

- **Introduced in 1995 as part of Human Development Indices**

- **Measures "participation of women" in public life**

    - **Income per person; power over economic resources**
    - **Economic participation and decision-making**
    - **Political participation and decision-making**

- **Research studies in economic development show that participation of women in education and in the economy:**

    - **Increases literacy**
    - **Reduces maternal & infant mortality**
    - **Increases national productivity**

Cf. www.undp.org/hdr2002 and www.undp.org/ahdr

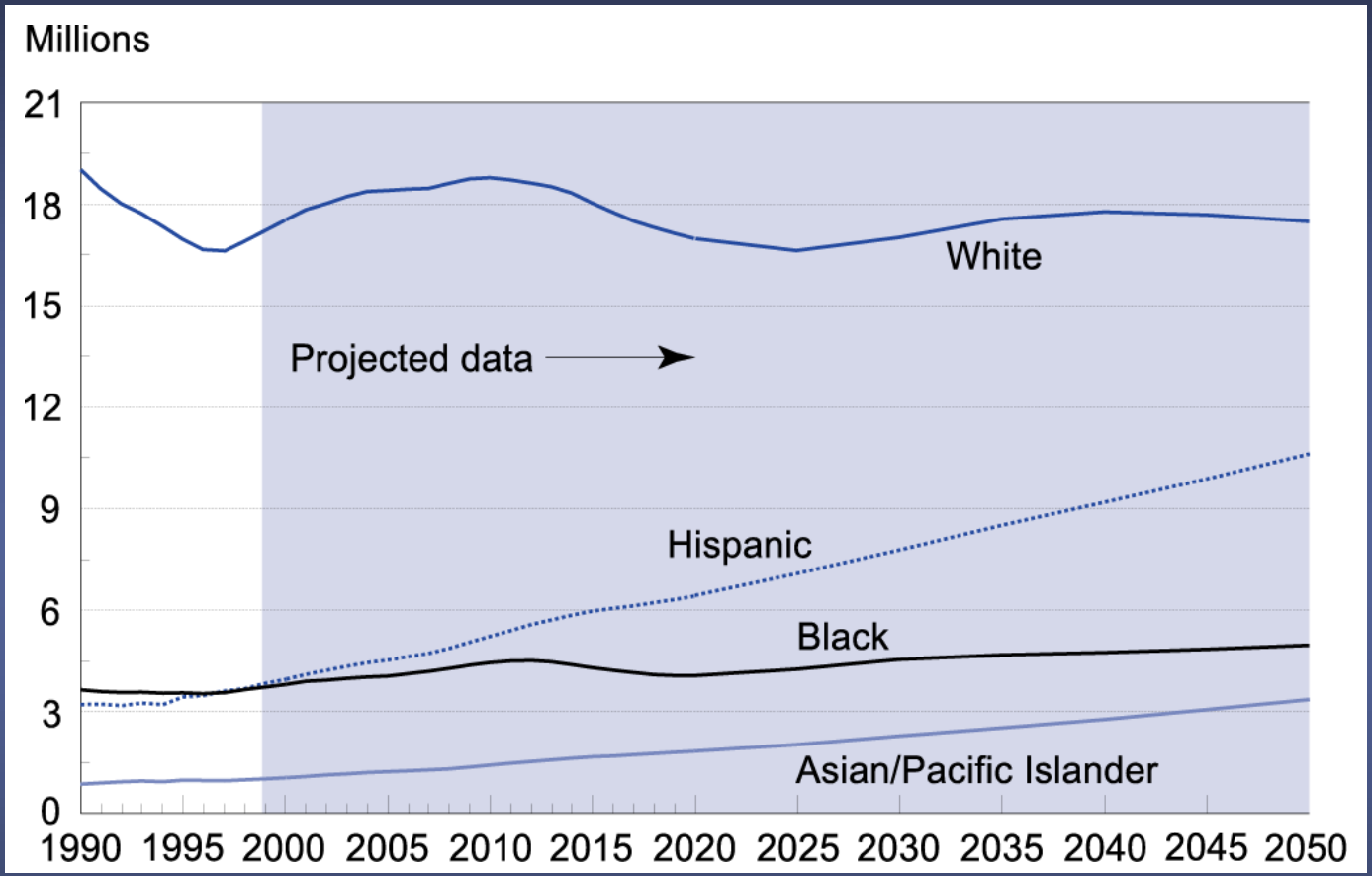
See also "the value of educating girls"

#8 USA

for HDI

HDI Rank	Country	Gender empowerment measure (GEM) value
1	Norway	0.908
2	Sweden	0.854
3	Australia	0.806
4	Canada	0.787
5	Netherlands	0.817
6	Belgium	0.808
7	Iceland	0.816
8	United States	0.769
9	Japan	0.531
10	Ireland	0.710
11	Switzerland	0.771
12	United Kingdom	0.698
13	Finland	0.820

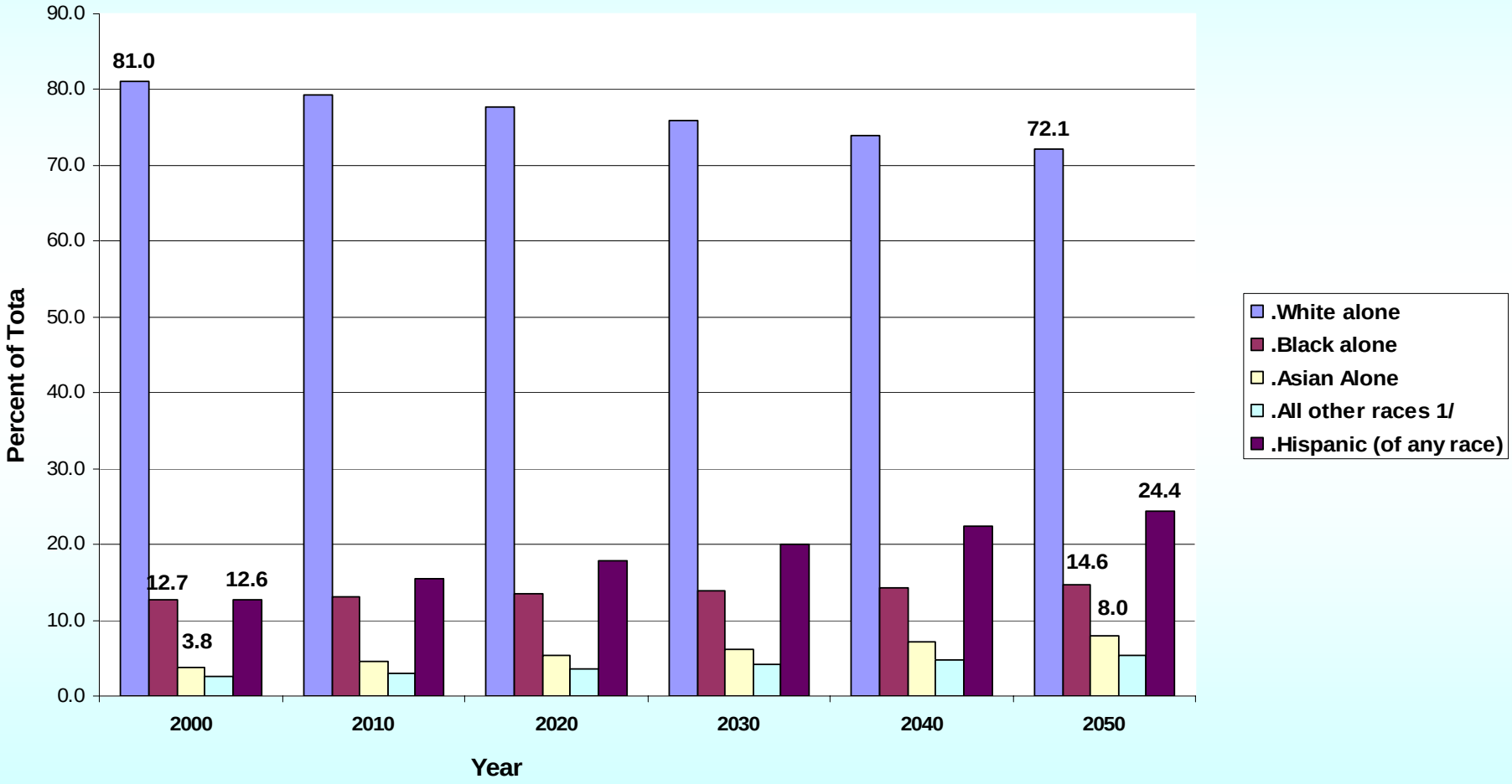
U.S. population 18-24 years old, by race/ethnicity: July 1990-99 and projections to 2050



NOTE: Hispanics may be of any race. Data for American Indians/Alaskan Natives are not shown.

