# in•for•ma•tion tech•nol•ogy:

How the power of IT and the power of women will power the future.

national center for

women&

INFORMATION
TECHNOLOGY

# IT is Here

Information technology (IT) is the language and toolbox of our information age. We use it to communicate and innovate, in our work and in our play. It is the means for our individual well-being and our collective progress. Participation with IT – both as its creators and its consumers – guarantees that it will be a dynamic force in our future; and IT's pervasive impact on all our lives makes our participation an imperative.

## IT is Important

IT has fueled much of our economic wealth and innovation over the last decades, and it will provide the lion's share of new job growth over the coming decades. The Department of Labor estimates that the professional-level IT workforce will grow at more than twice the rate of the overall workforce, creating 1 in 19 new jobs and adding more than one million new jobs by 2014[1].

Yet Americans' interest in computer science is plummeting (undergraduate college enrollment is down 59 percent over the last four years[2],) just as other countries increase their focus on technical education and innovation. The impending shortage of skilled American technologists portends a crisis in our nation's ability to remain globally competitive, a crisis that could be averted by increasing the participation of a group that traditionally has been under-represented in IT: women.

**in•for•ma•tion tech•nol•ogy**
1: all forms of technology used to create, store, exchange and use information in its various forms;
2: the design and use of computers and communications to improve the way we live, learn, work and play.

# IT Drives the U.S. Economy

According to the Organisation for Economic Co-operation and Developement (OECD) Science, Technology, and Industry (STI) Scoreboard, IT continues to be a key contributor to economic growth, accounting for approximately one-quarter of all productivity gains in the US economy in 2003.

The Federal Reserve Board has shown that about two-thirds of the increase in U.S. labor productivity since 1995 is due to the impact of communications and computer technology.[3]

The noted Harvard economist Dale Jorgenson has stated, "the enhanced role of IT investment as a source of economic growth is the most conspicuous feature of the U.S. economy since 1995 and a productivity revival is under-way in many important IT-using industries."[4]

IT research, and investment in its development (much of it funded by the federal government at the basic stage,) has created more than a dozen billion-dollar industries in the United States, including computerized entertainment, the Internet, graphic user interfaces, parallel and relational databases, data mining, portable communications, the World Wide Web, speech recognition, and broadband communications, to name a few. The chart[5] at right illustrates some of the important technological innovations, funded by the federal government, that we depend upon today.

## IT is a Critical Tool of National Security

IT provides the backbone to critical national infrastructures such as the telephone and power networks. IT also is critically important for national defense needs, such as controlling weapons systems, providing logistics for military forces, providing communications that are durable against attack, and identifying terrorists and other hostile groups. In fact, the Internet was developed as a result of the military's need for a durable communication system.

## Innovation Resulting from U.S. Federally Funded Research

| INNOVATION | FUNDER |
| --- | --- |
| The Internet | DARPA/NSF |
| Web | Browser NSF |
| Bar Codes | NSF |
| Fiber Optics | NSF |
| Routers | NSF |
| MRI | NIH/NSF |
| Doppler Radar | NSF |
| Speech Recognition | NSF/DARPA |
| Nanotechnology | NSF |
| Computer-aided Design | NSF/DARPA |
| Global Positioning Satellites | DARPA |
| The Mouse | DARPA |

