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# Women in Engineering Conference

Capitalizing  
on Today's  
Challenges

June 1-4, 1996  
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MASTER

Conference Proceedings

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# TABLE OF CONTENTS

WEPAN Board of Directors 1995 - 1997.....	iii
WEPAN Board of Directors 1995 - 1997 Ex-Officio Members.....	v
WEPAN Board of Directors 1996 - 1998.....	vi
WEPAN Board of Directors 1996 - 1998 Ex-Officio Members.....	viii
1996 WEPAN Conference Administration.....	ix

## WORKSHOP

<i>Moderator</i>	
Dorie McCubbrey, Ph.D.....	1
<i>AGRED Pre-Conference Evaluation Workshop</i>	
Lisa M. Frehill, Ph.D. and Emily M. Wadsworth, Ph.D.....	3
<i>Background Information on Program Evaluation</i>	
Irene F. Goodman, Ed.D. and Colleen F. Manning.....	4
<i>Process of Evaluation</i>	
Lisa M. Frehill, Ph.D.....	5
<i>Reporting Evaluation Results</i>	
Emily M. Wadsworth, Ph.D.....	6

## STEPS TO LEADERSHIP

Jill Tietjen, P.E.....	9
------------------------	---

## PLENARY I CLASSROOM CLIMATE REVISITED

<i>The Chilly Climate</i>	
Bernice R. Sandler, Ph.D.....	15, 17

## UTILIZING RESOURCES EFFECTIVELY: FROM THE LIBRARY TO THE WORLD WIDE WEB

<i>Moderator</i>	
Karan L. Watson, Ph.D.....	25
<i>Sorting the Wheat from the Chaff: Locating and Using Resources for Women</i>	
Tanya L. Zanish.....	27

BRIDGING THE GENDER GAP IN ENGINEERING AND SCIENCE: THE CASE  
FOR INSTITUTIONAL TRANSFORMATION.

Barbara B. Lazarus, Ph.D. and Indira Nair, Ph.D.....33

SITUATION OF WOMEN ACADEMICS IN THE NEW LÄENDER IN GERMANY

Ingrid Doberenz, Ph.D.....41

COMMUNICATION AND CONFLICT RESOLUTION IN THE WORKPLACE: AN  
AWARENESS WORKSHOP

Nancy E. Algert.....45

HELPING WOMEN SELECT CAREER PATHS

*Moderator*

Irene R. Mikawoz, P.Eng.....51

*Minority Women in the Engineering Freshmen Class*

Sangeetha Purushothaman, Ph.D.....53

*Factors that Affect a College Student's Academic and Career Path in  
Science/Engineering - Related Fields*

Mary J. DeLong, Ph.D.....61

*Guiding Attitudes in Career Choice: A Girls' Summer School*

Lynette Brodie.....67

PERSPECTIVES OF FEMALE EXECUTIVE SCIENTISTS AND ENGINEERS

*Moderator*

Antionette Joseph.....73

*Perspectives of Female Executive Scientists and Engineers: Panel Discussion  
Recorder*

Michele D. Fish.....75

THE EXPERIENCE OF BEING A WOMAN ENGINEERING STUDENT:  
PERSPECTIVES AND COPING

*Moderator*

Carmen B. Cannon, Ph.D.....81

*Strategies of Young Women Pursuing Degrees in Engineering and Science*

Linda Carlin and Suzanne Brainard, Ph.D.....83

*Creating Engineers: Processes that Exclude Women*

Karen L. Tonso.....93

## NAVIGATING CAREER AND FAMILY PATHS

<i>Navigating Career and Family Paths: An Introduction</i> Susan Staffin Metz.....	99, 101
<i>Navigating Career and Family Paths: A Personal Perspective</i> Carol McConica, Ph.D.....	105
<i>Navigating Career and Family Paths</i> JoAnn Silverstein, Ph.D.....	111

## K-12 PROGRAMS: INNOVATIVE AND COLLABORATIVE APPROACHES

<i>Moderator</i> Robyn E. Sandekian.....	117
<i>Partnering a Path for Women in Engineering</i> Kathy Weismehl Herbener and Sharon Carson, Ph.D.....	119
<i>PROJECT 1999: A Partnership in Association with Public Schools, Industry, and a University to Target the Recruitment of Anglo and Minority Girls into Engineering</i> Nancy Bottone Hellman, Ph.D.....	125

## SPECIAL PRESENTATION

<i>Miz Wizard's Science Secrets</i> Jane Curry, Ph.D.....	131
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## PLENARY II WOMEN ENGINEERS AND THE NEW FOCUS ON INTERNATIONAL EDUCATION

<i>WEPAN National Conference</i> William E. Kirwan, Ph.D.....	133, 135
<i>Women Engineers in the Global Marketplace</i> F. Suzanne Jenniches.....	133, 141

## AN INTERACTIVE DISCUSSION OF INTERNATIONAL PROGRAMS

<i>Moderator</i> Marilyn R. Berman, Ph.D.....	145
<i>Recorder</i> Barabara B. Lazarus, Ph.D.....	147

PRACTICAL ADVICE FOR WOMEN IN ENGINEERING PROGRAM  
ADMINISTRATORS: WHAT TO DO WHEN AN ALLEGATION OF SEXUAL  
HARASSMENT WALKS IN YOUR DOOR

Miriam K. Maslanik, Ph.D., P.E..... 149

CURRICULUM REFORM: WORKING TOWARDS GENDER EQUITY

*Moderator*

Judith W. McDonald..... 155

*Working to Achieve a More Gender Neutral Engineering Curriculum*

Patricia Laughlin, Ph.D..... 157

*Humanization of the Engineering Curriculum*

Patricia F. Mead, Ph.D , Elizabeth Rosenfeld, and David Bigio.... 163

GENDER COMMUNICATIONS: HE SAID....SHE SAID...

Jerri Gail McKinney and Gary McCarney..... 171

CAMPUS CLIMATE ISSUES

*Moderator*

Norman L. Fortenberry, Sc.D..... 177

*A Study of Campus Climate for Diversity: The Impact of Campus Climate on  
Engineering Women Students*

Mary Ann Evans, Ph.D. and Marlene Fisher..... 179

*Cross Cultural and Chilly Climate Issues in Engineering*

Susan Cavin, Ph.D. and Amy Siskind, Ph.D..... 185

*Women in Physics: Measuring Chilly Climate*

Jean M. Curtin, Geneva Blake, and Christine Cassagnau..... 193

CORPORATE FUNDING OPPORTUNITIES

*Moderator*

Suzanne R. Nagel, Ph.D..... 199

*Recorder*

Karin L. Mack..... 201

MAXIMIZING YOUR RESOURCES: WORKING EFFECTIVELY WITH STUDENT  
EMPLOYEES

Kathleen Bott..... 203

## RETENTION EFFORTS: PROGRAMS THAT WORK

### *Moderator*

Jane Z. Daniels, Ph.D..... 211

### *Fact Finding: What are the Needs and What is Working?*

Marsha LoFaro and Sandra C. Cooper..... 213

### *The Women in Science and Engineering Residence Program: A Model Living-Learning Program at the University of Michigan*

Cinda-Sue Davis, Ph.D. and Mary Hummel, Ph.D..... 219

### *Involving Students Through Building Community: Challenges for Women in Engineering Programs*

Jennifer L. Vest and Julie L. Goldberg..... 225

## K-12 OUTREACH PROGRAMS

### *Moderator*

Lisa J. Oliveira..... 231

### *The GOES Project: A Successful Outreach Program that Introduces Middle School Girls to Engineering*

Margaret A. Wheatley, Ph.D., Linda Schadler, Ph.D. and  
Banu Onaral, Ph.D..... 233

### *Combining Mentoring and Service Learning- A New Approach*

Jennifer Ocif and Beverly Marshall-Goodell, Ph.D..... 239

### *The Access Program for Women in Science and Engineering (ACCESS W.I.S.E.)*

Irene R. Mikawoz, P.Eng. and Laura Binkley..... 243

## PLENARY III

### AFFIRMATIVE ACTION: PROMISE OR PROGRESS? WHAT LIES AHEAD?

Yvonne B. Freeman, Ph.D..... 249, 251

## AN INTERACTIVE DISCUSSION ON AFFIRMATIVE ACTION

### *Moderator*

Kristy Schloss..... 261

### *Recorders*

Jill S. Tietjen and Kristy A. Schloss..... 263

## PROGRAMS AT TWO YEAR AND COMMUNITY COLLEGES

### *Moderator*

John C. Vergelli.....269

### *Community College Successful Intervention Programs: ATOMS, RSI, and Vocational Gender Equity*

Judy P. Remsberg and Wendy Buie.....271

### *Females Involved from Regional Schools in Technology and Engineering (FIRSTE): Overcoming the Challenge of Recruitment*

Joan A. Begolly and Tracie L. Brockhoff.....277

## NEW WAYS OF LOOKING AT ENGINEERING EDUCATION: TQM

### *Moderator*

Marjorie A. Leavene.....281

## EVALUATING THE IMPACT OF TWO INITIATIVES

### *Moderator*

Patricia Berry Glassner .....283

### *THE YEAR OF THE WOMEN: A Report on the First Year of Coeducation at Rose-Hulman Institute of Technology*

Caroline Carvill, Ph.D. and Susan L. Smith .....285

### *Factors Influencing Women's Pursuit of a College Science Major or Science Career: An Evaluation of the Women in Science Project (WISP)*

Christine M. Cunningham, Ph.D., Mary R. Pavone, and  
Carol Muller, Ph.D.....289

## CURRICULUM REFORM: INNOVATIVE TEACHING METHODS

### *Moderator*

Lisa M. Frehill, Ph.D.....295

### *Impact of an Alternative Teaching Method: Perspectives of Minority Female Engineering Students*

Linda F. Simmons, Judy A. Perkins, Ph.D., and I. K. Dabipi, Ph.D.....297

### *Inside Engineering Faculties: Developing a New Layer of Advocacy in Australia*

Sue Lewis, Ph.D.....305

### *The National Centre for Women: Employment, Education and Training for Women in Non-Traditional Areas*

Sue Lewis, Ph.D.....311

## CAMPUS CLIMATE: PERSPECTIVES FROM COALITIONS

### *Moderator*

Sue Scheff.....315

### *Efforts to Retain Women and Minorities in Engineering: A Perspective of the Foundation Coalition Project*

Karan Watson, Ph.D., Jorja Kimball, Karen Frair, Ph.D., Jan Rinehart, and Mary Anderson-Rowland, Ph.D.....317

### *Engineering Education for Women: A Chilly Climate?*

Diedre Hirschfeld, Ph.D., Deborah Collins, Ph.D., and Alan E. Bayer, Ph.D.....323