SOURCE: U.S. Bureau of the Census, Current Population Survey, annual series; and U.S. Bureau of the Census, *Projections of the Total Resident Population by 5-Year Age Groups, and Sex With Special Age Categories: Middle Series, 1999 to 2100*, NP-T3, http://www.census.gov/population/www/projections/natsum-T3.html.

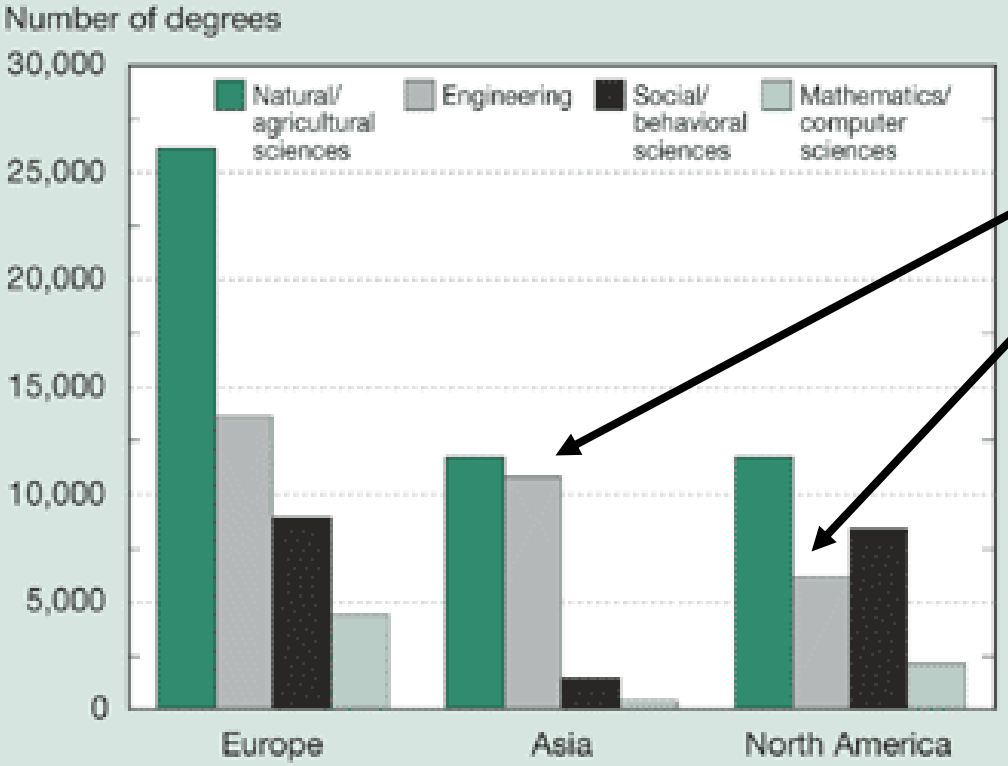
Demographic Trend - Total U.S. Population



U.S. Census Bureau, 2004"U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin," <http://www.census.gov/ipc/www/usinterimproj/

Figure 2-36

S&E doctoral degrees in Europe, Asia, and North America, by field: 2000 or most recent year



NOTES: Natural sciences include physical, biological, earth, atmospheric, and ocean sciences. Asia includes China, India, Japan, South Korea, and Taiwan. Europe includes Western, Central, and Eastern Europe. See appendix table 2-36 for countries/economies included within each region.

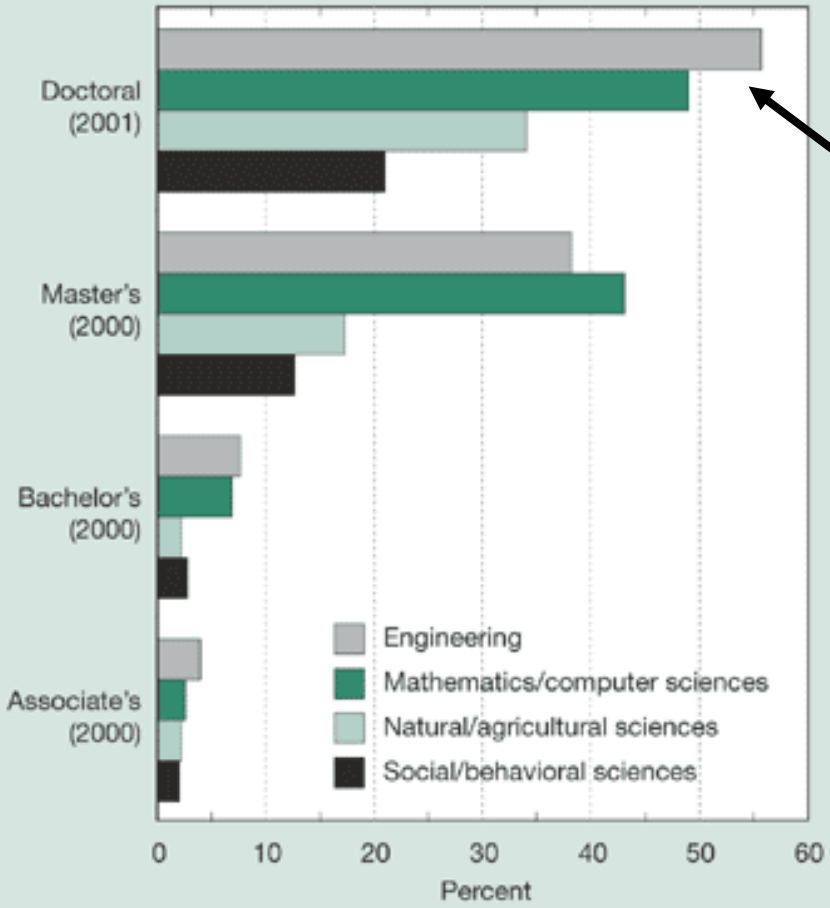
SOURCES: Organization for Economic Co-operation and Development, *Education at a Glance 2002;* United Nations Educational, Scientific, and Cultural Organization (UNESCO), UNESCO Institute for Statistics database; and national sources. See appendix table 2-36.

Science & Engineering Indicators – 2004

Asia is producing more engineers than the U.S.

(half in the U.S are foreign)

Figure 2-23
Foreign student share of S&E degrees, by degree level and field: 2000 or 2001



NOTES: At the doctoral level, foreign students include permanent and temporary residents; other levels include only temporary residents. Natural sciences include physical, biological, earth, atmospheric, and ocean sciences.

SOURCES: U.S. Department of Education, Completions Survey; and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database system, http://caspar.nsf.gov. See appendix tables 2-21, 2-23, 2-25, and 2-28.

Science & Engineering Indicators – 2004

in eng and CS >50% of PhD's are foreign students

RE: U.S. Global Competitiveness in Engineering

- China: graduates almost 4 times as many engineers
- India: pouring money into technology parks to lure back native talent
- South Korea: graduates as many engineers as U.S. altho it has 1/6th the population and 1/20th the GDP
- From 1980 to 2001, U.S. share of high-tech exports fell from 31% to 18% (nearly half over 20 years)
- EU: poised to graduate 4 times as many PhD's as U.S.