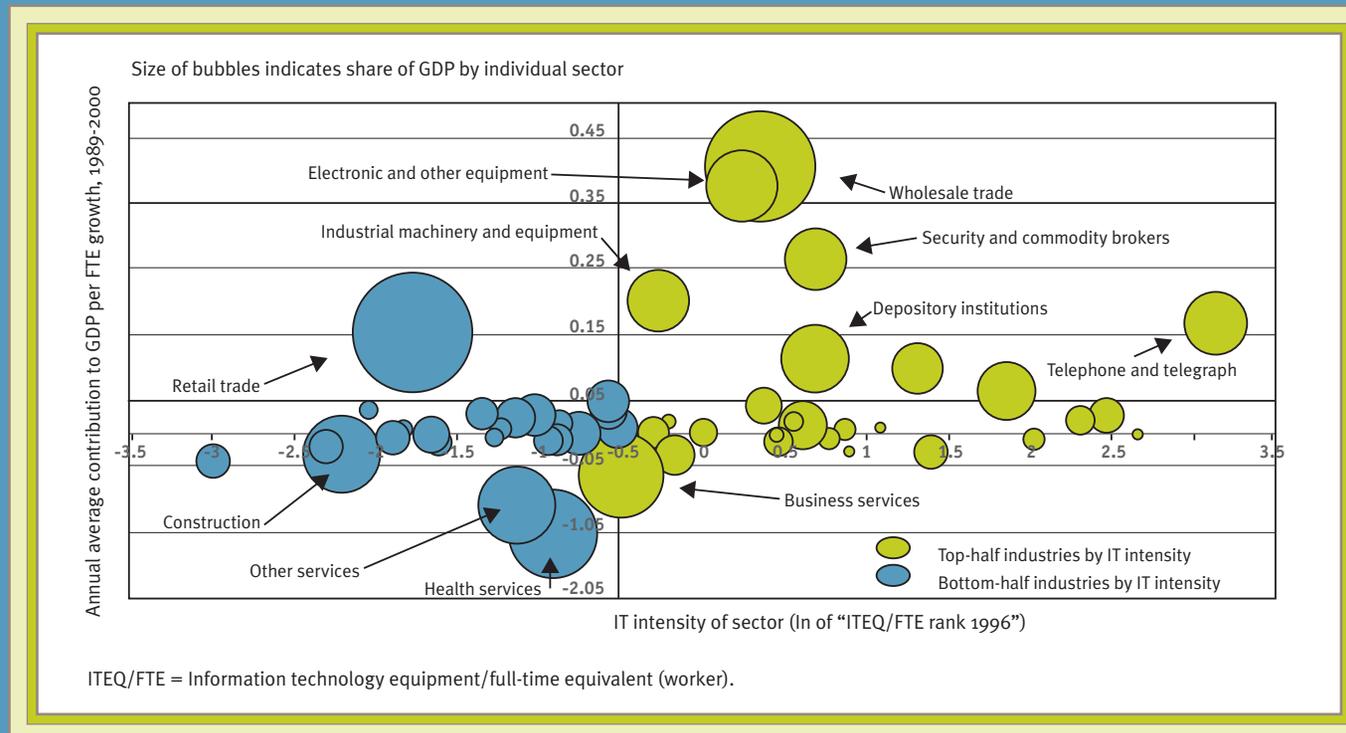# IT Drives Competitiveness in a Competitive Global Economy

IT has been at the center of American innovation for the past 50 years, and will undoubtedly continue as a critical innovation driver for some decades to come. With the ever-present threat of losing jobs and wealth to low-wage countries, there is growing consensus among politicians, academics, and executives that innovation is the key to maintaining our country's competitive edge.

## IT is a Fundamental Tool of U.S. Business

Information technology has become a critical tool of almost every American industry. IT also is becoming increasingly important in providing better communication and services from federal and state governments to citizens, and in making the work of government organizations more efficient.

The chart[6] below, prepared by economist Catherine Mann, shows the penetration of IT into various important sectors of the U.S. economy and demonstrates the strong correlation between investment in IT and productivity growth in most sectors of the U.S. economy.

## IT Intensity and Contribution to GDP per FTE Growth, 1989-2000



Size of bubbles indicates share of GDP by individual sector

Annual average contribution to GDP per FTE growth, 1989-2000

Electronic and other equipment
Wholesale trade
Industrial machinery and equipment
Security and commodity brokers
Depository institutions
Telephone and telegraph
Retail trade
Construction
Other services
Health services
Business services
Top-half industries by IT intensity
Bottom-half industries by IT intensity

IT intensity of sector (In of "ITEQ/FTE rank 1996")

ITEQ/FTE = Information technology equipment/full-time equivalent (worker).

# IT Drives Science and Technology

There used to be two kinds of science and engineering: experimental and theoretical. Today there is an increasingly important third kind of science, characterized by the use of information technology to simulate and model scientific and engineering problems.

In fact, IT is used in many different ways in science and engineering: not only to simulate problems, but also to collect and redact data, control laboratory equipment, provide exact and approximate numerical solutions to problems, visualize problems, enable teams of researchers to work together remotely, and communicate results almost instantaneously. Most nuclear weapons design is done now with computer simulation; the Boeing 777 commercial aircraft was designed completely using IT; and genomics research is almost entirely driven by IT.