## POSTER SESSIONS

Poster Session Presenters.....329

### *Linking Girls and Their Technological Futures Through Informal Science: An Implementation Model in Iowa*

Krishna S. Athreya, Ph.D.....331

### *Careers of Women Who Study Physics: Findings from a 1994 Survey of Sigma Pi Sigma Members*

Geneva Blake.....333

### *Careers in Science and Engineering: A Speaker's Series in Collaboration with an NSF Visiting Professor*

Stephanie Blaisdell, Angela Middleton, and Mary Anderson-Rowland, Ph.D.....337

### *Critical Connections: The Secret to the Success of Women in Math, Science, and Engineering*

Sandra C. Cooper and Charlena H. Grimes.....341

### *An Intervention Strategy to Retain Women Students in Engineering: Engr 194: Seminar and Small Groups*

Jane Z. Daniels, Ph.D. and Janine K. Reklaitis, Ph.D.....345

### *Clustering to Improve Retention of Women in Engineering*

Deidre Hirschfeld, Ph.D., Michael Gregg, and Beville Watford, Ph.D..349

### *1996 CSU, SWE, and Beattie Elementary Girls in Math and Science Club Sled Design Contest*

Susan P. James, Ph.D. and Mary K. O'Connell.....353



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

<i>Math Options: A Math and Science Equity Program for Young Women : The Past, The Present, and The Future</i> Janice M. Margle and Patricia VanLeuvan.....	357
<i>Freshmen P.O.W.E.R.</i> Dorie McCubbrey, Ph.D. and Mary C Verstraete, Ph.D.....	361
<i>Wonder to Exploration: A Collaborative Effort Between a WISE Program and the Girl Scouts to Introduce Girls to Engineering</i> Angela Middleton, Stephanie Blaisdell, and Mary Anderson-Rowland, Ph.D.....	365
<i>Early Cooperative Work Experience: A Comparison for Male and Female Freshmen Engineering Students</i> Laura L. Sullivan, Ph.D. and S. James.....	369
<i>Idaho JEMS: A Pre-College Engineering Experience for High School Students</i> Jean A. Teasdale, Ph.D.....	373
<i>Armed and Dangerous: Camp GMI, A Place for Girls</i> Edith Withey.....	377

#### APPENDICES

A:	WEPAN National Conference Participants.....	381
B:	WEPAN National Conference Program At-A-Glance.....	399
C:	WEPAN Annual Business Meeting.....	403
D:	WEPAN Action Group Meetings.....	409
	Faculty	
	International	
	Research, Evaluation, and Dissemination	
E:	Indexes.....	417
	Author Index	
	Organization Index	



## EVALUATION: INTERACTIVE HANDS-ON PLANNING

### Moderator

Dorie McCubbrey, Ph.D.  
Director, Women in Engineering Program  
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Dorie McCubbrey has a Bachelor's degree and a Master's degree in Mechanical Engineering and a Ph.D. in Bioengineering from the University of Michigan. She is currently employed as the Director of the Women in Engineering Program at the University of Akron, a position which she has held since August of 1994. She also serves as the counselor for the University's student section of the Society of Women Engineers. She is an active member of WEPAN, SWE, the American Society for Engineering Education (ASEE), and the American Society of Biomechanics (ASB).

### Presenters

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## AGRED PRE-CONFERENCE EVALUATION WORKSHOP

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Over the past several years evaluation of Women in Engineering Program (hereafter, WIE) activities has become increasingly important. Program directors and those to whom they report want to be able to make informed decisions about their efforts based on answers to the question: "Which kinds of initiatives work best to increase recruitment and retention of women in engineering?" Furthermore, the organizational need for evaluation goes beyond interests of program directors and personnel. Increasingly, funding agencies require that funds be set aside for evaluation. In response to these imperatives, WEPAN has incorporated evaluation into regional training seminars, added this workshop to the conference program, and supported compilation of an Evaluation Resource Book.

Since the 1960s, social scientists have been involved in evaluating many different kinds of social programs, ranging from poverty relief (such as "Head Start") to efforts that attempt to address race and gender equity issues. The methodologies of evaluation are standard social science research practices with an emphasis on special problems faced by applied researchers who must work in the "real" world rather than the "ivory tower" world of academia. As money for various initiatives has become more scarce, funding agencies are interested in verifying that interventions they support accomplish intended goals (e.g. summative evaluation). However, evaluation can also be an important tool for people who are involved in the day-to-day operation of social interventions such as WIE Programs. In this regard, formative evaluation strategies can be built into activities and used to continuously monitor and improve initiatives.

Although there are a few graduate level programs focussed on program evaluation in the U.S., most evaluation experts are drawn from the ranks of the social sciences or from education and business schools. There are several professional journals dedicated to program evaluation as well as a professional society. Program evaluation as a discipline is still comparatively young, program evaluators have recently turned their attention to dwelling on program evaluation theory.

This paper summarizes the WEPAN AGRED Pre-Conference Evaluation Workshop. The workshop consisted of three general segments dealing with evaluation: Background, Process, and Reporting Results. In addition to broad outlines of material covered in each of these segments, we have also included a brief, annotated bibliography of program evaluation and methodology sources for WIE personnel.

## Background Information on Program Evaluation

Irene F. Goodman, Ed.D. and Colleen F. Manning, M.A.

Goodman Research Group, Inc.  
Cambridge, Massachusetts

- I. What is evaluation? When you hear the word "evaluation" what do you think of?
- II. Results from Participant Surveys and Interviews Conducted by Goodman Research Group
  - A. What do participants want to know about programs and/or components?
  - B. How are participants currently evaluating programs and/or components?
  - C. What are the challenges to carrying out evaluation?
  - D. Budget for evaluation
- III. Why Do Evaluation?
  - A. External
    - 1. Program development, planning, and accountability
    - 2. For your funders/clients
  - B. Management-oriented (risk-taking)
    - 1. Program enhancement
    - 2. Making program more responsive to users' needs
  - C. Shaping policy at both the program and institutional levels
  - D. Identifying promising innovations and best practices
- IV. What Are You Evaluating?
  - A. Program goals and objectives
  - B. Evaluating entire programs versus individual program components
- V. When Are You Evaluating Your Program?  
(Phases of Program Development and Corresponding Evaluation)
  - A. Conceptualization
  - B. Design
  - C. Planning
  - D. Implementation
- VI. Types of Evaluation
  - A. Needs assessment/feasibility study
  - B. Formative
  - C. Summative
    - 1. Process
    - 2. Outcome
    - 3. Impact
    - 4. Cost-Benefit

## The Process of Evaluation

Lisa M. Frehill, Ph. D.  
New Mexico State University  
Las Cruces, New Mexico

- I. Define Objectives
  - A. Who are your stakeholders? How do these stakeholders define success?
  - B. Types of Outcomes and Measures of Success
    - 1. Reflect stakeholder interests.
    - 2. Source of help WEPAN Evaluation Resource Book
- II. Plan
  - A. Examine desired outcomes - develop measures of success.
    - 1. Validity: are the measures you've decided to use considered appropriate and believable by your stakeholders?
    - 2. Reliability: are your measures replicable? That is, if you use the measure this year with one group of people, will you be able to use the same measure next year with another group?
  - B. Locate/establish a "control" group for comparisons.
  - C. Administration: Who gets asked & how?
    - 1. Who:
      - a. Response Bias
      - b. Random Sampling.
    - 2. How:
      - a. Surveys
      - b. Focus Groups
      - c. Field Research
- III. Collect and Analyze Data
  - A. Collection procedures: methods listed above are well documented (see bibliography).
  - B. Data management.
  - C. Analysis: GROUP comparisons: "treatment" and "control" are essential.
    - 1. Keep analysis SIMPLE - frequencies and cross-tabulations.
    - 2. More complex analysis can also be useful. Seek assistance, refer to WEPAN Evaluation Resource Book.

### Reporting Evaluation Results

Emily M. Wadsworth, Ph. D.  
Purdue University  
West Lafayette, Indiana

#### I. Questions and Answers

- A. How can you set up results?
1. Plan in advance how to analyze data when first creating activities.
  2. Make decisions on format: table, graph, and/or chart.
  3. Outline mock tables, graphs, and/or charts - have ready for when your findings are available.
  4. Example: Videotape Effort at Purdue University.
- B. How can you simplify results?
1. Look at results over a short or long period of time for one program activity.
  2. Example: Note the number of participants in a recruitment effort, then calculate the percentage of those students who enroll.
  3. Example: Videotape Effort at Purdue University.
- C. How can you synthesize results?
1. Set up a design for one program activity.
  2. Randomly select and assign female engineering students to "program activity" and "non-program activity" groups.
  3. Conduct formative evaluations at end of monthly events and annual summative evaluations of activities.
  4. Compile results from the initiative.
  5. Assess retention rates of "program activity" and "non-program activity" groups.
  6. Example: Undergraduate M&M Mentoring Program at Purdue University.
- D. How do you interpret results?
1. Quantitative and/or qualitative?
  2. Look for commonalities in findings.
  3. Example: Personal Connection Program at Purdue University.
- E. How do you report results?
1. Construct a one-page sheet: objectives, results, and future plans of program activities.
    - a. Intended audience: program staff, department heads, and deans.
    - b. Example: Sloan Initiatives at Purdue University.
  2. More detailed description: summarize results; relate goals and objectives; describe activities; review methods; discuss findings; give conclusions; and make recommendations.
    - a. Intended audience: Funding agencies, sponsors, etc.
    - b. Example: Annual Report to the Sloan Foundation.

- F. How can you utilize results?
  - 1. Internal Distribution: directors, faculty, department and division heads, deans, and other administrators
  - 2. External Distribution
    - a. Annual report: private foundations, governmental agencies, state organizations, community groups, and alumni.
    - b. Present papers at conferences (such as WEPAN) Submit papers to professional publications.
  - 3. Maintain a database to track retention of program activity participants.

II. Regional Reports

- A. Western Region: Susie Laurich-McIntyre - Center Results.
- B. Midwestern Region: Cinda-Sue Davis - University Results.
- C. Eastern Region: Michelle Fish - National Effort.

III. Future Directions for Evaluation

- A. Standardization of measures used for evaluation.
- B. Comparisons within and across institutions - using standard measures.

CONCLUSIONS

Evaluation of Women in Engineering Programs and/or activities provides professionals with information that can underscore objectives, document achievements, shape policies, and be used to obtain funds. The process of evaluation involves measuring success as defined by a diverse group of stakeholders such as students, directors, faculty members, department heads, deans, university presidents, and/or sponsoring organizations. The important steps to consider in evaluation are: identifying goals; establishing comparison groups; developing instruments (measures); administering surveys, interviewing, etc. to obtain information; and then analyzing the data that has been collected.

Administrators need to plan in advance for evaluation. This plan needs to specify how results will be set up and presented, how the process can be simplified, and what can be done to synthesize findings and interpret outcomes. Planning evaluation makes compilation of results into a report more straight-forward. These reports can be important both internally and externally for the benefit of the program.

Finally, in order to advance the state-of-the-art of evaluation of Women in Engineering Programs and/or activities, professionals should consider using standard measures and instruments. Such standard measures will enable comparisons both within and between institutions.

### PROGRAM EVALUATION: PARTIAL BIBLIOGRAPHY

Denzin, Norman K. and Yvonna S. Lincoln (eds.). 1994. Handbook of Qualitative Research. (Thousand Oaks, CA: Sage).

Qualitative methodologies have come far in the past twenty years and social scientists have established guidelines and standards for their use. This volume features excellent articles about many qualitative techniques, including a review article by Greene on qualitative methods for program evaluation.

Michael, Robert T., John H. Gagnon, Edward O. Laumann and Gina Kolata. 1994. Sex in America: A Definitive Survey. (Boston, MA: Little, Brown).

This guide to the findings of the only scientifically gathered information about sexual practices in the U.S. was written for the "lay" person (a more technical version was written for academics). The first 41 pages are an excellent and readable review of the methodological issues confronted by survey researchers.

