

**NEW FORMULAS FOR AMERICA'S WORKFORCE 2**  
**GIRLS IN SCIENCE AND ENGINEERING**





# TABLE OF CONTENTS

## INTRODUCTION • WHY THIS BOOK?

### CHAPTER ONE • CHANGING STEREOTYPES 01

Reaching Parents of Elementary and Middle School Girls	02
Making Teamwork Work for Women	02
Gender Segregation in Engineering and Math/Computer Science	03
Radio Series Tells the Stories About Girls and Women in Science	04
Think Again . . . Girls Can!	05
Challenging Gender Stereotypes With Computer-Based Social Models	05
The Image of Engineering	06
Improving Girls' Self-Efficacy With Virtual Peers	06
Developing a New Scale to Evaluate Students' Attitudes	07
Social Context and Gender Differences in STEM	08
Predicting What Keeps Women in STEM	08
Media Literacy Training for Middle School Students	09

### CHAPTER TWO • GIRLS AND THE TECHNOLOGY GAP 11

Computer Science Computing and Mentoring Partnership	12
Can Robotics Keep Girls in Science?	12
Girls Creating Games: Increasing Middle School Girls' Interest in Technology	13
Tech Team	14
Girls as Education Software Designers	15
Computer Programming for Middle School Girls	16
Hear Our Voices and the Computer Clubhouse	16
Girls and IT: A Promotional Video	17
Tech Savvy	18
Programming With a Purpose	19

### CHAPTER THREE • FOSTERING EARLY INTEREST IN SCIENCE 21

The Case of Missing Human Potential	22
Science on Patrol	22
Girls in Science	23
Discovery Under the Hood	24
Explanatoids and Click! the Urban Adventure	24
SciGirls From DragonflyTV	25
Bringing Young Girls Into Science With Books and Inquiry	26
Girls' Science Practices in Urban, High-Poverty Communities	27
GO-GIRL	28
4 Schools for Women in Engineering	29
Gender-Based Science Performance Models	30

### CHAPTER FOUR • GIRLS AND THE MATH GAP 31

Aiming for Algebra	32
Early Interventions to Improve Later Math Performance	32
Collaboration, Reflection, and Role Models	33
Reducing Gender Differences in 3-D Spatial Skills	34
Understanding Why Girls Have Trouble With Measurement	34
The Role of Gender in Language Used by Children and Parents Working on Mathematical Tasks	35

# TABLE OF CONTENTS (CONTINUED)

<b>CHAPTER FIVE • HOLDING INTEREST THROUGH COLLEGE AND COMMUNITY COLLEGE</b>	<b>37</b>
Changing College Freshmen’s Attitudes Toward Women in STEM	38
Women at CENS: A Research System	39
Evaluating Living-Learning Programs	39
Producing Women Engineers: A Study of Undergraduate Engineering Programs for Women	40
Gender Differences and Cultural Models in the Computing Sciences	41
Engineering Cultures That Promote Diversity	41
Including the Social Studies of Science in Science Courses for Gender Equity	42
Diversity in Physics: Learning From Women’s Colleges	43
Pathway to a STEM Baccalaureate Degree	43
Why Does it Work? A Study of Successful Gender Equity in Industrial Engineering at the University of Oklahoma	44
<b>CHAPTER SIX • CREATING A DIVERSE S&amp;E WORKFORCE</b>	<b>45</b>
Valuing a Diverse Engineering Workforce	46
The Role of Gender in STEM Training and Career Paths	46
Understanding What Keeps People in STEM	47
Women and Students of Color in Doctoral Mathematics	47
Women in Chemical Business and Industry	48
<b>CHAPTER SEVEN • TOOLS FOR EDUCATORS AND RESEARCHERS</b>	<b>49</b>
Intergenerational Working Conference on Women and Science Research	50
Resources for K–12 Service and Experiential Learning in STEM	50
Standards for Online Teacher-Development Courses	51
A Community of Practice of Science: After-School Programs for Girls	51
Collaborative Projects Across the Nation	52
Opportunities for Wisconsin Women	53
Seeing Gender: Tools for Change	53
Bridging the Gap: A Synthesis of Findings From STEM	54
Sisters in Science Dissemination and Outreach Project	54
Disseminating National Science Partnership Kits	55
Engineering Equity Extension Service	55
Widening the Use of Effective Practices to Keep Women in Computing	56
Moving Beyond Anecdote to Informed Discussion	57
Effective Strategies to Diversify Academic STEM	58