## IT is Changing the Economic and Social Foundations of Our Society

The following table indicates changes that have been enabled in people's lives by the introduction of information technology.

| In the Past... | Today... |
|---|---|
| Access to information was a way to control people. | People have inexpensive, direct access to all kinds of information. |
| A few large organizations controlled the ability to communicate news and opinions to the public. | Anyone can share their news, music, or opinions inexpensively over the Internet. |
| Capital barriers to entry controlled the number of people who could enter many businesses | Many of those barriers have evaporated through the opportunities of e-commerce. |

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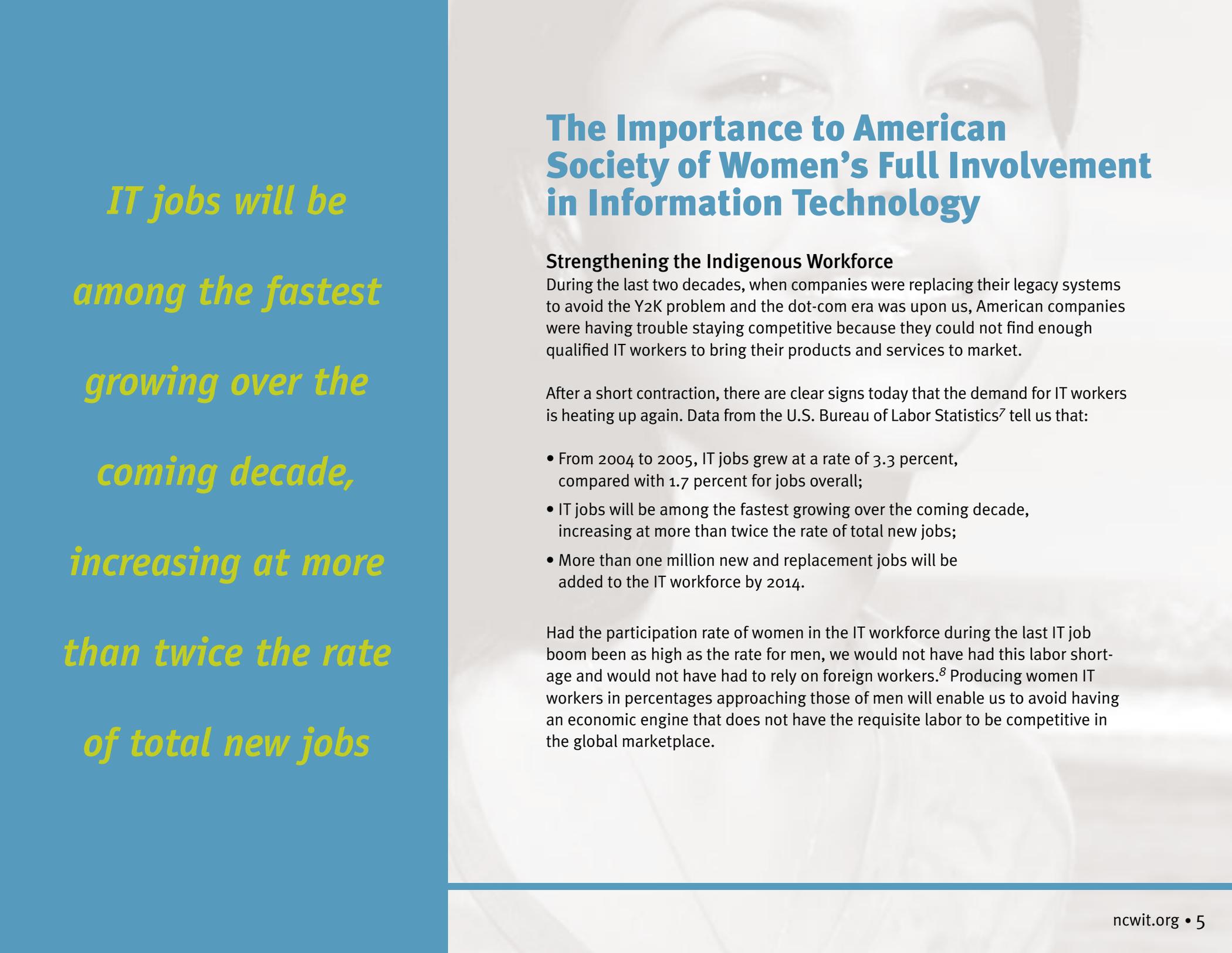
# The Importance to American Society of Women's Full Involvement in Information Technology

### Strengthening the Indigenous Workforce

During the last two decades, when companies were replacing their legacy systems to avoid the Y2K problem and the dot-com era was upon us, American companies were having trouble staying competitive because they could not find enough qualified IT workers to bring their products and services to market.