Monette, Duane R., Thomas J. Sullivan, and Cornell R. DeJong. 1994. Applied Social Research: Tool for the Social Services. (Fort Worth, TX: Harcourt, Brace College Publishers).

Of the many social research methods textbooks available, a book such as this is ideal for people in social service. Written for social work students with an emphasis on applied practice, this book reviews the many social science research methods. The numerous case studies are helpful and the text clearly reviews the advantages and disadvantages of the various methods of research.

Rossi, P. H. and H. E. Freeman. 1985. Evaluation: A Systematic Approach (Newbury Park, CA: Sage).

This is the standard program evaluation textbook, which may be a good reference, but you should plan on having other sources about specific research methods to supplement this information. Rossi and Freeman give very little of the "step-by-step" advice that you will need to receive from other sources.

Rossi, Peter H., James D. Wright and Andy B. Anderson. 1983. Handbook of Survey Research. (Orlando, FL: Academic Press).

If you plan to do survey research, this compilation of more than fifty years of social scientific research is indispensable. This book is not written for the "lay" reader, but those with a moderate mathematics background should have no problem with this book. A newer edition should provide more information about the use of computers.


Quill, Joyce. 1992. "Using Consultants in Evaluation Research: A Client's Perspective." Evaluation and Program Planning 15: 67-69.

A good guide with useful hints, this article is helpful if you plan to bring in outside evaluators.

Sichel, Joyce. 1982. Program Evaluation Guidelines: A Research Handbook for Agency Personnel. (New York, NY: Human Sciences Press).

Although some advice is a bit dated, this is a helpful, no-nonsense overview of evaluation for practitioners. This guide gives good ideas for evaluation but takes a rather limited view of evaluation, given the greater breadth of evaluation research since its publication.

Note: The Sage (publisher) series on program evaluation contains little procedural guidance and assumes readers have a good research methods background.

 OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## STEPS TO LEADERSHIP SUCCESS

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Every single one of us can become an effective leader. But it takes hard work and commitment. I would like to share with you some steps I believe we each can take to become successful leaders. I have identified seven steps that I think are key:

1. Just do it
2. Believe in yourself and your ideas
3. Communicate
4. Value each person and her ideas
5. Have high expectations
6. Love and serve others
7. Say "Thank you."

### 1. As the Nike commercial says "Just do it."

In my opinion, as important as any other leadership skill is the ability to take action. This action is probably in an area where you have a passion, and I strongly believe that one person can make a difference. Candy Lightner founded Mothers Against Drunk Driving in 1980 after her 13-year old daughter, Cari was hit from behind and killed by a drunk driver. This was one person with a passion, a sense of purpose, a stick-to-itiveness that didn't take no for an answer. Look at the organization she has spawned.

And then there is Thelma Sibley. After her five-year old daughter Nancy was killed when a drawstring in her coat got snagged on the playground, Thelma embarked on a letter writing campaign to 128 clothing manufacturers as well as government agencies, news organizations, and prominent individuals including Hillary Rodham Clinton and Tipper Gore. One federal agency, the Consumer Product Safety Commission and its chief, Ann Brown, persuaded 32 clothing manufacturers to voluntarily remove the drawstrings. Did this happen overnight? No, it took almost two years. Thelma had decided taking action to prevent this occurrence from ever happening to someone else's child was her way, not suing a clothing manufacturer. And, it became her passion, her "fire in the belly."

Think about people of whom you are aware that have made a difference. This list might include Gandhi, Mother Teresa, and Martin Luther King. Other people who would merit being on such a list are Dr. Virginia Apgar, Rachel Carson, Admiral Grace Murray Hopper, Lucretia Mott, and Sojourner Truth, all of whom have been inducted into the National Women's Hall of Fame to recognize their accomplishments. In fact, Admiral Hopper embodied the "Just do it" philosophy with her saying that it is always easier to ask forgiveness than to ask permission.

I have seen many examples of the “Just do it” aspect of leadership within the Society of Women Engineers (SWE). Mary Rogers of the Santa Clara Valley Section has a passion for scholarships and an in-depth knowledge of fund development techniques. Each year she raises \$20-40,000 for scholarships that are awarded to deserving young women who plan to study engineering.

Mary McCarthy, also of the Santa Clara Valley Section has a passion for teaching young people about math and science. She brought the 4-H and SWE together in California and eventually on a national basis to enable such 4-H programs as “Sciencing with Snails” and “Planted Earth” to reach more students.

Terri Morse of the Pacific Northwest Section conceptualized and worked hard to establish the Boeing Team Tech Competition in SWE. This annual contest, with prize money, emphasizes the key role of teamwork and interface with industry in the engineering educational process. Competing teams of from four to twelve students are evaluated on 1) the ability of the team to work together, 2) use of engineering processes, 3) product, 4) the quality of the results, and 5) the ability of the team to work with industry. Competitions have been ongoing since 1992.

There are many other examples of leaders within organizations like SWE and the Women in Engineering Program Advocates Network (WEPAN) who acted on their passions. The dedication of the founders made both organizations possible. Many individuals, such as Miriam Maslanik from the Women in Engineering Program at the University of Colorado-Boulder, have decided that their city could host a conference and, lo and behold, the conference was held in their city. Scholarships have been envisioned, funds raised, and endowments established through the efforts of passionate individuals.

I recently heard a story about Katherine Drexel of the Drexel furniture family. Apparently she was a very religious Catholic, who was concerned about the plight of Native American education. During a visit to the Pope, she asked him “What can you do about the education of the Indian children?” His response was “What can you do about this problem, Sister?” She came back to the U.S. and had schools built for the children’s education. She was now responsible, and had become a leader.

Katherine Drexel now also understood that she could do something about the problem she had seen. We need to learn from this story that we don’t need to wait until someone tells us to do something; we don’t have to wait to be empowered or wait for permission to be empowered. We each have the ability to grab the ball and run with it, now. Just do it!

It is almost always easier to complain about situations than to take action, and it is also easier to expect others to fix problems. But to be a leader, we must each take responsibility to fix problems, to make the world a better place. We must, as leaders, do the difficult things and own them. We must set an example by what we do. Determination, focus, and hard work. Remember, “The harder I work, the luckier I get.” And from the book of Proverbs, “Hard work always yields its profit; idle talk brings only want (Proverbs 14:23, The Jerusalem Bible)” and “Diligence brings a man to power. (Proverbs 12:24, The New English Bible)” Don’t talk about it endlessly. Just do it! And do it now!

## **2. Believe in yourself and your ideas.**

Abraham Lincoln said in 1858 when he was nominated to run for the U.S. Senate “a house divided against itself cannot stand.” These were very powerful words that

**WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY’S CHALLENGES**  
**1996 WEPAN National Conference**

communicated his position to others. Leaders assume power, that power is not granted. Think about who takes the leadership role in a volunteer setting - probably the person who believes that she can accomplish the task at hand. Those people usually radiate self-confidence. Because they believe in themselves, tremendous energy comes through and others pick up on that energy. Note that we are not talking about arrogance. I want to give you an example that I always think about when I come to the concept of belief in oneself.

Gina Holland, another SWE member from Denver, and I caught a cab in New York to the airport. The cab driver was very concerned because the traffic was very heavy, it was hot outside, his heat indicator was going up, and he was afraid his car was going to overheat. Gina told him that by turning up the heat all the way, he wouldn't overheat the car. He did not want to do this. I very calmly told him that she knew what she was talking about. (Of course, I did not know why he should do this.) Several times, insistently, I repeated that, yes, I knew that it was hot outside, but, he needed to turn up the heat. Well, he did finally turn up the heat, was amazed that his cab did not overheat, and we made it to the airport. I could tell that Gina knew what she was talking about and that we had to convince the cab driver or end up with an overheated cab. She believed, and thus I believed in her. I later found out why this was the right solution - the fan moves hot air off the engine into the car when the heat is turned on.

You can do what you set your mind to, if you believe in yourself and what you want to accomplish. And you can practice the WOWSE concept - I will move forward to do this "With or without someone else." A leader must be so committed to an idea that she will do it WOWSE. She will do whatever it takes to see the concept through - none of the "This is not my job" attitude. She will lead by example. Everything becomes one's job from the stuffing and stamping of envelopes to accepting and presenting large checks - the good, and the bad. A good leader does not ask anyone to do something she is not willing to do herself. A good leader pitches in on anything and everything that needs to be done. As Harvey Firestone said, "You get the best out of others when you give the best of yourself."

Now this does not mean that you know all the answers or aren't afraid of certain situations. If we wait to deal with all of our fears or wait for them all to disappear before taking action, we will probably never get started. Fear of failure is normal. Successful leaders are highly motivated not to fail. Waiting for the perfect time is a great excuse and rationalization not to move forward from where you are.

### 3. Communicate

There are a couple of really key points here. Remember, first and foremost, communication is both listening and speaking; not just speaking - listening is very important! One cannot truly communicate without both listening and expressing oneself.

And when you do talk or write always communicate the truth, without hiding information. People can sense if you are hiding the truth. Only when you are open does trust, love, and learning begin. Do not have a hidden agenda - no secrets. Behaving secretly indicates a lack of trust and arrogance which tends to breed resentment and retaliation. Again from the book of Proverbs, "The upright man is secure in his own honesty (Proverbs 14:32b, The New English Bible)."

Trust will be built when you behave as follows: listen, remember the little things, keep promises, clarify expectations, be loyal, admit when you are wrong, and admit that you don't know. These are, of course, also the seeds of friendship.

Keep people informed and include everyone who has or might have a need to know. It is better to tell some people about a topic in which they are not included (or interested) than to exclude someone who really did need to know.

I want to relate a story from my term as SWE President. Admiral Grace Murray Hopper, the 1964 SWE Achievement Award recipient, received the National Medal of Technology from President Bush in September 1991, having been nominated for that award by SWE. She died shortly thereafter. At the Board of Directors meeting in early 1992, we discussed the concept of endowing a scholarship in her name, decided it was a good idea, and determined that I would take the lead in the fundraising effort. Mary Rogers, the fund development chair, and I discussed how we would solicit funds from the members of SWE; our plan required the cooperation of and work efforts from each director. I called and talked to each director telling her what I was planning to do and what I was asking her to do. Every single director jumped on the band wagon and promised her support to this project. It was a wonderful experience for me. One scholarship was endowed in 1992 and three are now endowed. You better believe that I wrote thank you notes (see step 7)! It was an eye-opening and confirming experience for me.

#### **4. Value each person and her ideas.**

Each person has value and her ideas have merit as well. In the current environment, this might be called "diversity". Treat everyone as an equal, treat them as you wish to be treated, value them personally, and listen to their ideas.

During the time that I served as SWE President, there was one particular member of the Board whose views were almost always different from the rest of the Board. Sometimes others on the Board did not want to hear her opinions because they were so different. But I believed then and still believe that it was very important to listen to her views because by doing so we were able to consider different outlooks and make better decisions.

I have discovered that by treating everyone fairly, with caring, and with value, they will respect you and actually be happy to help you with your requests. In addition, you will be able to function better within a team. Again the book of Proverbs provides guidance in this area "The tongue has the power of life and death; make friends with it and enjoy its fruits (Proverbs 18:21 The New English Bible)."