From Senator Lamar Alexander (R-TN)
Senate hearings on the FY 2006 S&T Budget

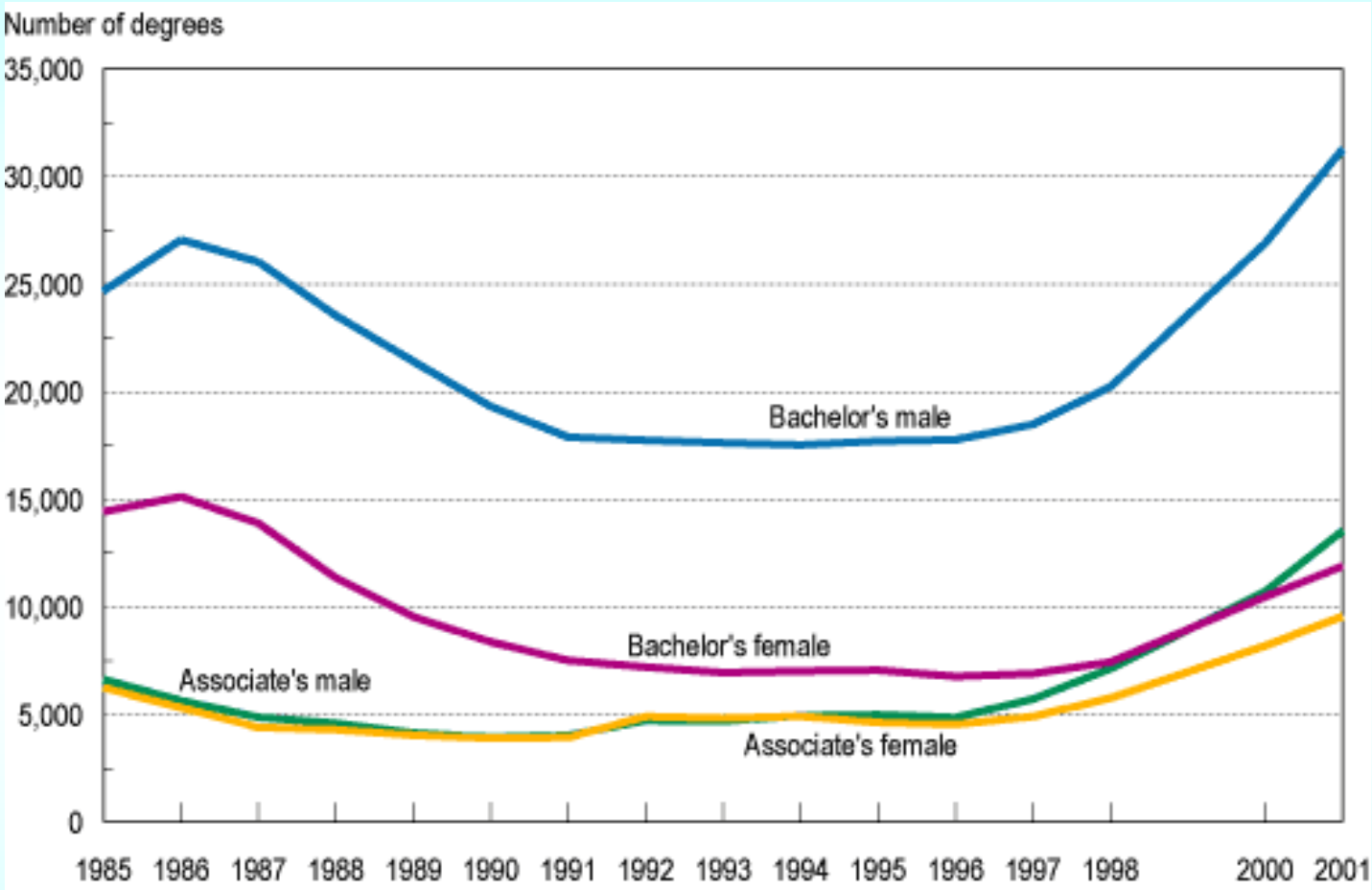
RE: U.S. Global Competitiveness generally

COST OF LABOR (manufacturing direct labor cost per hour)

U.S.	**$30**
Europe	**$24**
Russia	**$ 3**
China	**$ 2**
India	**$ 1**

Source: talk by Dr. John Cassidy, Jr., United Technologies Corp, March 10, 2005 at NSF

Figure C-2.
Bachelor's & associate's degrees in computer sciences, by sex: 1985–2001

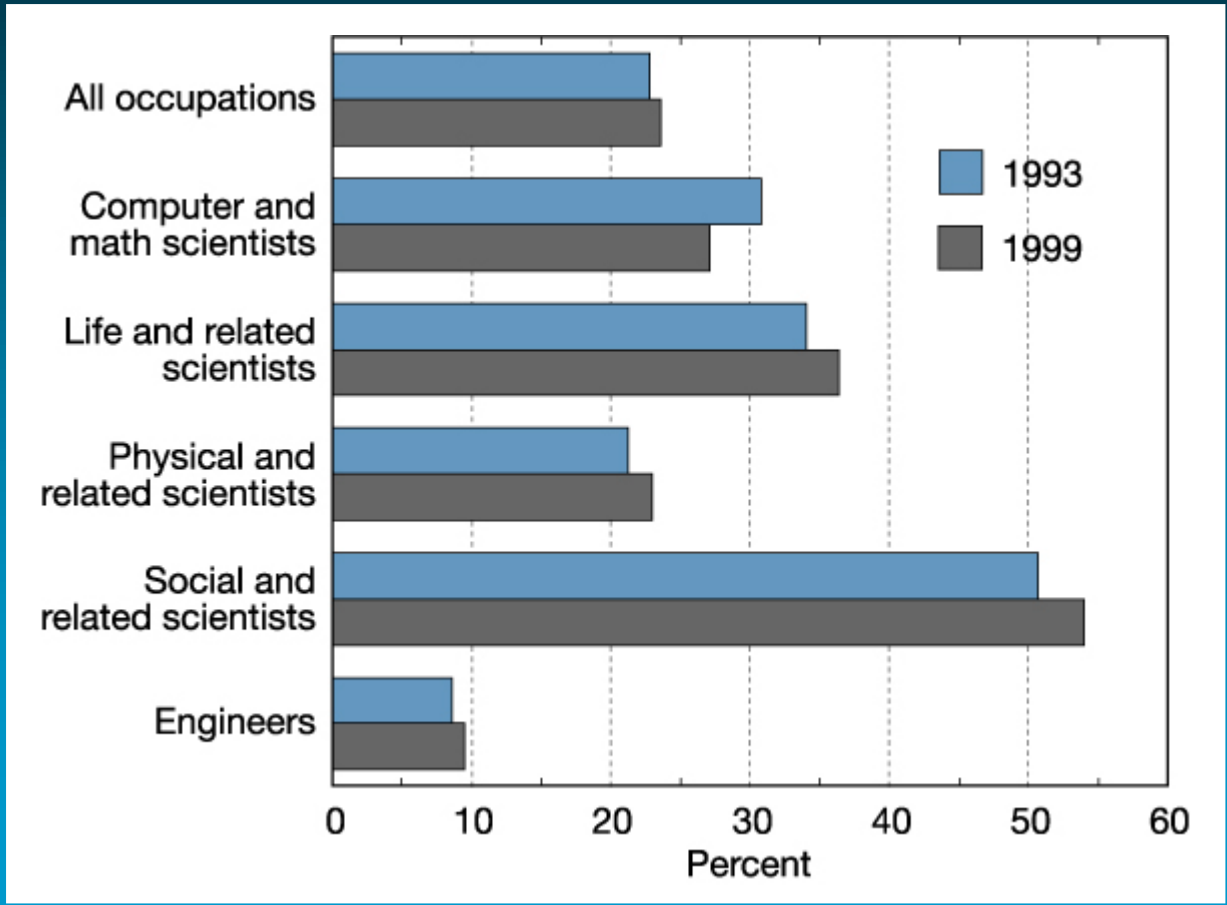


Bachelor's degrees awarded in computer sciences rose steeply in the latter part of the 1990s, especially for males.

•The female share of bachelor's degrees in computer sciences dropped from 37 percent in 1985 to 28 percent in 2001.