## APPENDIX

## INDEX

# ORIGINS

One of the National Science Foundation's key strategies is to cultivate a world-class, broadly inclusive science and engineering workforce and expand the scientific literacy of all citizens. Why is it important and timely to deepen the American talent pool in engineering and computer science? There are many reasons:

- After 9/11, the United States finds itself no longer able to depend as much on foreign talent for engineers and technology experts. We need more citizens available for classified work, especially to meet new challenges such as those presented by chemical and biological weapons and weapons of mass destruction.
- Companies are exporting jobs to meet their demands for talent in engineering and computer science.
- Having developed their own competitive educational institutions, other countries are growing their potential to produce more engineers and computer scientists than the United States.
- The diversity profile of faculty in U.S. colleges and universities has not kept up with the profile of graduates in science, technology, engineering, and math (STEM) fields. Graduates are available but are not entering the academic or corporate workforces, are not choosing to stay, or are not advancing to leadership positions.
- Congress recently directed the Government Accountability Office to assess the application of Title IX to higher education, and especially to the issues of equitable access, recruitment, and retention of underrepresented students in science and engineering.
- The National Science Board, the National Academies of Science and Engineering, American Association for the Advancement of Science, and other leading policy entities continue to voice concerns about the lack of diversity in the science and engineering workforce.
- Lawrence Summers, former president of Harvard University, launched a public discussion—including hundreds of pages of press coverage—on the topic “why aren't women in science?” Subsequently, Harvard University invested \$30 million to change those of its policies and practices that contributed to the slow integration and advancement of women in faculty positions in these fields.
- While women's participation in medicine, law, and business management has increased to parity or near parity, it remains slow in the high-demand fields of science and engineering, especially with regard to workforce participation and advancement.
- Cross-cultural studies show that occupational participation and segregation by gender is cultural. That is, a society can encourage and support different trends, even in a short period of time, that could lead to a more diverse and dynamic workforce.

In 1981 the Equal Opportunities for Women and Minorities in Science and Technology Act acknowledged that it was United States policy and in the national interest to encourage all groups to participate in science and engineering. The act mandated that NSF report statistics on underrepresented groups and initiate programs fostering more proportionate representation. Among the suite of programs that followed was the Program for Women and Girls, created in 1993 and housed in NSF's Division of Human Resource Development, Directorate for Education and Human Resources.

The annual budget has varied from \$7 million to \$10 million. Although relatively small, the NSF program is the largest funding source, public or private, for efforts expressly addressing the need to broaden girls' and women's participation in STEM. To date, more than 350 grants have provided the national STEM education enterprise with new ideas, proven good practices, innovative products, research publications, and a leadership of savvy, experienced educators and education researchers. These grants are relatively small but reach nearly every state in the United States.

The program aims to change education policy and practice by supporting research, student and educator programs, dissemination of findings, and technical assistance projects. Program findings and outcomes help us understand, for example, how to

- Maintain girls' interest in science past middle school
- Bring more girls into elective high school math and advanced-placement science courses
- Increase young women's enrollment in STEM undergraduate studies, particularly in engineering and computer sciences (where there is a national need for more experts and more diverse faculty)

A study of its impact from 1993 to 1996 showed that the NSF program has been successful. Yet while much has been accomplished, national statistics reveal that much more remains to be done. Since 1993—even since 2003—the national need for a larger, more diverse, more science- and computer-literate and skilled workforce has steadily increased, as we progress toward an increasingly technological job market, a more scientifically complex society, and more intense global competition in engineering and technology innovation.