The results of your work efforts will also be better because many different viewpoints will have been considered and incorporated in the process of coming to decisions. People who are engineers approach problems differently than people who are lawyers or accountants or marketers. And as most of us now admit, women and men approach problems differently. This is, of course, why female directors on corporate Boards of Directors should be actively sought, to help those Boards make better decisions.

People have different dominant thought processes which experts label as 1) analytical, 2) structural, 3) self-awareness, and 4) conceptual. Through having complete teams with representation from each process (referred to as whole brain teams), better results can be obtained. Value diversity and the ideas that each person brings.

#### **5. Have high expectations**

My experience truly demonstrates that people perform up to high expectations and down to low expectations. But people wish to be challenged, to push a little harder and have the feeling of success associated with meeting high, but not unreasonable, expectations.

In conjunction with high expectations, people will need to be held accountable for their efforts. Accountability has been called the cornerstone of empowerment and personal growth. If a person is not held accountable for the results of a specific effort, he or she will not have the benefit of the growth and experience of the effort itself. As people accomplish projects for which they have been responsible and held accountable, they will gain self-confidence and become increasingly successful. When negative feedback is required, make sure positive comments are given first - "A spoonful of sugar helps the medicine go down." People are more receptive to hearing something negative if something positive is said first.

Although people need to be held accountable, good leaders do not let them "sink or swim." If a person is having trouble completing a project or assignment, a good leader will be around to answer questions, suggest alternatives, and provide direction. All good leaders offer encouragement and urge people on so that they may have successful experiences. A Wise Man once said "A lot of people have gone further than they thought they could because someone else thought they could." Good leaders stay in contact, not to do the work themselves, but to be available for support and guidance.

#### **6. Love and serve others.**

This step to leadership success ties directly into valuing each person and her ideas. When you genuinely care for other people and demonstrate this through your actions, helping them with their problems and listening to them, the love and service they will return can be amazing.

I realize that not everyone is capable of receiving or returning that love, respect, or trust, but the overwhelming majority of people will. Don't get discouraged by a few bad apples!

You have probably heard the saying, befriend the secretary because she is really in charge and you can get anything you want and need. What this says to me is by being sincerely interested in other people and caring around them, and believe me our antennas detect insincerity in others in a split second, others return our friendship and wish to love and serve us as well.

#### **7. Say "Thank you"**

My former assistant used to display an article on her door comparing two ten-item lists, the first was what employees wanted from their employers and the second was a list of what employers thought employees wanted. The first item that employers thought employees wanted was money. But what did employees want? First and foremost, appreciation. A thank you. A pat on the back. A gold star. Recognition for a job well done. An atta-girl or an atta-boy. Zig Ziglar said "A sincere compliment is one of the most effective teaching and motivational methods in existence."

I was raised to always say thank you. As SWE President, I took the time to write many hand-written thank-you notes. This helped to demonstrate my appreciation to many people for their efforts. I had taken my time to remember to thank them for their actions. And I believe that time spent saying thank you is always repaid many times over by those thanked.

## Conclusions

I do not think and I will not tell you that taking these steps for leadership success are always easy or fun. They take much hard work and must reflect a passion in what you are doing. However, I do think that following these seven steps:

1. Just do it,
2. Believe in yourself and your ideas.
3. Communicate,
4. Value each person and her ideas.
5. Have high expectations.
6. Love and serve others, and
7. Say "Thank you."

will help make you a successful leader.

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## Biography

Jill S. Baylor, P. E. is an Assistant Vice President with Stone & Webster Management Consultants where she specializes in utility planning. She served as the National President of the Society of Women Engineers 1991-1992. She is currently a member of the Board of Directors of WEPAN.

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## CLASSROOM CLIMATE REVISITED

### Keynote

Bernice R. Sandler, Ph.D.

Senior Scholar in Residence

National Association for Women in Education

Dr. Bernice R. Sandler is a Senior Scholar in Residence at the National Association for Women in Education (NAWE), where she consults with colleges about achieving equity for women on campus, and edits a quarterly newsletter, *About Women on Campus*. Dr. Sandler has a long list of firsts, such as first reports on campus sexual harassment, gang rape, campus peer harassment, and a series on the chilly climate for women, including the first report on how men and women are treated differently in the classroom. She played a major role in the development and passage of Title IX. She has served on more than thirty boards, has nine honorary doctorates and has received numerous awards.





## THE CHILLY CLIMATE

Bernice R. Sandler

National Association for Women in Education  
Washington, District of Columbia

### INTRODUCTION

Over the last twenty five years we have eliminated many of the overt barriers that deprived girls and women in education. We thought that was all we had to do: open the doors and everything would be equal. We were wrong, for there are still many hidden barriers, barriers which are almost invisible to students and to faculty -- indeed most of the time both faculty and students are unaware that anything unusual is occurring. Yet the classroom is not a place of equality. The classroom is very different for girls and boys, women and men. Even though they may sit side by side in the same classroom, males and females often have very different experiences.

Women students are treated differently, by men and women faculty alike, as well as by their fellow students--in ways which ultimately undermine girls' and women's self confidence in their academic ability, lower their academic and occupational aspirations, inhibit their learning, and generally lower their self-esteem.

What I want to talk about today is how male and female students are treated differently in the classroom, and how male and female students themselves may act differently, so that ultimately, perhaps, we can begin to see what still needs to be done to make coeducation truly equal.

When I talk about women and girls, today, I mean all females, of all races and ethnicity. And I want to add here that minority men are often treated in the same way.

The behaviors I'm talking about today are not limited to males. Often women faculty and staff and other female students may engage in these behaviors; even those who are the most concerned about discrimination may unknowingly treat male and female students differently.

The behaviors do not happen in every class, nor do they happen all the time. Individually, by themselves, the behaviors are generally small and seemingly not important. But when they happen again and again, they constitute a pattern of behavior that dampens women's

ambitions, their classroom participation and self-confidence.

I'm not going to talk today about the most overt kinds of behavior. Although they have diminished greatly in the last twenty years or so, they still happen. These behaviors include making disparaging comments about scholarship by or about women. Indeed, sometimes when a student raises women's issues, faculty are hostile and ridiculing, thereby effectively silencing the student from speaking about women again, and perhaps silencing her altogether.

### TREATMENT IN THE CLASSROOM

Let me start with how teachers often treat male and female students differently. You can check out these behaviors in your own classes, and in some instances students may behave this way too. Sometimes you can see the same behavior at a committee meeting.

Faculty members generally call on men more often, asking them more questions, and not calling on females as much, even when they raise their hands. White males generally get the most questions, then minority males, then white females, with black females receiving the least.

Faculty members generally pay more attention to male students. They may stand closer to males students. Professors nod and gesture when males speak, but may look elsewhere when females talk.

Teachers are more responsive to comments and answers from males than from females. Men get more feedback, more praise, more criticism, more help. In other words, when a male speaks the teacher is likely to engage in a dialogue; when females speak, they are more likely to get "uh-huh" which says nothing other than "You said something and I heard it." For some females the only praise they get from teachers is for their attractiveness or for neat work. Males are more likely to be praised for their achievements and intellectual effort, not for the way they dress.

Teachers, male and female, give women less eye contact. Eye contact is very reinforcing because it tells students that the teacher is concerned about their understanding the material and is checking to see if they are paying attention. Recently I noticed that during workshops I give on the chilly classroom, that I only looked at my watch when women were talking, I never looked at my watch when males were speaking; I gave them my full attention.

Men get more coaching -- "Tell me more about that," or "Why do you think that is?" -- words that tell the person that he has more things to say, that his intellectual effort is worthwhile.

Men are called by name more often -- it makes people feel good in conversation when they

are called by name, particularly by a person of higher status such as a teacher or administrator.

Males and females may be asked different kinds of questions -- Females are more likely to be asked factual questions, such as, "Who discovered radiation?" Men and boys are more likely to be asked harder and more open-ended questions, such as, "What is radiation?" -- the kind of question where students can really shine if they know the answer, and can try to fake it if they don't.

Courtesy and politeness may be used as a way to patronize women students -- particularly when used in a paternalistic or patronizing manner, as in "We have a group of lovely ladies in our classroom." This shifts the focus away from intellectual activities to social behavior, simultaneously trivializing women students as well as setting different expectations from them compared to men.

Males (students and teachers) may perform a task for a woman student under the guise of being helpful -- "Let me do it for you," but thereby depriving her of hands-on experience (as in a laboratory experiment). At the same time this communicates their own low expectations of the woman's ability to complete the task on her own.

Men (faculty and students) interrupt women more than they interrupt men. Additionally, women may be particularly vulnerable when they are interrupted. One study at Harvard noted that once a woman was interrupted, she tended to stay out of the discussion for the remainder of the class, and thus there are more one-time female contributors than male.

### THE INFLUENCE OF GENDER ON BEHAVIOR

I want to talk next about some of the differences between men and women and how these differences can also create a chilly climate for women and girls in the classroom.

I'm going to talk in generalizations, and of course, generalizations are always subject to criticism. Certainly not all men behave in a certain way, and certainly not all women behave in a certain way. But it is just as true to say, for instance, that many women (or many men) are more likely to behave in one way more of the time than men (or many women). Such generalizations can help us understand some of the classroom behaviors faculty members and students engage in, and how gender often (but not always and certainly not solely) shapes what happens in the classroom.

Although most of us like to believe we are free of sexist prejudices, stereotypes and biases, each of us has deeply buried beliefs and expectations of which we may be unaware. Despite our conscious beliefs that men and women are "equal" we may nevertheless value men who are strong and assertive, and may be uncomfortable with women who act the same, because we expect them to be more passive and acquiescent, nurturing and nice.

Many of our gender expectations are subtle. Women are expected to be more modest about their achievements; men are expected to brag. In conversation, men are expected to analyze, explain, clarify, and control the topic and flow. In contrast, women are expected to reinforce and maintain the conversation, to reduce tensions and restore unity.

Men generally are more competitive in a classroom, speaking more often than females, trying to impress others. Often they try to be in charge, particularly when there are small groups of students working together, as in study groups or in lab groups.

Male students are more likely to be concerned about autonomy and prefer to interact with others through competition and power. Women students are more likely to be concerned about connecting to other people and developing relationships and are more likely to interact by cooperating and synthesizing. Thus females may be uncomfortable when men or women assert their autonomy; men may be uncomfortable when women or men try to establish some level of intimacy. (Of course, everyone has autonomy and intimacy needs, but in most people, one or the other will predominate in their behavior.)

Women are more likely to seek intimacy, friendship, and community; men are more likely to seek power and status. More men than women enjoy competitive verbal sparring and controversy; a classroom which stresses intellectual competition makes them feel good. In contrast, females often present information in a way that invites others' opinions rather than defend a single viewpoint.

Women tend to raise their hands when they want to ask or respond to a question. Men are more likely to quickly call out the answer without waiting to be called on--a pattern of behavior which has the effect of limiting women's contributions.

### DEVALUATION

Male and female behaviors are perceived very differently. I want to talk for a moment about devaluation. Throughout our society, what girls and women do is seen as less valuable than what men do.

There have been numerous experiments in which two groups of people rate things such as a set of articles, pictures of works of art, a set of resumes. The names of the authors are changed for each group. Those items for the first group which have men's names, have women's names for the second group, and those items with women's names for the first group have men's names for the second group. In other words, the gender of the author is reversed for each group. The results of these studies are remarkably consistent: Articles that have a male name attached to them tend to get higher ratings than when the same article has a woman's name. Both men and women do this: They devalue those items ascribed to females. Studies of how women's success is perceived show a similar pattern: Men's success is attributed to talent; women's success is attributed to luck.