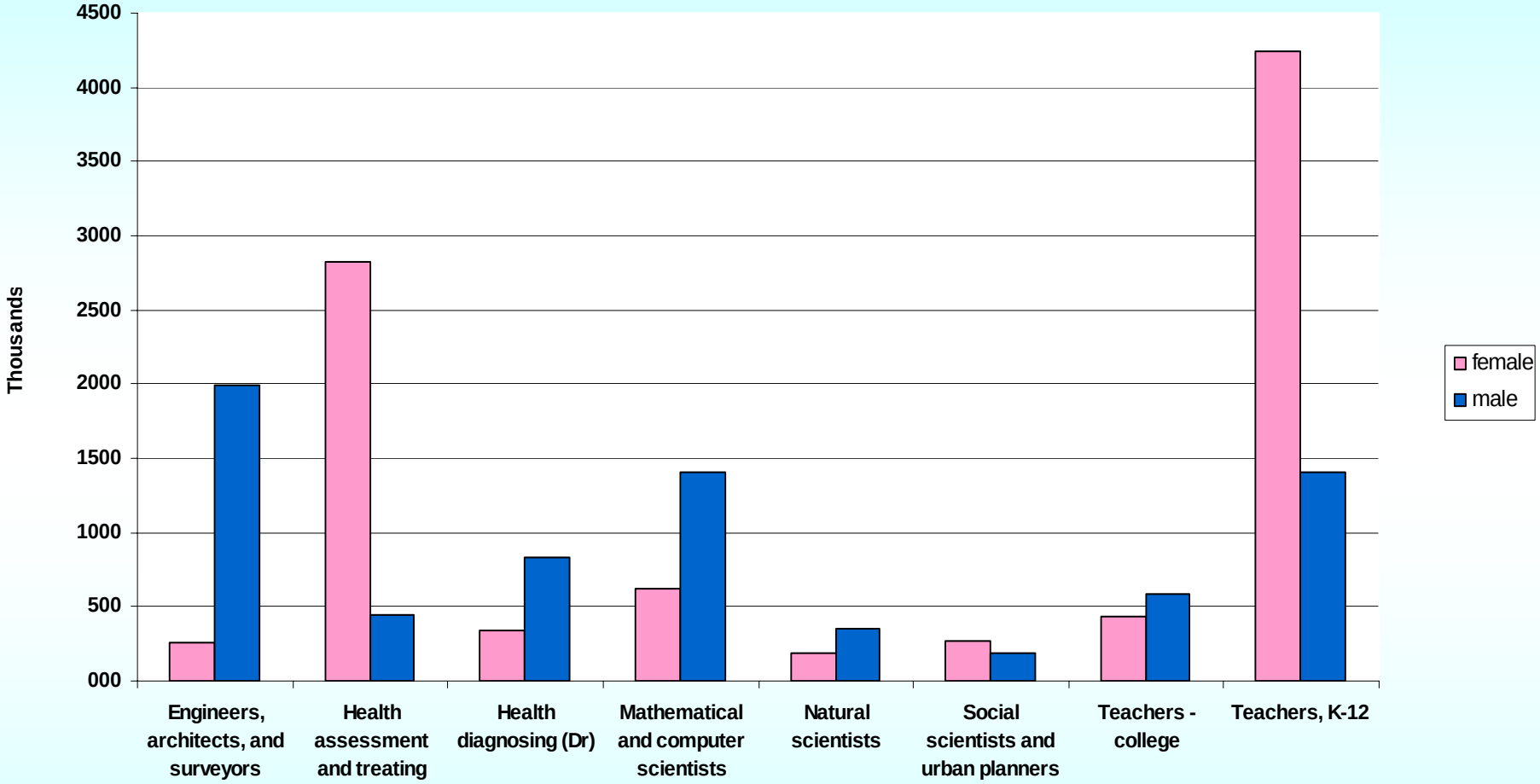
•The number of associate's and bachelor's degrees awarded in computer sciences to both males and females increased substantially in the late 1990s.

Women as proportion of S&E workforce, by broad occupation



SOURCE: National Science Board, *Science and Engineering Indicators-2002*

Distribution among selected occupations (2002, by sex)
"Pink" versus "Blue" Jobs



Source: Women, Minorities, and Persons with Disabilities in Science and Engineering: 2004, Table H-3

"In today's economy, women cluster in only 20 of the more than 400 job categories, and two out of three minimum wage earners are women."

- AAUW, Gender Gaps, 1998
www.aauw.org

Policy Reports on Workforce, esp Engineering:

1. Council on Competitiveness. 2004. Innovate America

2. NSB, NSF. 2004. Broadening Participation…

3. NAE. 2005. Assessing the Capacity of the U.S. Engineering Research Enterprise

4. NAE. 2004. The Engineer of 2020

E.g., NSB. 2003. The Science and Engineering Workforce

The Need for Action

Areas of national skill needs include:

- National priorities in emerging areas – e.g., nanoscale science and engineering;

- Interdisciplinary skills – e.g., bioinformatics;

- Traditional disciplines where enrollments are insufficient… -- e.g., in computer sciences; and

- Federal mission-related fields where enrollments are falling and projected needs rising, e.g., nuclear physics and engineering.

What is the value of having more native IT workers?

- We need IT students to maintain educational capacity
  - Portion of students from abroad is declining
  - Higher Ed in Australia, New Zealand, England growing
  - China and India have educational infrastructure now
- We need IT students because the greatest growth in the future workforce is in IT and engineering
- IT and engineering are a "big engine" for our economy and GDP
  - We won't compete in a global economy without building workforce

MANY SOURCES FOR "PROVEN" or "BEST" PRACTICES

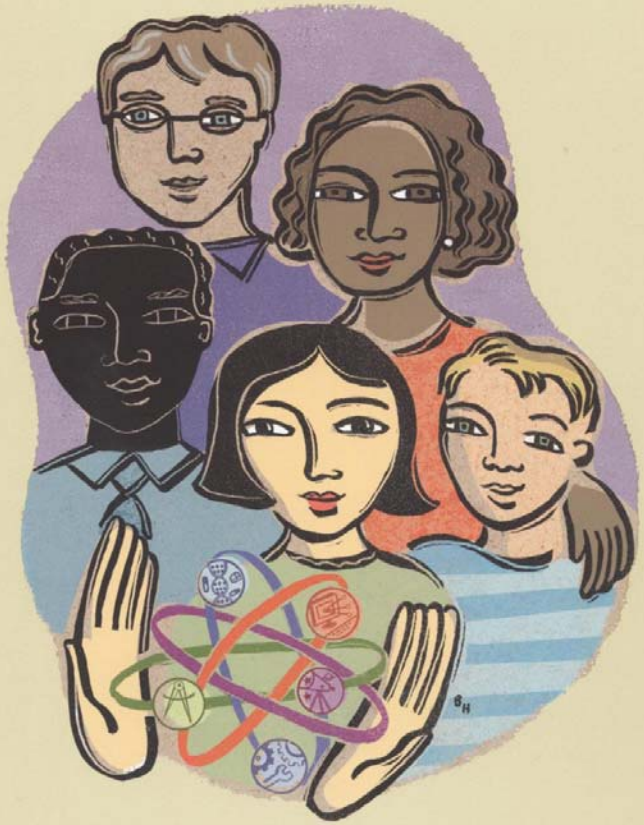
- **BEST www.bestworkforce.org**
- **NRC, Committee on Women**
  http://www7.nationalacademies.org/cwse/Publications.htm
- **New Formulas for America's Workforce: Girls in Sci & Eng**
  http://www.nsf.gov/pubs/2003/nsf03207/start.htm
- **Balancing the Equation (NCRW) www.ncrw.org**
- **Warming the Climate for Women in Academic Science**
  http://www.aacu.org/issues/women/index.cfm
- **National Initiative for Women in Higher Education**
  http://www.campuswomenlead.org/
- **Commercial:**

  Unlocking the Clubhouse, Talking About Leaving, Teaching the Majority, Women and Information Technology: Research on the Reasons for Underrepresentation (forthcoming)

www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf

Land of Plenty

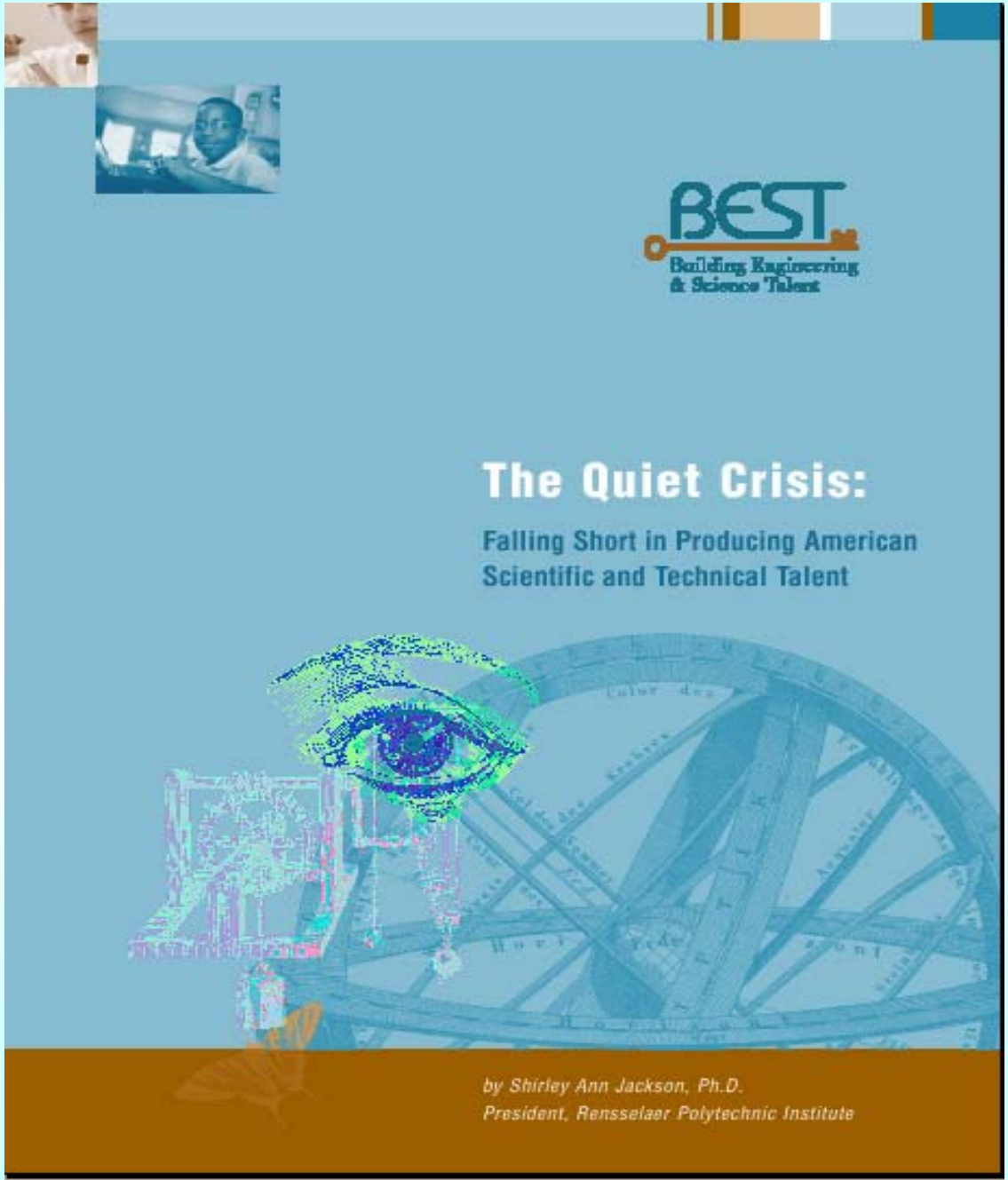
Diversity as America's Competitive Edge in Science, Engineering and Technology