After a short contraction, there are clear signs today that the demand for IT workers is heating up again. Data from the U.S. Bureau of Labor Statistics[7] tell us that:

• From 2004 to 2005, IT jobs grew at a rate of 3.3 percent, compared with 1.7 percent for jobs overall;

• IT jobs will be among the fastest growing over the coming decade, increasing at more than twice the rate of total new jobs;

• More than one million new and replacement jobs will be added to the IT workforce by 2014.

Had the participation rate of women in the IT workforce during the last IT job boom been as high as the rate for men, we would not have had this labor short-age and would not have had to rely on foreign workers.[8] Producing women IT workers in percentages approaching those of men will enable us to avoid having an economic engine that does not have the requisite labor to be competitive in the global marketplace.

## Improving American Competitiveness

American competitiveness is driven by maintaining levels of innovation higher than those in other countries. This lesson has been demonstrated time and again over the last century. Innovation, in turn, is driven by having adequate research funding, an ample supply of educated workers, and a tolerant, diverse workplace that includes people and ideas from many backgrounds.

The social scientist Richard Florida has studied what makes communities innovative. According to Florida, "Building a vibrant technology-based region requires more than just investing in R&D, supporting entrepreneurship, and generating venture capital. It requires creating lifestyle options that attract talented people, and supporting diversity and low entry barriers to human capital … Diversity of human capital is a key component of the ability to attract and retain high technology industry. Talent powers economic growth, and diversity and openness attract talent."[9]

## Enhancing Product Innovation

Many IT products have focused on white male customers. This is particularly obvious in video games, but it is much more widely and generally true. Presumably this is because the people developing the products are predominantly male. As William Wulf, President of the National Academy of Engineering, has written, "Since the products and processes we create are limited by the life experiences of the workforce, the best solution – the elegant solution – may never be considered because of that lack…. At a fundamental level, men, women, ethnic minorities, and people with handicaps experience the world differently. Those experiences are the 'gene pool' from which creativity springs."[10]

## Why IT Needs Women

Department of Labor statistics predict that women will account for more than half the increase in total labor force growth between 2004 and 2014[11] (women currently hold 56 percent of all professional occupations in the U.S. workforce.) Yet women hold only 27 percent of professional IT occupations[12], and in 2003, only 11 percent of corporate officers at top technology companies were female.[13] A greater percentage of women earned computer science degrees in 1983 than in 2004; and at PhD-granting schools, which account for one-third of all computer science bachelor's degrees and which tend to be major research institutions, women earned less than 18 percent of all undergraduate computer science degrees.

Women's lack of participation in IT has deep implications for our country's preparedness, competitiveness, economic wellbeing, and quality of life. Women bring a different life experience and a different perspective to the innovation process, and diversity in innovation leads to the design of products and services that benefit a broader range of people. Women, who make over 83 percent of U.S. consumer purchases and control 80 percent of household spending, are a valuable, untapped resource whose absence can only be measured in technology not created, problems not solved, and jobs not filled. Their absence represents a loss of opportunities for corporations and individuals, as well as a loss of talent and creativity for the workforce. If U.S. companies wish to maintain their competitive advantage, they cannot afford to miss out on the input of half the population – women can, and must, play a more significant role in building an innovative and technically trained workforce.

# The Current Participation Rate of Women in Information Technology in the United States

**Women and IT Education**

Women currently are under-represented at every level of computing and information sciences (CIS) higher education, as the following table[14] shows.

| | Proportion of U.S. Population | CIS Associate's Degree | CIS Bachelor's Degree | CIS Master's Degree | CIS. Ph.D | |
|---|---|---|---|---|---|---|
| **Female** | 51% | 37% | 27% | 34% | 23% | |

Girls at the K-12 level outnumber boys in Advanced Placement (AP) classes, but they represent only 15 percent of all test-takers in AP computer science – the lowest female representation of any AP test.[15] Among the scant 4 percent of college-bound high-school seniors who identified computer science as an intended major while taking the SAT in 2005, only 13 percent – fewer than 6,000 – were women. This is a nearly 50 percent decline from 1996, when women comprised one-quarter of all students declaring a major in computer and information sciences.[16]

**Women Entering and Progressing in IT Careers**

In the U.S. workforce women make up less than one-third of all programmers, hardware and software engineers, and computing and information systems managers – despite the fact that they hold more than half of all professional occupations overall.[17] Of corporate officers at the 500 top technology companies in the U.S., only 11 percent are women.[18]

Several trends suggest that women are participating in IT and IT-related fields following alternative pathways, and that there may be op-portunities to attract them into more innovative, professional, and technical positions. Some trends worth noting include: women obtained more than 47 percent of math degrees and 59 percent of biology degrees last year; nearly 40 percent of African American computer scientists are female; intended English majors have higher mean SAT scores than intended computer science majors; and underrepresented groups in general are found in greater proportions at community colleges and technical training schools.