Women may be seen as less bright because they may speak in a more polite, hesitant and deferential manner, while men may be seen as brighter because the valued speech is strong, concise, clear, and assertive, the way that many men speak.

Even when men and women behave the same, women's behavior may be devalued. For example, males value verbal aggression as positive, except when women speak that way. Silence itself may be viewed differently for men and women. Men who are silent may be viewed as "thinking." Women who are silent may be viewed as shy or not knowing much.

## HARASSMENT

The last thing I want to talk about may make some of you uncomfortable, maybe even angry. Some people may even want to accuse me of male-bashing. Because what I want to talk about next is the way in which students often treat each other, particularly male students harassing female students. Do you remember when it was okay for the boys to tease the girls? People laughed -- or at least the boys laughed. The girls may have been uncomfortable, but no one took this kind of teasing seriously. In fact, many people thought of it -- and some do -- as cute, as "boys will be boys", as normal, natural behavior. Remember the rhyme: Georgie Porgy, pudding and pie, kissed the girls and made them cry." Well, this kind of behavior, a kind of sexual bullying -- is not okay anymore. When big boys do it, in the workplace, or in colleges, it is illegal. Sexual harassment, whether it occurs in the classroom or outside of it, makes coeducation less equal for girls and women. Between 70-90 percent of undergraduate women report that they have experienced at least one sexual incident from one or more male students to which they reacted negatively and viewed as a serious incident.

Student-to-student harassment is one of the most explosive issues on campus. Many times male students harass women students both sexually and otherwise; they may push women away from the computers; they may roll their eyes and show other negative body language when some women speak; they may tell women that they don't "belong" in physics, in mathematics, or in engineering. Some may even hiss or boo when women raise women's issues. They may make blatantly sexist remarks by denigrating or ridiculing women, engaging in rude behaviors that express hostility to women in the classroom or to women in general.

If these behaviors are overlooked, if there is no discussion or other response to behavior demeaning to females, the message to men and women in the classroom is clear: Such behaviors are acceptable.

## CREATING EQUITY

One of the major issues which must be faced in the coming century is that of gender and race in the classroom: how do we bring about classroom equity? For it is clear that men and

women sitting in the same classroom do not receive the same education; despite the good intentions of faculty members, the classroom experiences of women, shaped by gender and race, are often different from those of their brothers who sit by their sides.

Many people have noted the advantage of single sex education for females, and suggest that this is the way to insure that women receive a good education. Indeed, there is a small but growing body of research that suggests that women often learn better, participate more and have greater self-esteem when educated in single sex institutions. There is also a tiny body of research that suggests that single sex education for males has either no effect or a negative effect, suggesting that men need coeducation and women need single sex education.

The ultimate question, however, is not whether single sex education or coeducation as we know it is better for women or not, but whether we can improve coeducation so that it is truly coeducational, so that women and men alike can benefit equally from it.

### CONCLUSION

Many years ago, back in 1972, when I worked for the passage of Title IX, the law that prohibits sexual discrimination in most educational institutions, I thought it would take about two years and we would solve all the discrimination that existed. After two years, it was clear, that we needed at least another year, and then another two, and then I thought in the next five years, then fifty years --- I no longer think it will come easily or quickly. We are talking about changing the relationships between men and women, toward making them more equal -- a social change which ultimately will have as much impact as the Industrial Revolution.

The relationships between men and women are changing. We, women and men, are a generation of transition. We are giving up old ways of relating to each other and are not quite sure what the new ways ought to be.

Let me close now with a newly discovered "Biblical" revelation which is symbolic of the new mood of women and which was discovered by a woman archeologist, accompanied by an all women team of assistants. And you will probably recognize the paraphrase:

And they shall beat their pots and pans into printing presses  
And weave their cloth into protest banners  
Nations of women shall lift up their voices with other women  
Neither shall they suffer discrimination any more.

That may sound apocryphal, but I suspect it may yet prove to come from the book of Prophets, for what women are learning is the politics of power and the politics of change. This school, and other schools, and the nation, and the world, will never again be the same.

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**UTILIZING RESOURCES EFFECTIVELY: FROM THE LIBRARY TO THE  
WORLD WIDE WEB**

**Moderator**

**Karan Watson, Ph.D.**

Associate Dean of Engineering and  
Professor of Electrical Engineering  
Texas A&M University

Karan Watson is currently on the WEPAN Board of Directors and serves as the National Treasurer. She is a professor of electrical engineering and the Associate Dean of Engineering at Texas A&M University. She serves as the national coordinator for the Foundation Coalition efforts to recruit, retain and graduate more minorities and women in engineering.

**Presenters**

**Tanya L. Zanish**

Curator, Archives of Women in Science and Engineering  
Iowa State University

**Lisa J. Oliveira**

Director of Admissions  
Horace Mann School



## SORTING THE WHEAT FROM THE CHAFF: LOCATING AND USING RESOURCES FOR WOMEN

Tanya L. Zanish

Archives of Women in Science and Engineering  
Iowa State University, Ames, Iowa

The twentieth century has been referred to as the information age, and we see constant references to the growth and influence of the information superhighway. In this new technological culture, knowledge equals power and it is to our every advantage to learn how to navigate our way through the mountains of data and locate what will aid us in our careers and lives.

As women we face multiple barriers in the modern world. At a recent conference, librarian Joan Challinor said "If women are to assert their rightful place in the world's evolving social, intellectual, political, and economic systems, they must investigate the issue of their access to and use of the world's growing information base." The value of information for functioning efficiently in American society has become increasingly clear in the last thirty years.

The impact of the revitalized women's movement of the 1960s cannot be underestimated - culturally, politically, socially, or historically. The publication of Betty Friedan's "The Feminine Mystique" in 1963 touched a sensitive nerve in the American psyche. The women's movement brought a new interest to women's issues; and stimulated the development of numerous women's studies programs and a social history that, for the first time, focused on the role of women. The result for today's researcher is a plethora of materials on women in the form of published and unpublished materials.

Sifting through these materials and finding helpful resources is a time consuming process, and therefore it is worthwhile to focus our attention on learning to quickly evaluate sources and locating organizations that will provide the information that we need. What should women in engineering look for, in regards to the resources currently available?

1. Archival and historical collections

Can include pamphlets, ephemera, correspondence, photographs

2. Articles and Periodicals

3. Bibliographies and bibliographic databases

Bibliographies can be located in either published form, or at the end of a published book or article. There are also national databases, such as OCLC and RLIN that can locate materials throughout the United States.

4. the Internet - discussion lists and the World Wide Web

5. Library indexes

6. Organizational newsletters and statistics

7. Reports and working papers

8. Secondary books

The next part of this discussion will focus on some examples of the resources currently available, not only for women in general, but specifically targeted to women in engineering. There are resources out there, it only requires some time and inclination to ferret them out.

**Repositories with collections related to women in engineering**

Archives of Women in Science and Engineering (Iowa State University); Cornell University; Harvard University - Schlesinger Library, History of Women in America; Library of Congress; Massachusetts Institute of Technology; Pennsylvania State University; University of California at Berkeley; University of Colorado; University of Michigan at Flint; University of Minnesota; University of Tennessee; Wayne State University

**Discussion Lists on the Internet**

EdeEquity (concerns gender educational equity)

majordomo@confer.edc.org

H-Women Women's History Discussion List

listserv@uicvm.uic.edu

Society of Women Engineers  
sbswe-1@ccvm.sunysb.edu  
Women in Science and Engineering  
wisenet@uicvm.uic.edu  
WEPAN (Must be a WEPAN member)  
WEPAN-L@vm.cc.purdue.edu  
WMST-L Women's Studies Listserv  
listserv@umdd.umd.edu

### **Selected Library Resources**

Compendex Plus (Engineering Index)  
Dissertation Abstracts International  
McGraw-Hill Encyclopedia of Science and Technology  
Science Citation Index  
U.S. Patent Search

### **Selected Organizations**

- 1) American Society for Engineering Education  
1818 N St. NW, Suite 600  
Washington, D.C. 20036  
<http://www.asee.org/asee/about/vision.html>
- 2) Center for Research on Women  
Wellesley College  
106 Central Street  
Wellesley, MA 02181-8259
- 3) Commission on Professionals in Science and Technology (CPST)  
1500 Massachusetts Avenue NW--Suite 831  
Washington, D.C. 20005
- 4) Federation of Organizations for Professional Women  
2001 S St. NW--Suite 500  
Washington, D.C. 20009
- 5) International Center for Research on Women  
1717 Massachusetts Avenue NW--Suite 302  
Washington, D.C. 20036

- 6) National Academy of Engineering  
2101 Constitution Avenue NW -- NAS 046  
Washington, D.C. 20418  
<http://www.nas.edu/>
- 7) National Action Council for Minorities in Engineering  
3 West 35th Street  
New York, NY 10001
- 8) National Council for Research on Women  
530 Broadway, 10th Floor  
Seattle, WA 10012-3920
- 9) National Society of Professional Engineers  
1420 King St.  
Alexandria, VA 22314  
<http://www.nspe.org/>
- 10) National Women's History Project  
7738 Bell Road  
Windsor, CA 95492-8518
- 11) Programs for Women and Girls  
National Science Foundation  
4201 Wilson Blvd.  
Arlington, VA 22230
- 12) WEEA (Women's Education Equity Act Program)  
Equity Resource Center at EDC, 55 Chapel Street  
Newton, MA 02158-1060
- 13) Women in Mining National  
1801 Broadway, Suite 400  
Denver, CO 80202

### **Newsletters and Periodicals**

*Comments* (Commission on Professionals in Science and Technology)  
*Feminist Collections: A Quarterly of Women's Studies Resources*  
*Graduating Engineer*  
*Journal of Women and Minorities in Science and Engineering*  
*Manpower Assessment Brief* (U.S. Dept. of Energy)

*U.S. Woman Engineer/Society of Women Engineers Newsletter*  
*The Woman Engineer*  
*Women and Engineering News* (College of Engineering-Cornell University)

### **Selected Secondary Resources**

Directory of Archives and Manuscripts Repositories in the United States.  
Washington, D.C.: National Historical Publications and Records  
Commission.

The Glass Ceiling and Women in Engineering: Report of the National  
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1995.

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Baltimore: The Johns Hopkins University Press, 1982

Who's Who in Science and Engineering. Wilmette, Ill: Reed Reference  
Publishing Company.  
Women in Engineering: An Untapped Resource. New York, N.Y.: Catalyst,  
1992.  
Women and Minorities in Science and Engineering. (Directory)  
Washington, D.C.: National Science Foundation, 1982- .