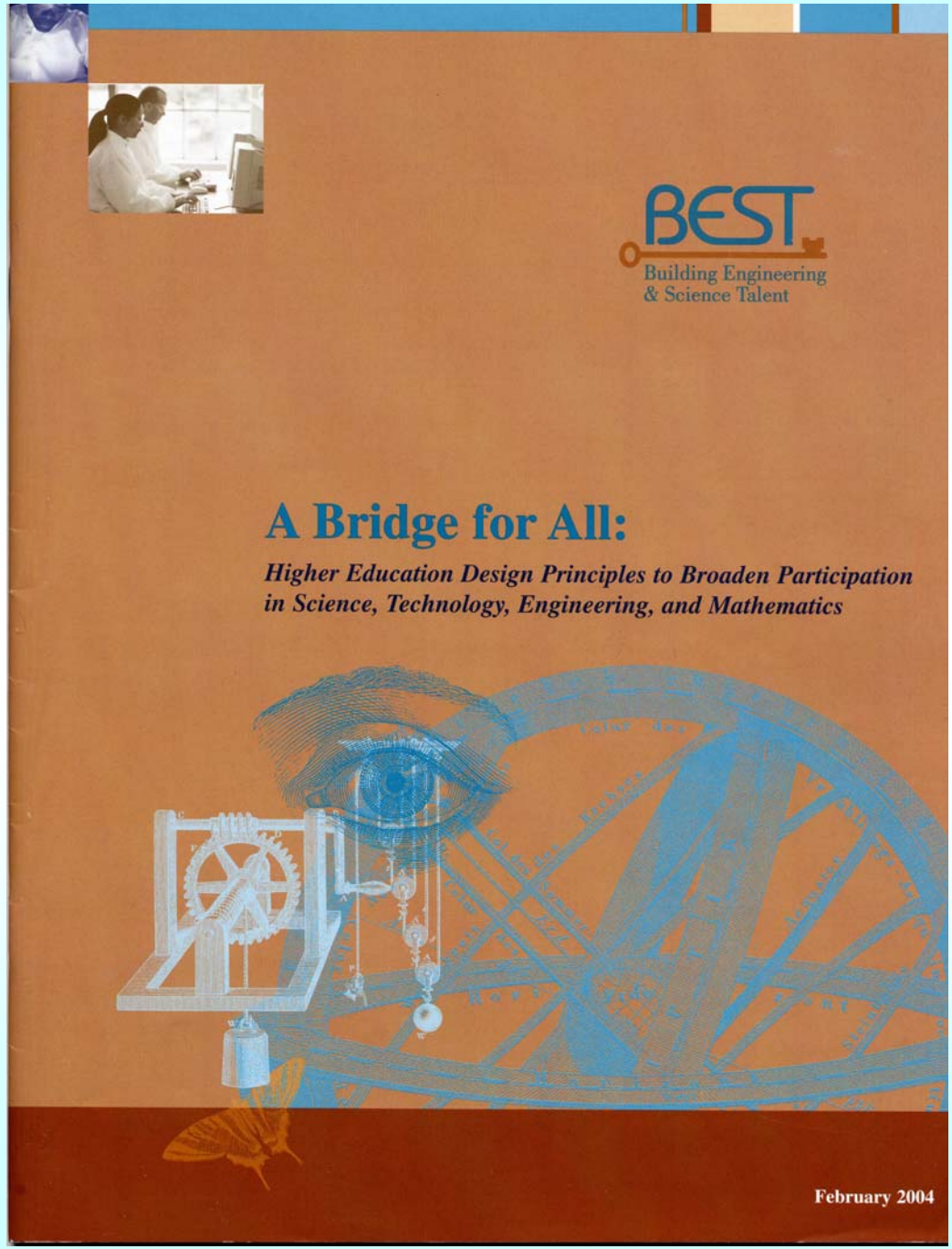
September 2000

Report of the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development

www.bestworkforce.org

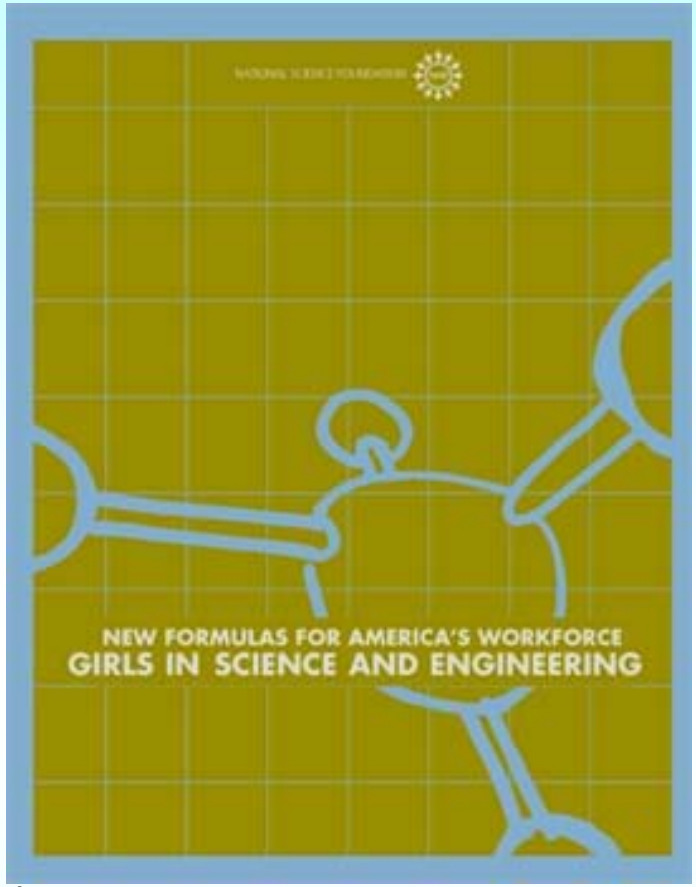


www.bestworkforce.org



New Formulas for America's Workforce:

Girls in Science and Engineering



- **A free book from the National Science Foundation**
- **Find experts, get ideas to change the face of science and engineering**
- **More than 200 ways to engage students**
- **For teachers, counselors, museums, schools, faculty, parents**

Go to http://www.nsf.gov/home/orderpub.htm and request

NSF 03-207 for book

NSF 03-208 for CD

Also online at http://www.nsf.gov/pubs/2003/nsf03207/start.htm

K-12 Research – What Do We Know?

- Stereotypical image of scientist emerges by 2d grade
- By 8th grade, boys are twice as interested in SEM careers
- Teachers unconsciously interact more with boys in classroom
- Encouragement from parents & teachers works
- All students and esp. girls like inquiry-based, hands-on, cooperative team problem-solving with social relevance
- Most adults & students are unaware of range of careers open
- US high school students are ahead internationally at 4th grade and behind by 12th grade
- Girls don't have same exposure to tools, computers, informal science as boys
- Girls think about computers: "We can, but I don't want to"
- Special clubs and summer camps work to change this

College – What Do We

- ✓ Changing the curriculum works: encourage, don't weed; incorporate social issues (women's)
- ✓ Bridge programs work
- ✓ Residential learning communities work
- ✓ Mentoring and networking
- ✓ Career awareness
- ✓ Research experience

College – What Do We

- ✓ Industry internships
- ✓ Positive interaction with faculty
- ✓ Presence of female faculty & role models
- ✓ Women interpret lack of encouragement as discouragement
- ✓ Some single-sex classrooms work
- ✓ Train faculty in gender research

Graduate School – What Do We Know?