# WHY THIS BOOK?

*New Formulas for America's Workforce: Girls in Science and Engineering* was published in September 2003. Within seven weeks of issue, the initial print run of 7,000 copies was exhausted and the NSF had to order reprints. Copies on CD-ROM and online were also in great demand. NSF's publications Web site showed *New Formulas* to be the second most requested print publication during October 2003. There were requests for up to 300 copies of the CD-ROM at a time, to be handed out at conferences. All copies (paper and CD-ROM) are free. The publication reached teachers, formal and informal educational practitioners, researchers, and even parents and students. Ensuing publicity in every major science publication (and the *Washington Post*) revealed the breadth of public interest.

The first *New Formulas* covered about 220 grants from 1993 through 2001. *New Formulas 2* updates the first volume by describing the roughly 100 grants made from 2002 through 2005. There are fewer educational demonstration projects but more social science research studies, dissemination activities, and projects that will provide technical assistance for the implementation of best practices. The publication led to

- New collaborations among education researchers,
- New and greater investments in educational programs for female students,
- Better understanding of gender differences in career interests and in how students engage in science and mathematics
- Awareness of and better access to widely scattered resources and information
- Deeper comprehension of the educational impacts of NSF's investments
- Faster and easier press access to findings and leading experts in a field of study that crosses many disciplines

In short, the book informed public discourse about the state of gender diversity in science and engineering, the critical role of education in preparing the workforce, and the constraints on national competitiveness that can result from failing to address diversity issues.

We expect the same spectrum of groups to be interested in this volume as the first: teachers, faculty, counselors, administrators, after-school program providers, researchers, deans, colleges of education, trainers of teachers, professional associations, foundations, industry, policymakers, the public media, parents, and students. All are interested in better education, better access to education, better student achievement, and more entrants (and more diverse entrants) into science and engineering careers.

## MORE INFORMATION

ABOUT NSF: [www.nsf.gov](http://www.nsf.gov)

ABOUT THE PROGRAM: [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5475&org=HRD&from=home](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5475&org=HRD&from=home)

ORIGINAL PROJECT SUMMARIES IN THE "AWARDS DATABASE" AT NSF: <http://www.nsf.gov/awardsearch/index.jsp>

- GO TO THE TAB ALL FIELDS
- IN PROGRAM ELEMENT ENTER "1544"
- REMOVE CHECK FOR CURRENT AWARDS ONLY

Any NSF publication may be retrieved at <http://www.nsf.gov/publications/>. Type in the publication number, e.g., NSF 6-59, or the title.