### **World Wide Web Sites for Women in Engineering**

Advocates for Women in Science, Engineering, and Mathematics  
<http://wwide.com/awsem.html>  
Archives of Women in Science and Engineering  
<http://www.lib.iastate.edu/spcl/wise/wise.html>  
Engineering Coalition of Schools for Excellence in Education  
<http://web.mit.edu/ethics/www/ecsel/>  
Institute of Electrical and Electronics Engineers (IEEE) Women in  
Engineering  
[http://www.ieee.org/ieee\\_women\\_in\\_eng/women.html](http://www.ieee.org/ieee_women_in_eng/women.html)  
International Network of Women in Technology  
<http://www.witi.com/>  
National Science Foundation  
<http://www.nsf.gov/nsf/homepage/about.htm>  
Organizations Encouraging Women in Science and Engineering  
<http://xerxes.nas.edu:70/1/cwse>  
Society of Women Engineers  
<http://www.swe.org>  
Some Women's Studies and Women in Science Resources  
<http://www.astro.phast.umass.edu/~brockman/womenstudies.html>  
Women and Minorities in Science and Engineering  
[http://www.ai.mit.edu/people/ellens/Gender/  
wom\\_and\\_min.html](http://www.ai.mit.edu/people/ellens/Gender/wom_and_min.html)  
Women in Engineering links  
<http://keating.anu.edu.au/~jason/wie.html>  
Women's Resources on the Web  
<http://www.women-online.com/women/>



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## BRIDGING THE GENDER GAP IN ENGINEERING AND SCIENCE: THE CASE FOR INSTITUTIONAL TRANSFORMATION

Dr. Barbara B. Lazarus and Dr. Indira Nair

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### Abstract

For the past several decades, intervention programs for women and for minorities in engineering and science have mushroomed. Most programs have focused primarily on helping individuals develop the skills necessary to survive and thrive in the academy. Now, after decades of experience, many groups are calling for an institutional change. Though many barriers to creating a fully diverse workforce appear early in informal and formal education, higher education must remain a focus of this change. Higher education remains the true gatekeeper to careers in engineering and science: higher education defines the criteria for entry and the required credentials to be a scientist or an engineer.

In October 1995, Carnegie Mellon held a participatory conference, *Bridging the Gender Gap in Engineering and Science*, bringing together 150 stakeholders—researchers on gender issues in engineering and science, deans, department heads, faculty members, students, elementary and high school teachers, parents and colleagues from foundations and industry. The participants discussed the changes required in higher education to assure more equitable opportunities for all women in those fields.

*Bridging the Gender Gap* came at a critical time in the many on-going discussions on equity in engineering. For the past decade, groups such as the American Association for the Advancement of Science, the Association for Women in Science, Cross University Research in Engineering and Sciences, the National Academy of Sciences, the National Science Foundation and the Women in Engineering Program Advocates Network have held meetings on increasing diversity. Thanks in part to their work, intervention programs for women and for minorities in engineering and science have mushroomed, focusing primarily on helping individuals develop the skills necessary to survive and thrive in the academy. And now, after decades of experience, these groups and others are calling for an expanded approach: a

focus on institutional change. Though many barriers to creating a fully diverse workforce appear early in informal and formal education—from parents' attitudes in the home and toys given to children, to the implicit and explicit curriculum from preschool through high school—higher education must be a major focus of this change. For higher education remains the true gatekeeper to careers in engineering and science:

- Higher education defines the criteria for entry and the credentials required to be a scientist or engineer.
- Higher education teaches the teachers who work in kindergarten through 12th grade.
- Higher education impacts attitudes of many of yesterday's, today's and tomorrow's parents.

With affirmative action under attack, research budgets in jeopardy and the role of the traditional Ph.D. in question, this shift in attention towards the institution comes at a particularly challenging time. Yet many reasons exist to encourage women to enter these fields and at the highest levels. Despite the current challenges, science and engineering present greater rewards than most traditional fields for women. Equity requires that women—as well as men—have the full range of career choices available. And, our country desperately needs a scientifically and technically literate population of teachers, parents, and citizens. Equally important, the nature of the worldwide economy requires that we draw on the best resources of our total population if we are to remain competitive. The *Bridging Conference* and this paper are based on several assumptions:

- There is a problem of under-representation. The dramatic increase in women's participation in engineering and scientific fields that occurred in the 1970s and early 1980s has leveled off. In the mid 1990s, women earn circa 15% of all bachelor's degrees, 14% of all master's degrees, and only 9% of doctorates from U.S. engineering schools. Women's lower salaries, higher unemployment rates and slower opportunities to advance and achieve tenure are consistent throughout all disciplines, but particularly in engineering, computer science and the physical sciences. Women faculty and professionals in engineering are so underrepresented at all institutions in the U.S. that they often find themselves the only woman in the department. Currently, women comprise circa 3% of the faculty in engineering and circa 9% of the working engineers.
- Under-representation has costs. When women are in the minority, they have less opportunity to speak and to offer opinions and are less likely to participate. Research has shown that women benefit from experiences when they are involved with a "critical mass" of women. Once they

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

experience success and establish confidence in their ability, they are more able to be equally visible in situations where men typically overshadow women's contributions. Studies suggest that graduates of women's colleges or colleges with a high number and/or percentage of women faculty attain a higher level of career achievement.

- Women are not a monolithic group: diversity matters. At all educational levels, girls and women have dramatically different educational experiences than boys and men, but this is true in different ways for majority women and women of color. A full appreciation of women's experiences requires a still larger understanding of diversity: race, ethnicity, social class, sexual orientation and disability. Also, if we are going to understand women in science and engineering we need to desegregate by individual sub-disciplines. When too little is known of diversity, it is impossible to create appropriate responses.
- Changing higher education can make a difference. While higher education cannot reverse the influence years of socialization have had on girls' and women's career decisions, higher education can have an impact in several critical ways—by maintaining the aspirations of women who come to the academy committed to the fields, and by opening doors for others to be recruited during the college years. This may require re-thinking entrance requirements and financial aid policies; it may require changing the traditional curriculum, academic support structure and reward systems.
- Much of what is wrong reflects unconscious bias. Whether we examine women as undergraduates, graduate students or faculty, institutionalized barriers to full participation in these fields arise in large measure from practices which are unintended. Even benign looking practice can be biased: when you use GRE scores for screening awards and fellowships, men do better; when you use the GPA, women do better. Achieving equity for undergraduates, graduate students and faculty members requires that we both uncover these practices and change them appropriately. This requires carefully crafted, systematic and quantitative and qualitative research. Again, we may need to review access, funding, climate, curriculum, the nature of scientific inquiry and the traditional reward structure. Institutional transformation in any of these areas will require continuing careful evaluation so that we can understand what works and what does not.
- The responsibility for creating a more diverse community in engineering belongs to all the stakeholders—to K-12 teachers, to parents, to students,

to faculty members, to department heads, deans, professors and presidents, to the foundations and to industry.

The strategic recommendations emerging from the *Bridging Conference* may be grouped in three categories: those that involve the interaction of the academy with other institutions or the society at large; those that involve modifying existing practices through critical examination; and, those that involve collecting data for understanding and decision-making.

Interactions outside the academy:

- Get girls interested in science and engineering at a young age.
- Provide early mentoring, role models, and research opportunities for young women.
- Help the public overcome the assumption that engineering is an inherently "male" field.
- Emphasize that there is room for social responsibility and good work within the field of engineering.
- Promote academic/industry diversity partnerships. Because it is currently the leader in diversity, industry can teach the academy what it knows about creating equitable climates.
- Communicate to teachers, counselors, and school boards the importance of high school mathematics.

Practices and behavior in the academy:

- Create multiple points of entry into the pipeline so that one need not take a required series of classes in high school in order to become an engineering major in college.
- Examine entrance requirements that may discriminate against qualified women: for example, consider the integrated profile of applicants over standardized test scores.
- Create less competitive environments that foster cooperation among students.
- Change scientific and engineering texts, examples, homework and test problems to reflect subjects of interest to a broader population of current students.
- Increase faculty sensitivity to different ways of promoting and evaluating learning and to the implications of their interactions with women students and among students in classroom and laboratory settings.
- Ground changes in the departments, courses, and in reward structure such as merit increases, promotion, and tenure.
- Create gender equity in engineering faculty and increase accountability for the hiring and promotion of female faculty.
- Reconfigure tenure policies to allow for childbearing and childrearing.



Recommendations for data collection and analysis:

- Use tracking systems to determine if differences exist in the retention of female and male students and faculty, and to identify specifically where and why such differences occur.
- Conduct regular alumnae surveys for internal quality assessment.
- Examine the experiences and participation of subsets of women – by race, ethnicity, social class, sexual orientation, and disability – instead of as a single, monolithic group.

**A Framework For Systematic Transformation**

These recommendations will require that institutions change their values and behaviors. They require that institutions internalize the value of inclusion when they define policies for external interactions, "gatekeeping" practices, and creation and sustenance of a healthy educational environment. In discussing curricular transformation, Doug McAdams notes that there are "unexplained assumptions that reinforce and lend scientific legitimacy" to the way we conduct an institution. (McAdams, 1988) Two of these assumptions are particularly relevant to transforming institutions to be inclusive for gender in engineering and science. One is the distinction between the private and the public with women restricted to the private realm. The second is the belief that views discussed and considered in the academy should be based only on reason and should be disinterested and disengaged to be legitimate. Joan Tronto has argued that such unexamined assumptions provide boundaries that shape the morality of an institution and in turn lead to widely accepted social values that "constitute the concept with which we interpret all (moral) arguments. Some ideas function as boundaries to exclude some ideas (of morality) from consideration." (Tronto, 1993)

Transformation will require a planned, deliberate change in the ethos of the academy. The active projection of the image of science and engineering as an instrument of service and the acceptance of social responsibility is one key to this new ethos. Engineering has always been a profession of service. Historically, the discipline of engineering was first marshalled into social service as an instrument of the military. As Taft Broome noted in his paper for the *Bridging Conference*, the first engineering school in the U.S. was at West Point. Only later did it enter the "civil" realm. (Broome, 1996) An acceptance of social responsibility now would require an examination of our social contract and commitment to ethics as a routine part of the curriculum and other aspects of the academy. Ideally, this would make a process of self-reflection inherent in the teaching and learning processes, and in the

conduct of all matters. While it would take significant effort to activate this process of reflection, it could significantly change the environment to one of mutual respect and support once it is in place. Once the environment has changed, one would expect universities' outreach programs to mirror its ethos. Rather than being an image-building or advertising effort, outreach programs would then serve as responsible providers of mentors, advice, and experience. This might include a spectrum of entry points and modes to the study of science and engineering, and enable people at various stages of their life make informed decisions about education and careers in science and engineering. With the current upheaval and restructuring of all institutions, this kind of outreach would help all people, not just women, orient or modify their education for a changing world.

Another critical component of transformation will be a continuous process of active and conscious analysis and enunciation of policies for entry and retention of students and junior faculty. This would include active establishment of mentoring and networks for young faculty as well as for non-traditional students. Accountability of the institution would require an examination and correction of the disparities between stated expectations and actual assessment of performance. It would require an explicit consideration of life cycle needs of students and faculty of different ages and stages of life. Keeping track of alumni and asking them explicitly for suggestions could help in redefining the environment and paying attention to their suggestions should be a part of the process of evolution of the institution.

The new ethos will also require that we examine the existing compartmentalization between "education" and "work," beginning with the redefinition of our relationship with our industrial colleagues. We must begin to appreciate the industry as a learning place and the academy as a workplace. While, it is well-accepted that Cooperative Education programs provide us with the best strategies for retention in engineering, there has not been an appreciation of how much we can learn from industry about strategies for designing an inclusive environment.