Graduation rate affected by:

- interaction with faculty
- isolation/integration with department
- department's attitude toward family responsibilities
- nature of the discipline
- role models & mentors
- female faculty
- presence of other female students
- sexual harassment

Professional Life – What Do We Know?

- **Female scientists not informed about business careers**
- **Women exit S&E industry at twice rate as men**
- **Barriers to advancement**
  - Absence of role models
  - Isolation
  - Exclusion from informal networks
  - Lack of mentoring
  - Work/life balance
- **Covert discrimination exists: recruitment, selection, advancement**
- **Salaries are not equal**
- **Supportiveness is key factor**

Good departments: "Many small things add up"

- Faculty support structure
  - More women on the faculty
  - Family-friendly policies (a place attractive to people w/ families)
    - "two-body problem"
    - Family leave
    - Childcare
  - Tolerant atmosphere
    - no sexist remarks
    - female speakers
  - Good team work
  - Support for junior faculty (difficult first year)

Good departments: "Many small things add up"

- Introductory and early course experience
  - Interactive
  - Value on and use of team work
  - Include learning "the culture of the profession"
  - Special math skills development (3-D spatial skills)
  - Applications of engineering to environment and social issues
  - Student-faculty research
  - Safe labs
- Student care
  - Four-year mentoring
  - Student lounge
  - Tutorial service
  - Lab assistants
  - Seminars on career aspects
  - Club and social activities

Good departments: "Many small things add up"

- Recruiting and outreach
  - Inviting departmental website
  - Community presence – science fairs, summer programs, school visits
  - Work with admissions office
  - Bridge programs
- Role of alumni and alumnae
  - Maintain relationships with former students
  - Use alums to illustrate career options
  - Highlight accomplishments
  - Bring back to give talks as role models
- Departmental culture
  - Students have active role in maintaining supports for others
  - Strong sense of community

See:

Whitten, Barbara L., Suzanne R. Foster, Margaret L. Duncombe,
Patricia E. Allen, Paula Heron, Heather M. Zorn,
Laura McCullough, Kimberly A. Shaw, and Beverley A.P. Tayler. (2003).

"What Works? Increasing the participation of women in undergraduate physics"

**Journal of Women and Minorities in Science and Engineering,
9(3&4), pp. 239-258.**

ISSN 1072-8325
JWMSEX 5(1)1–95(1999)

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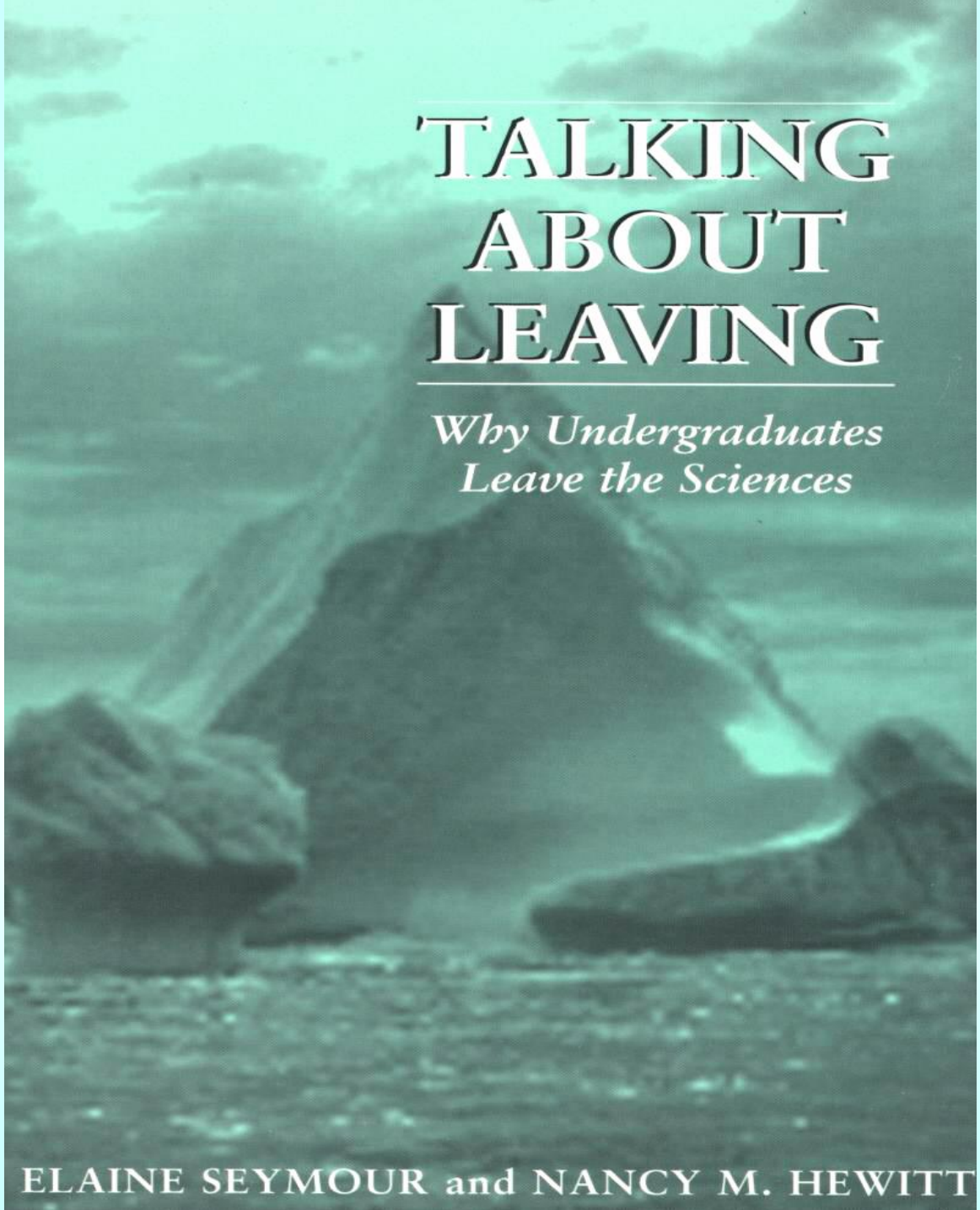
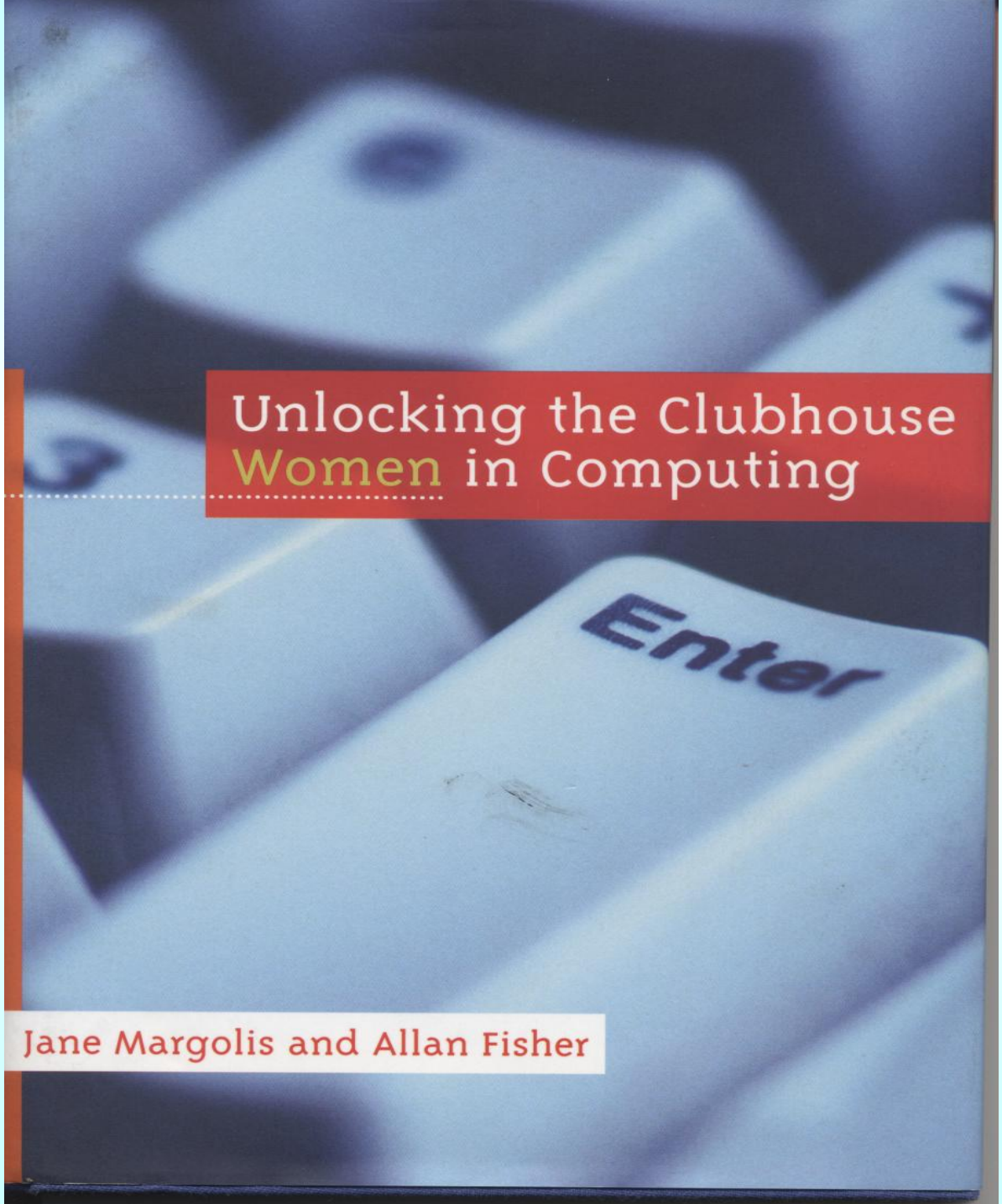
Editor-In-Chief
CAROL J. BURGER