# Diversity as an Opportunity, Not an Obstacle

There are many opportunities to increase the number of women participating in every aspect of information technology. The National Center for Women & Information Technology (NCWIT) is implementing aggressive plans to increase diversity in computing fields across the entire academic and workforce pipeline.

• We are forming alliances that include industry representatives, school teachers, university faculty and administrators, and others who can be change agents.

• We are focusing on institutional reform, based on practices that have been proven to be effective by solid research.

• We are working to ensure that computer science is taught in high schools across the country.

• We are helping to reform curricula at both the K-12 and higher education levels.

• We are improving the public image of computing, giving young people a chance to see that IT is not a narrow field only for white male hackers, but is socially valuable work that can be a good career choice.

• We are broadening the appeal of information technology to people who previously may have considered themselves merely its consumers and not its creators.

# Recommendations

Following are recommendations for how individuals and institutions can help NCWIT increase women's participation in IT.

## For Educators

• Track recruitment and retention by gender; report results of diversity efforts
• Support and encourage student interest in IT, and promote positive peer interactions
• Implement curricular reform; use novel methods of working computing concepts into other core courses at the K-12 level; emphasize computing's more relevant social and creative contexts
• Emphasize a community college (two-year) to four-year institution pipeline and look to minority-serving institutions as a graduate school pipeline

## For the Media

• Foster a more accurate representation of IT and technologists
• Realize that diversity has a critical role to play in maintaining U.S. leadership in IT innovation
• Emphasize the fundamental role of IT in a wide variety of disciplines and careers

## For Not-for-profits

• Work together and share resources
• Commit to practices that have been shown, through evaluative evidence, to work
• Use distribution lists and member bases to build awareness and activism

## For Corporations and Business Owners

• Write job descriptions for flexible, creative IT positions that allow for work/life balance
• Demonstrate support and encouragement for employees
• Create bridge programs for people to re-enter the IT workforce, and provide them with skills training and mentoring
• Demand excellence in IT education

## For Government

• Implement innovation legislation and offer communities ways to contribute to the development and successful implementation of this legislation
• Consider a military to civilian re-entry program, capitalizing on technically trained armed forces members and their potential contributions to the workforce
• Support sustaining infrastructures to ensure that progress happens over the long term

## For Everyone

• Pay attention to how diversity in IT impacts your life
• Be an advocate for change
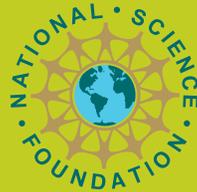
1 Occupational Outlook Handbook, Department of Labor Bureau of Labor Statistics, 2004-2005.

2 Higher Education Research Institute (HERI), 2005.

3 Oliner, Stephen D. and Sichel, Daniel E., The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?, Federal Reserve Board, Washington DC, February, 2000

4 See http://post.economics.harvard.edu/faculty/jorgenson/papers/InfoTech.pdf.

5 Losing the Competitive Advantage? The challenge for Science and Technology in the United States. American Electronics Association, 2005.

6 Mann, Catherine L. Globalization of IT Services and White Collar Jobs: the Next Wave of Productivity Growth, Bureau of Economic Analysis, Department of Commerce, Digital Economy, 2003.

7 Current Population Survey (CPS), Department of Labor Bureau of Labor Statistics, 2005.

8 Freeman, Peter, and William Aspray, eds. The Supply of Information Technology Workers in the United States. Washington, D.C.: Computing Research Association, 1999.

9 Florida, Richard and Gary Gates: "The Importance of Diversity to High-Technology Growth," The Brookings Institution Center on Urban & Metropolitan Policy Survey Series, June 2001.

10 William Wulf, President, National Academy of Engineering, "Testimony to the Commission on the Advancement of Women and Minorities in Science Engineering, and Technological Development," 2001.

11 Occupational Outlook Handbook, Department of Labor Bureau of Labor Statistics, 2004-2005.

12 Department of Labor Bureau of Labor Statistics, 2005.

13 Catalyst, via Fortune magazine, 2003

14 NSF Science and Engineering Indicators, 2006, based on 2002 data for all groups.

15 The College Board, 2005.

16 2005 College Bound Seniors, College Board.

17 Department of Labor Bureau of Labor Statistics, 2005.

18 "Women CEOs of Fortune 500 Companies," Fortune, 2003.

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