A transformed institution must make an active effort to design inclusive practices and material for the classroom and for research guidance. Faculty workshops that raise issues of classroom pedagogy for a diverse audience should be as important as those for various cognitive details of learning, currently the norm for such workshops. An institutional initiative would be required before traditionally trained faculty would consider legitimate—the discussion of different ways of learning as a constructive approach to teaching.

In the book, *To Engineer is Human*, Henry Petroski points out that engineers can learn more from failed designs than from successful ones. (Petroski, 1985) This is an important fact to keep in mind as we re-engineer the academy. Examining what happened in "failed" cases of students and faculty may yield more valuable insights than looking at the models of success as we normally tend to do. Ideally, this would include not only the examination of one's failure, but factoring the case to see how and why they succeeded elsewhere. At least an analysis of the institutional processes that led to a student or junior faculty failing after she or he was selected carefully to fit the expectations may make explicit, the implicit norms that led to the failure.

We have posited that for institutional transformation to begin the academy must examine its ethos. The University defined as a service institution—the provider of education and "habits of the mind" for the future professionals—and not as the keeper of a closed crucible of exclusive knowledge is crucial to this process. From the realizations of the classroom as "participating spaces for the sharing of knowledge" to the design of the intellectual as someone who seeks to be whole, the academy provides endless possibilities to provide what Paolo Freire has called "praxis"—action and reflection upon the world in order to change it.

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## SITUATION OF THE WOMAN ACADEMICS IN THE NEW LÄENDER OF GERMANY

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In the former GDR there was not any unemployment. On the other hand side it is well known, that the result was a big crash of the economical and political system like in the other socialist countries.

The liquidation of administrations, enterprises, scientific and cultural institutions and organizations caused the liquidation of millions of jobs.

No wonder, that since the reunification in 1990 has started an increasingly rate of unemployments.

Most of people without jobs are women in the age after 40 (and of course very young people).

Especially big number of jobless women worked in science and culture. They had children and had their job as well. This was a double load for them, a double charge. But nowadays their children have left the home and the women have lost their jobs. They are feeling completely useless because nobody in the former GDR was prepared for such a situation.

To have a job was the foundation of self-confidence for a woman.

Typical results of such a situation are the loss of social contacts with colleagues, the loss of social admission and an increasing isolation.

But there are not only psychical problems as result of unemployment.

Often the husband also has lost the job, so that suddenly the living standard of such an "academic" family dramatically has broken down.

Some statistical details:

In 1994 every 9th man and every 4th woman had lost their jobs.

More than 66% of all these women do not believe, that they will have any chance for a new job.

Let us divide the woman academics into two groups:

The first one are the engineers and the second one are the scientists.

An interesting fact is, that the engineers are much more optimistically to get a new job (80%) as the scientists (20%).

The statistic says, that higher qualified women have better chances on the job market.

They push away the lower qualified women. On the other hand side having visited an university isn't a protection against pushing away from younger but lower qualified women.

Fear of Dequalification				
Group	All	Yes	No	No answer
Scientists	19	11	3	5
Engineers	10	6	3	1

What activities do the unemployment womens to find a new job? Let's have a look at the following table:

Woman activities to improve the chances on the job market		
	Number	
Kind of activity	Scientists	Engineers
Applications	21	18
Retraining	18	4
Further Education	16	2
Direct contacting of Personal Managers	5	6
Informations getting from friends	2	0
Labour Exchange	1	0
Visiting professorship for a limited time	0	2
Advertisements	1	2

### Summary / Thesis

- Unemployment of 10-Thousands of women academics as the result of the German reunification is not only a deep lost of living quality for them. The losts are of spirit-intellect and material nature as well as losts of sense of living.

- The unemployment of such a large number of women scientists, engineers and artists is a very big lost of spirit potential for our nation especially in the situation where Germany is fighting for more attractivity as a centre of science and culture in europe and in the world.
- Among the unemployment woman academics is a big disapointment and disillusion about the new Germany. They had wished the new Germany and had a very big hope for a better life. Now they know, that the new society do'nt need them and will not help them. As the result they do'nt think about future and society - they have become egoistic and only do think about their own future.



## COMMUNICATION AND CONFLICT RESOLUTION IN THE WORKPLACE: AN AWARENESS WORKSHOP

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Conflict and disputes are a natural part of our daily existence but an uncomfortable issue and feeling for most people to address in a productive manner. Conflict directly influences communication, unfortunately usually as an impediment. Therefore, it is important for the members of any group or organization, which must depend upon communication for success, to be skilled at recognizing and managing conflict.

The academic and corporate climates are challenging for all people, but women have an additional stress balancing what their profession demands and also what burdens of culture and society have been placed upon them. Understanding one's style of managing conflict and being aware of the conflict styles of colleagues facilitates positive opportunities for productive communication.

This paper will specifically address; (1) defining conflict and how we traditionally manage it, (2) our own personal style of handling conflict, (3) understanding how our professional colleagues handle conflict, (4) managing conflict and why it is important, (5) how communication improves when conflict is addressed and processed productively, and (6) how, through improved communication, an individual can work more productively with a group, thus increasing group success.

### CONFLICT AND CONFLICT MANAGEMENT

Conflict is defined as an antagonistic state or action involving divergent ideas, interests, or persons. Conflict arises when the needs or wants of one person are perceived by that person as being denied to them by another. Dispute is defined as a matter in controversy between two or more parties which may, in varying degrees contribute to the animation and orchestration of conflict.<sup>1</sup> Traditionally, a person responds to conflict in one of three ways: fight, flight, or flow.

Handling conflict by fighting includes competition and aggressive confrontation. Competition indicates one person's use of power or authority over another. Competition defines a win-lose situation. Aggressive confrontation happens when one person attacks the other either physically or more often in a professional setting, verbally. This usually happens when two people are not willing to listen to each other's side of the problem or to talk about it; instead they attack, blame, or put-down the other's idea. The resolution for this type of conflict is of a competitive nature, a win-lose or lose-lose solution. Both parties may yell, vent, and be angry and the situation usually escalates when handled in this manner.

Flight is avoidance or denial of a conflict or dispute. Denial is when someone does not admit there is a problem. Avoidance happens when someone chooses to ignore the problem or withdraw from it. The outcome in this situation usually results in a lose-lose outcome. No solution is usually achieved and both parties leave frustrated and distrustful on one another. Trust, to some degree, must be a factor in addressing conflict.

Flow is equated to problem solving in addressing a conflict. Problem solving is when people talk about the problem without insulting or blaming one another. They know that a problem exists, that they have a problem with one another, and they think of ways to solve it. Finally, they choose a solution that is best for the situation at hand and for everyone involved.<sup>2</sup> The outcome is a win-win situation.

### **PERSONAL STYLES OF HANDLING CONFLICT**

Our personal styles of handling conflict can be divided into five categorical areas: competing, avoiding, accommodating, compromising, and collaborating.<sup>3</sup> Most of us operate from many of these areas but we will primarily use one or two specific areas in dealing with conflict. Understanding our style of handling conflict helps us in identifying what positions we may be entrenched in and also gives us the opportunity to change our style if needed or desired. No specific style of handling conflict is right or wrong. However, some styles may yield more productive results for a person both personally and professionally.

Gender and self-image also must be considered when discussing conflict styles. Research indicates that our ability to handle conflict is often related to our level of self-confidence. Men and women between the ages of 18-34 are more highly sensitive to conflict, because they are still in the process of developing a sense of identity. Women are traditionally raised to view criticism and disputes as meaning something is wrong with them. Because of this, when a conflict arises, women generally assume the fault lay with them and not the other person or an outside variable. Generally speaking, women tend to internalize a conflict immediately and tend to externalize their successes.<sup>4</sup> 85% of all women in the United States claim to be highly self-critical. Based upon these facts, women and men are expected to handle conflict in very different ways.

## YOUR AND YOUR COLLEAGUES CONFLICT STYLE

First, competing is viewed as forcing someone to your position of thinking in regard to a particular situation or being determined to “win” even when there is a better solution. Competitively oriented people often act in an aggressive and uncooperative manner. Win-lose power struggles and attempts to dominate are common. There are times when this method is most appropriate. However, men have been encouraged in our culture to dominate the workplace and “win at all costs” and women have been discouraged from this type of competitiveness.<sup>5</sup>

Second, avoiding is withdrawal from conflict. When faced with a potential conflict, an avoider seeks to distract attention from the issue or may attempt to ignore the issue entirely. Typically, this is a style presented more often by women than by men. Although women have moved into the professional communities of engineering and science, they are often not included in the communities entirely. Expectations from our culture are transferred onto women and men in the workplace. More often than men, women remain outside the heated discussions, inner cadres, and social networks in which research ideas are aired, exchanged, and evaluated.<sup>6</sup> Because of these types of exclusions and the idea that these exclusions were indoctrinated into women when they were young girls, research demonstrates that women tend to be more avoiding and accommodating when in conflict. Depending on the circumstances, this behavior can be perceived either as evasive or as effective diplomatic maneuvering.

Accommodating, the third method of handling conflict, involves smoothing over a situation. It is the opposite of competing. Women are often encouraged to be the peacemakers in the office, even when they are not one of the disputing parties. People who favor this style often sacrifice their needs and desires in order to keep the peace and to make others happy.

Compromising consists of the sharing ideas and creating a solution, although the solution is sometimes created prematurely. It is an intermediate, “middle-of-the-road” approach to conflict. This method of addressing conflict can be viewed as productive as long as neither party believes they sacrificed too much, yielding an insufficient or incomplete resolution. Each side gives up something to gain something. A person who practices the collaborative style neither fully avoids the problem nor fully collaborates with the other party. The compromising mode is at the midpoint of both the cooperative and assertive scales.

Finally, collaboration is similar to compromising in the fact both individuals in conflict are communicating with one another. Collaboration is considered more productive and successful because the necessary time is taken to create the best possible solution. Both parties have communicated, considered each others position and needs, and together

created a solution that both parties can feel and be committed to. People with a collaborative orientation tend to demonstrate highly assertive and highly cooperative behavior. Collaborative people value mutual benefit, integration, and win-win solutions. The conflict style opposite of collaborating is avoiding.

## **MANAGING CONFLICT**

The method of managing conflict will depend upon the situation at hand. All of the above mentioned methods of handling conflict will be necessary at different times. It is important to realize that each method can be beneficial under certain circumstances. For example, when there are time constraints in making a decision, compromising may be necessary because there are necessary time constraints to adhere to and collaboration would be too laborious.

People are not locked into one style of conflict management, and potentially can utilize all of the styles. However, individual differences and experiences tend to make each person more comfortable with one or two styles; these styles, therefore, are the ones that the person is most likely to employ.

The importance in managing conflict is deciding what style is best for you to use in a given situation. How you respond to conflict and managing disputes should be within your control. The style you choose to use should depend upon the given situation, nature of the conflict, and constraints of time. A style should not be followed because of societal constraints regarding what is appropriate for your gender or because of your discomfort with a different conflict resolution style. Remember there is a history within each of us that taught us how we handle our conflicts. Without conscious effort and change, you will not change your style of resolving conflict. If you are comfortable and content with your conflict resolution style this is wonderful. However, if you are resisting change because it is uncomfortable, consider the following: often we believe that change would be easier without people - without ourselves or others involved. However, remember that people, including ourselves, do not resist change; we only resist being changed by others but not ourselves.<sup>7</sup> Changing your style of conflict is within your control and is your choice.