Volume 5
Number 1

1999


TALKING
ABOUT
LEAVING
Why Undergraduates
Leave the Sciences
ELAINE SEYMOUR and NANCY M. HEWITT


Unlocking the Clubhouse
Women in Computing
Enter
Jane Margolis and Allan Fisher

Science, Gender, and Afterschool

A RESEARCH-ACTION AGENDA

Educational Equity Concepts, Inc.

Academy for Educational Development

A Publication of Educational Equity Concepts, Inc. and the Academy for Educational Development, Inc.

http://www.nsf.gov/sbe/srs/stats.htm

http://www.nsf.gov/sbe/srs/wmpd/start.htm

Women, Minorities, and Persons with Disabilities in Science and Engineering

National Science Foundation

Home | U.S. Demographics | Undergraduate Enrollment | Undergraduate Degrees | Graduate Enrollment | Graduate Degrees | Postdoc Status | Empl

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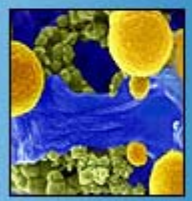


Topics

- U.S. Demographics
- Undergraduate Enrollment
- Undergraduate Degrees
- Graduate Enrollment
- Graduate Degrees
- Postdoc Status
- Employment

About this site

This site provides data on the participation of women, minorities, and persons with disabilities in science and engineering education and employment. The data are organized by topic and are presented in tables, graphics, and spreadsheets for downloading. More...

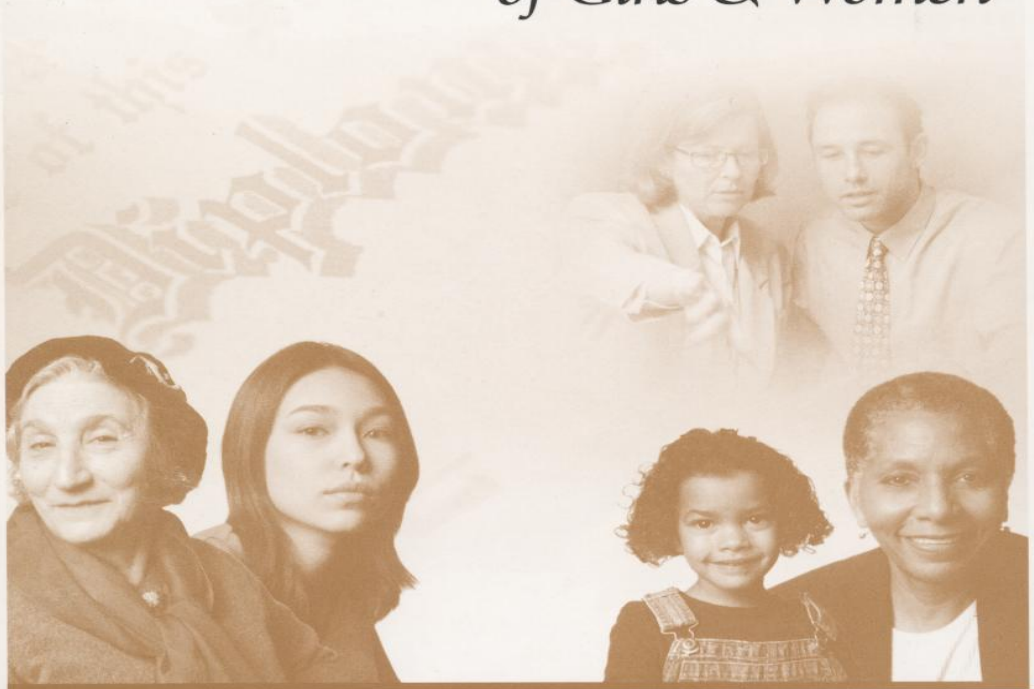
View Information by Group

Sex | Race/ethnicity | Minority women | Disability status

See All Figures and Tables

NATIONAL CENTER FOR EDUCATION STATISTICS

Trends In EDUCATIONAL EQUITY *of Girls & Women*



No person shall, on the basis of sex, be denied an education

U.S. Department of Education
Office of Educational Research and Improvement

NCES 2000-030

NATIONAL CENTER FOR EDUCATION STATISTICS

Research and Development Report September 2000

Entry and Persistence of Women and Minorities in College Science and Engineering Education

U.S. Department of Education
Office of Educational Research and Improvement NCES 2000–601

http://www.hunter.cuny.edu/gendertutorial/tutorials.htm

Tutorials for Change: Gender Schemas and Science Careers

Tutorials for Change, 509 Thomas Hunter Hall
Department of Psychology
Hunter College of the City University of New York
695 Park Avenue
New York, NY 10021 USA

Email: gender.tutorial@hunter.cuny.edu

About Us 

Tutorials 

Resources 

E-mail Us 

Internships 

http://cheminfo.chem.ou.edu/faculty/djn/diversity/top50.html

A National Analysis of Diversity in Science and Engineering Faculties at Research Universities 15 Jan 2004