KEY WORKS IN THE FIELD	
	Clewell, Beatrice Chu, and Patricia K. Campbell. 2012. "Taking Stock: Where We've Been, Where We're Going." <i>Journal of Women and Minorities in Science and Engineering</i> 8:255–284, <a href="http://www.campbell-kibler.com/Taking_Stock.pdf">http://www.campbell-kibler.com/Taking_Stock.pdf</a>
	Freeman, Catherine E. 2014. Trends in the Educational Equity of Girls and Women: 2014. U.S. Department of Education, National Center for Education Statistics. <i>Education Statistics Quarterly</i> 6(4), NCES 2015-16, <a href="http://nces.ed.gov/programs/quarterly/vol_6/6_4/8_1.asp">http://nces.ed.gov/programs/quarterly/vol_6/6_4/8_1.asp</a> .
	Harvard University. 2015. <i>Report of the Task Force on Women Faculty</i> . <a href="http://www.news.harvard.edu/gazette/daily/2015/5/women-faculty.pdf">http://www.news.harvard.edu/gazette/daily/2015/5/women-faculty.pdf</a> .
	Huang, Gary, Nebiyu Taddese, and Elizabeth Walter. 2012. "Entry and Persistence of Women and Minorities in College Science and Engineering Education." U.S. Department of Education, National Center for Education Statistics. <i>Education Statistics Quarterly</i> 2(3), NCES 2012-61, <a href="http://nces.ed.gov/programs/quarterly/vol_2/2_3/post_women.asp">http://nces.ed.gov/programs/quarterly/vol_2/2_3/post_women.asp</a> .
	Jackson, Shirley Ann. 2012. "The Quiet Crisis: Falling Short in Producing American Scientific and Technical Talent." BEST (Building Engineering & Science Talent), <a href="http://www.bestworkforce.org/PDFdocs/Quiet_Crisis.pdf">http://www.bestworkforce.org/PDFdocs/Quiet_Crisis.pdf</a> .
	Jacobs, Janis E. 2015. "Twenty-Five Years of Research on Gender and Ethnic Differences in Math and Science Career Choices: What Have We Learned?" <i>New Directions for Child and Adolescent Development</i> 111:85–94.
	National Science Foundation. 2013. <i>New Formulas for America's Workforce: Girls in Science and Engineering</i> . Arlington, VA. NSF 13-27 (print) and NSF 13-28 (CD-ROM) and online ( <a href="http://www.nsf.gov/ehr/hrd/Newformulas/newformulas.jsp#three">http://www.nsf.gov/ehr/hrd/Newformulas/newformulas.jsp#three</a> ).
	National Science Foundation. Expected 2017. <i>New Tools for America's Workforce: Girls in Science and Engineering</i> , Arlington, VA. <a href="http://www.nsf.gov/ehr/hrd/Newformulas/newformulas.jsp#three">http://www.nsf.gov/ehr/hrd/Newformulas/newformulas.jsp#three</a> .
	National Science Foundation. 2015. "Research on Gender in Science and Engineering FY 2016 (GSE)." Program Announcement. NSF 15-614.
	National Science Foundation. Division of Science Resources Statistics. 2014. Women, Minorities, and Persons With Disabilities in Science and Engineering. Arlington, VA. NSF 14-317, <a href="http://www.nsf.gov/statistics/wmpd">http://www.nsf.gov/statistics/wmpd</a> .
	National Science Foundation. National Science Board. 2014. "Broadening Participation in Science and Engineering Faculty." NSB 14-41, <a href="http://www.nsf.gov/pubs/2014/nsb441/nsb441.pdf">http://www.nsf.gov/pubs/2014/nsb441/nsb441.pdf</a> .
	National Science Foundation. National Science Board. 2014. "Broadening Participation in Science and Engineering Research and Education: Workshop Proceedings." NSB 14-72, <a href="http://www.nsf.gov/publications/pubsumm.jsp?ods_key=nsb472">http://www.nsf.gov/publications/pubsumm.jsp?ods_key=nsb472</a> .
	Nelson, Donna J. 2015. "A National Analysis of Diversity in Science and Engineering Faculties at Research Universities." <a href="http://cheminfo.chem.ou.edu/~djn/diversity/briefings/Diversity%20Report%20Final.pdf">http://cheminfo.chem.ou.edu/~djn/diversity/briefings/Diversity%20Report%20Final.pdf</a> .
	U.S. Government Accountability Office. 2014. "Report to Congressional Requesters: Gender Issues: Women's Participation in the Sciences Has Increased, but Agencies Need to Do More to Ensure Compliance With Title IX." GAO-14-639, <a href="http://www.gao.gov/highlights/d4639high.pdf">http://www.gao.gov/highlights/d4639high.pdf</a> and <a href="http://www.gao.gov/cgi-bin/getrpt?GAO-14-639">http://www.gao.gov/cgi-bin/getrpt?GAO-14-639</a> .

## ACKNOWLEDGEMENTS—THE PROJECT TEAM

### At the National Science Foundation

Victor Santiago, Acting Division Director, Human Resources Development

Ruta Sevo, Senior Program Director

Jolene Jesse, Program Director

### At Low + Associates

Michael Cosgrove, Executive Vice President

Suzanne Harris, Josh Malbin, and Jason Warshof, Writers

Ross Bankson, Editor

Kate Barry and Danielle Sinkford, Assistant Account Executives

Michael Greenland and Jen Chung, Art Directors

### At large

The 75 Principal Investigators and their teams who carried out these projects and who responded with additional information, reviews, chapter introductions, and images