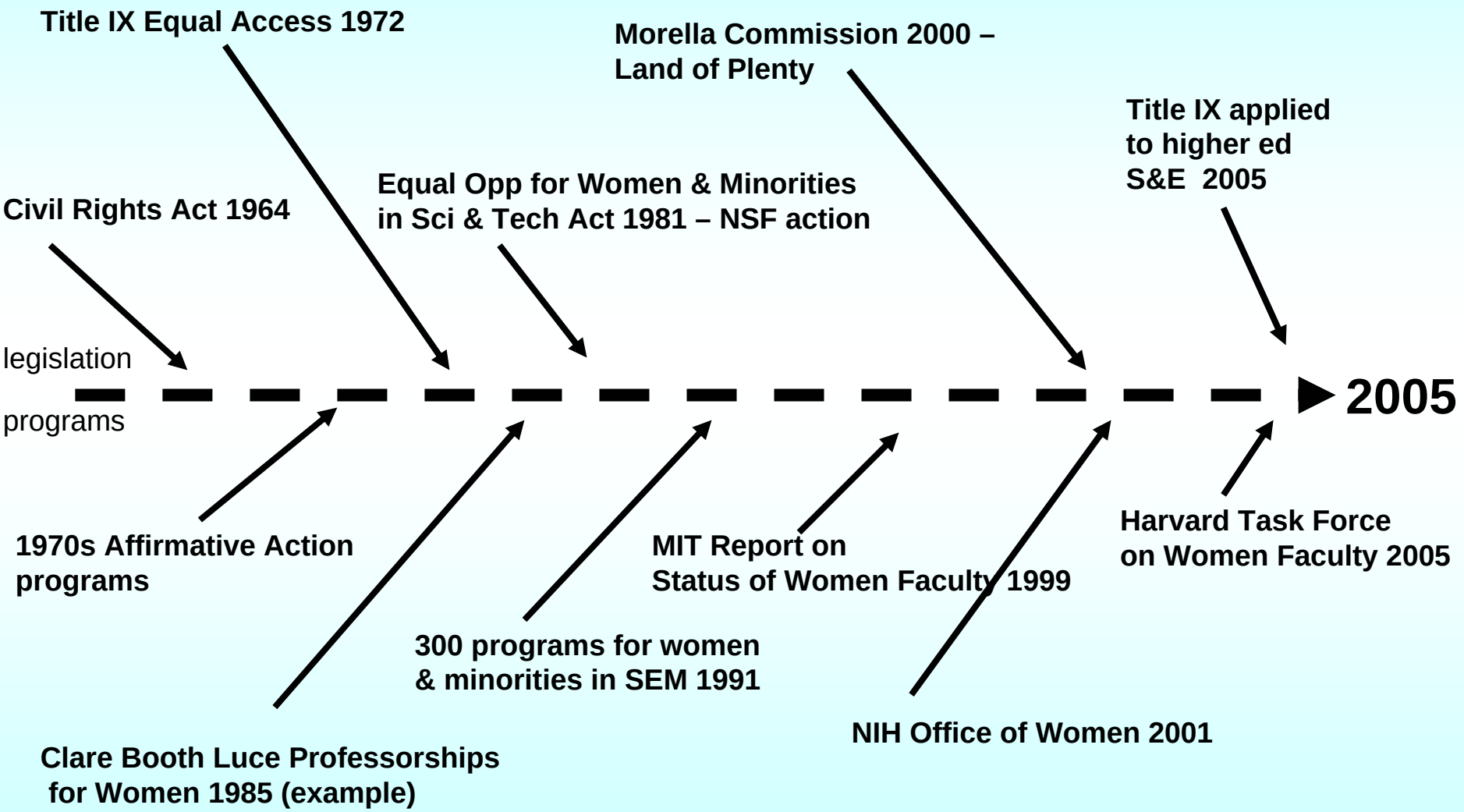
From left: Catherine Didion of the Association for Women in Science, Jacqueline E. Woods of the American Association of University Women, NOW President Kim Gandy, Dr. Donna J. Nelson, Dr Jemison, and Marcia D. Greenberger of the National Women's Law Center. *Photo by Lisa Bennett.*

Press Briefing 10AM-12 NOON
Media Advisory (w/Agenda)
(NOW report of briefing)
(AAUW / Black Issues in Higher Education report of briefing)

Dr. Catherine Didion, Moderator, Director of the Association for Women in Science (AWIS)

Speakers:
Dr. Donna Nelson, Associate Professor, Department of Chemistry, University of Oklahoma
Final Report "A National Analysis of Diversity in Science and Engineering Faculties at Research Universities"
(Appropriate reference wording: "A National Analysis of Diversity in Science and Engineering Faculties at Research Universities," Dr. Donna J. Nelson, Norman, OK. Janua
http://cheminfo.chem.ou.edu/~djn/diversity/briefings/Diversity%20Report%20Final.pdf)
Dr. Mae Jemison, first African-American woman astronaut, and President of BioSentient
Dr. Kim Gandy, President of the National Organization for Women (NOW)
Ms. Marcia Greenberger, Co-President of the National Women's Law Center (NWLC)
Dr. Jacqueline Woods, Executive Director of the American Association of University Women (AAUW)

CONTRIBUTIONS TO POSITIVE CHANGE:



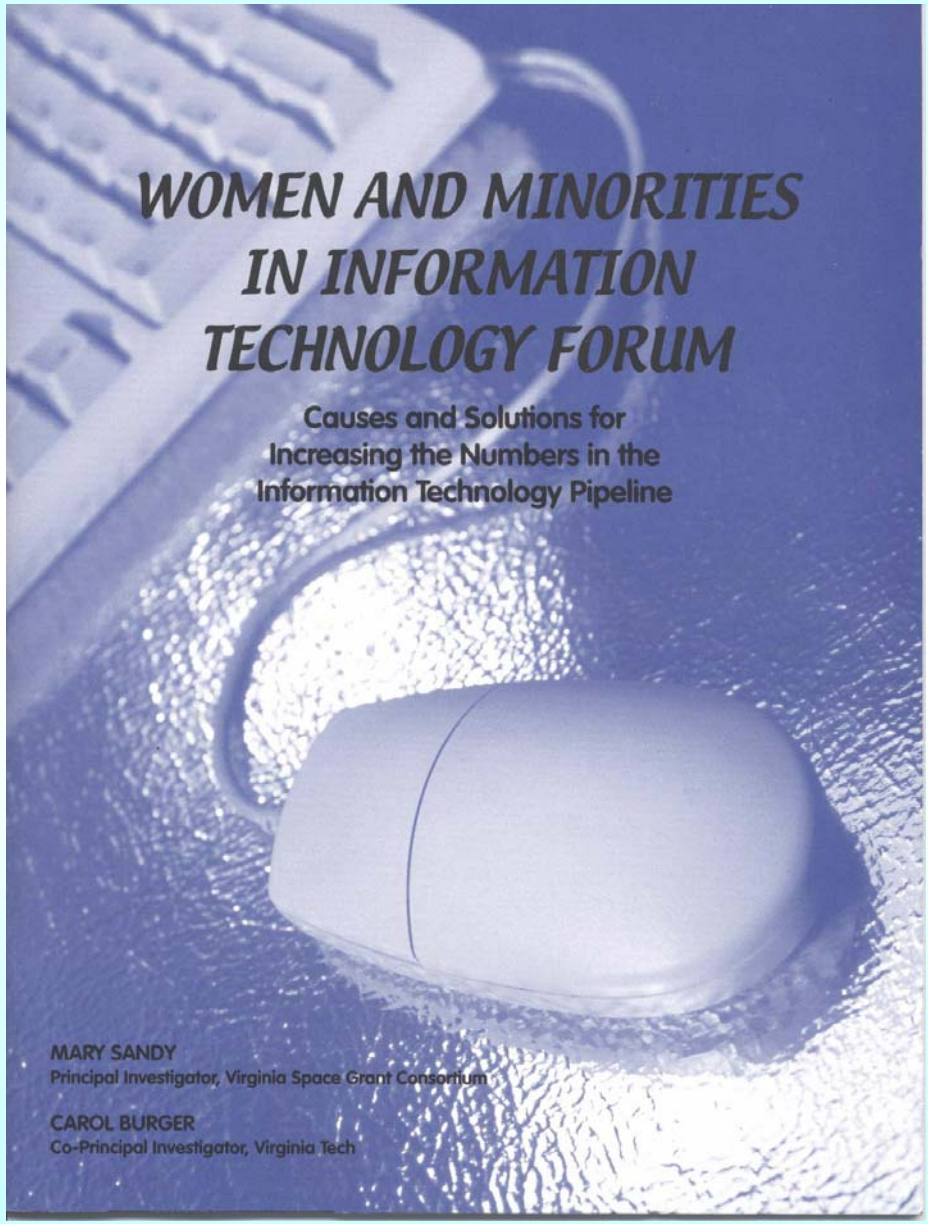
The driving force is leadership,

not isolated programs.

Cf. American Council on Education:
On Change III: Taking Charge of Change:
A Primer for Colleges and Universities, 1999.

www.acenet.edu

http://www.vsgc.odu.edu/Forum.pdf

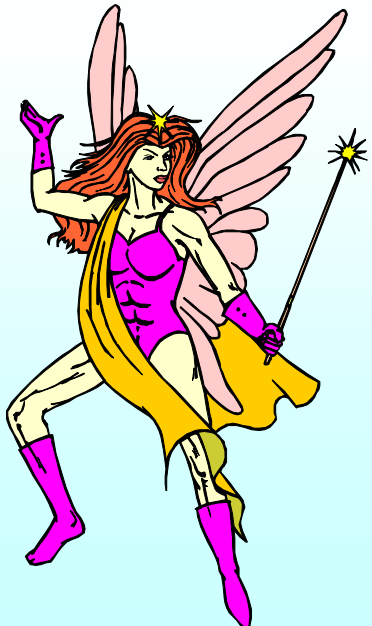


WHAT'S MISSING?

Vision

Information

Leadership



Resources

What You Can Do:

COUNT, WITNESS the problem

Propose solutions:
workplace climate, recruitment, development

Identify talent and promote it personally –
break the stereotypes

Identify recruitment strategies for your unit

Learn to use humor to raise awareness

What You Can Do:

Send information to Human Resources

Bring in speakers to your workplace –
esp. those influential to your leaders

NETWORK with others for ideas & support

Promote an accurate & appealing image of careers
Student internships, visit schools, universities

Show academe that you care; you are aware –
ALUMNI POWER

Seek more information and share it routinely –
get your library to help