## **IMPROVED COMMUNICATION INCREASES PRODUCTIVITY**

Communication between colleagues is improved when issues, including uncomfortable and controversial issues, can be addressed in straightforward manner. The aim in conflict and addressing disputes is understanding, not blame.<sup>8</sup> Improving communication in the workplace means that conflict will have to be addressed. We know conflict is part of the workplace and our collegial relationships, but we often do not want to address it because



our social organization within our culture defines conflict as wrong, at least wrong for women.<sup>9</sup> However, the conflict itself is not harmful. It can be made helpful or harmful depending on how one handles and responds to the conflict. Overcoming the social stigma towards conflict can create a workplace that is friendlier and more productive.<sup>10</sup>

Addressing conflict is good for an organization. When a group understands conflict and how to work with it, communication and productivity increases. Individuals in workplace will view disagreements as opportunities to make things better. Conflict is viewed as a mode of give and take. People will develop skills to be wise enough to compete when necessary and surrender when appropriate.

## INCREASED GROUP SUCCESS

With the idea of openly addressing conflict in the workplace, the work of the group will be more successful. Colleagues can communicate more freely through developing trust of the conflict resolution process. Openly disagreeing and working through conflicts reduces the tension in the work environment. The following guidelines should be considered when addressing conflict in the workplace:

- describe the other person's behavior objectively
- use concrete terms
- describe a specified time, place, and action
- describe the action, not the "motive"
- acknowledge your feelings
- express them as calmly as possible
- state feeling positively as related to goal
- direct yourself to the specific, problem behavior
- ask for change in behavior
- specify (if appropriate) what you are willing to change to make the agreement
- reaffirm the other's ability to make the change
- end on a positive (not necessarily happy) note

When these guidelines are adhered to by people in conflict, resolution of the conflict is obtained, and the disputing parties feel more comfortable with their work environment. When people feel comfortable with their workplace productivity is higher and, most importantly, people feel good about themselves.

## CONCLUSION

In conflict situations, there are many ways to address the situation. There is no "best way" to handle all conflicts other than being aware of your stance and the stance of the

person you are having a dispute with. Remember: there is a time for flight and a time to fight. You should choose the battles, challenges, and conflicts that are important for you. In choosing your conflicts, consider the following in deciding how you will respond:

- how invested in the relationship are you
- how important is the issue to you
- do you have the energy for the conflict
- are you aware of the potential consequences
- are you ready for the consequences
- what are the consequences if you do not engage in the conflict

Conflict is a part of all of our lives; it is not a matter of whether we deal with conflict but how we are going to handle it. Conflict is an opportunity for a positive change.

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## HELPING WOMEN SELECT CAREER PATHS

### Moderator

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Irene Mikawoz has a BA in Psychology and Sociology and a BSc in Industrial Engineering from the University of Manitoba. Following graduation, Irene worked for Proctor and Gamble in a variety of positions ranging from production management to human resources. While working, Irene began a Master's program in Mechanical Engineering at McMaster University. In 1992 she became the Director of Student Recruitment for the Faculty of Engineering at the University of Manitoba. She is now Director of Student Affairs for the Faculty.

Irene has been and continues to be actively involved in a number of organizations and committees within the university, the profession, the community, and internationally. In 1988 Irene was selected by Chatelaine Magazine as one of Canada's top 10 female graduates and in 1995 she was nominated for the Canadian Council of Professional Engineers Young Engineer Award. Irene is a registered professional engineer in the provinces of Ontario and Manitoba.

### Presenters

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**MINORITY WOMEN IN THE ENGINEERING FRESHMAN CLASS:  
(1990-91 to 1995-96)**

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**INTRODUCTION**

Minority women are the most underrepresented group of students in the nation's engineering institutions. They currently constitute only 4.6 percent of the engineering freshman class and comprised an even smaller proportion (2.5 percent) of engineering graduates in 1994-95. Past and ongoing NACME research has focussed on minority women graduates<sup>1</sup>. This paper explores the enrollment patterns of minority women to determine whether there is a relationship between the institutions they choose and those that minority men select, in which to study engineering, or whether the distribution of minority women more closely resembles that of nonminority women in the freshman engineering class. To understand these relationships, we examined and compared the distribution of minority women, minority men, nonminority men and nonminority women in the freshman class by type of institution, cost and selectivity.

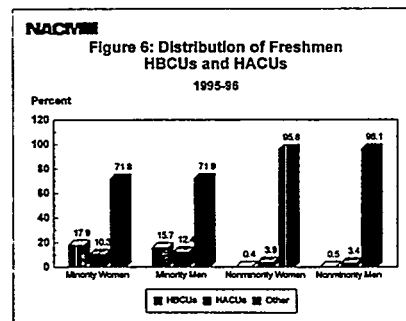
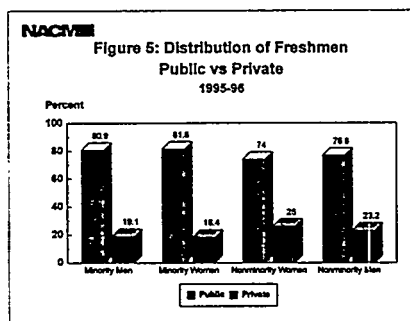
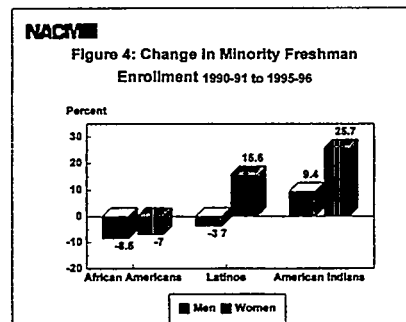
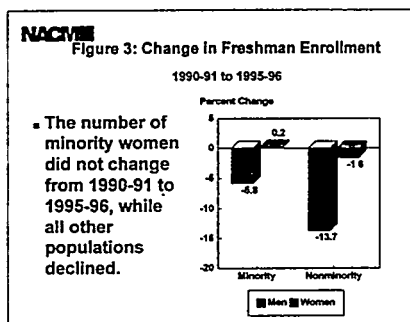
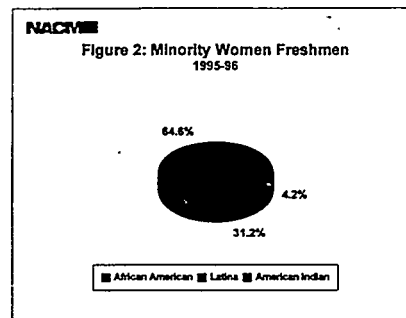
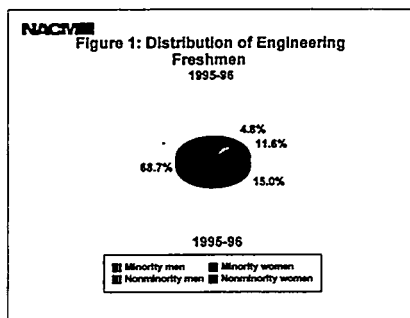
Our findings indicate a strong relationship between the selection of institutions made by minority men and minority women in the engineering freshman class. In other words, factors relating to race and ethnicity seem to be far more significant in determining the distribution of minority women in the freshman class than factors relating to gender.

**METHODOLOGY**

This research was conducted using enrollment data for minority women in the freshman engineering classes from 1990-91 through 1995-96, because data by gender and ethnicity was not available prior to 1990, when the Engineering Workforce Commission began to collect it under a grant from NACME. We explored the distribution of minority women in engineering colleges and universities relative to that of minority men, nonminority men and nonminority women, over the last six years looking at the following variables: type of institution (Historically Black Colleges and Universities, Hispanic Association of Colleges and Universities, public, private and research institutions), college cost and selectivity.

**OVERVIEW OF MINORITY WOMEN IN THE FRESHMAN CLASS**

Minority women constituted only 4.8 percent of the freshman engineering class in 1995-96 (Figure 1). Among minority women, African American women comprised the largest group, 64.6 percent (Figure 2). Figure 3 shows that over the last six years, the



Source: National Action Council for Minorities in Engineering, Inc., New York, NY

07/08/1996

number of minority women stayed stable, while the minority male freshman population declined (5.8 percent). The total nonminority freshman population also declined, with nonminority women decreasing by a smaller proportion (1.6 percent) than nonminority men (13.7 percent).

The number of African American women in the freshman class declined by 7.0 percent from 2,768 in 1990-91 to 2,574 in 1995-96 (See Figure 4). This decline paralleled the decrease of 8.5 percent in the number of African American male engineering freshmen. Nationally, however, the number of African American freshmen in departments outside engineering increased over this time period. Latinas, unlike their male counterparts whose numbers fell by 3.7 percent, increased their numbers by 15.6 percent. The numbers of American Indian women and men increased by 25.7 percent and 9.4 percent respectively.

To test the hypothesis that the distribution of minority women and minority men is more closely correlated than the distribution of minority women and nonminority women, we first explored the demographics of the freshman class in individual institutions using correlation tests, excluding the Historically Black Colleges and Universities (HBCUs) and the Hispanic Association of Colleges and Universities (HACUs). We found that schools that enroll high numbers of minority women usually are the same schools with a large minority male population.

One explanation for this relationship could be the demographics of the states in which the schools are located. So we tested the relationship between the distribution of minority women in the freshman class and the distribution of minority women in the college age population by state,<sup>2</sup> and found that the higher the number and percent of minority women in the state, the higher the number and percent of minority women in the freshman class for engineering schools within those states.

To explore individual institutions, we ranked engineering schools by the number of minority women, nonminority women and minority men they enrolled in the freshman class and compared these rankings. With the exception of three institutions, the listings of the top 30 institutions were identical for minority men and women. Comparing the rankings of institutions with the most minority women to those with the most nonminority women, we find only 9 institutions appeared on both lists while 42 institutions were different.

#### Distribution of Freshmen by Type of Institution

To more closely examine parallel enrollment patterns, we classified engineering institutions into five categories: a) public and private schools<sup>3</sup> b) minority serving institutions defined as HBCUs<sup>4</sup> or HACUs<sup>5</sup> c) research institutions<sup>6</sup> d) institutions defined by cost and e) institutions defined by selectivity. The freshman population

distributions were compared separately for each, since these categories are not mutually exclusive.

Public and Private Institutions: The majority of all students attend public institutions (Figure 5). However, a larger proportion (four fifths) of minority men and women attend public schools compared with three-fourths of nonminority men and women.

HBCUs and HACUs: Similar proportions (approximately 30 percent) of the minority male and female populations attend the HBCUs and HACUs (Figure 6).

Research Institutions: More than half of nonminority men and women attend research institutes, while less than half of minority of male and female populations attend these schools (Figure 7).

Institutions By Cost: Dividing engineering schools into three equal groups based on cost, we found that most minority women and men (45 to 50 percent) attend low cost institutions (Figure 8), while most nonminority men and women attend medium cost institutions (approximately 43 percent).

Institutions By Selectivity: Examining freshman enrollment among the five selectivity categories defined by the Peterson's Guide,<sup>7</sup> we found no significant difference in the distribution of the four population groups, with most students attending moderately selective institutions.

Overall, we found that both minority men and women are concentrated in low cost, public and minority serving institutions. Nonminority men and women in the freshman engineering class, while also concentrated in public institutions are mostly enrolled in the medium cost and research institutions.

#### Changes in Distribution of Freshmen by Type of Institution: 1990-91 to 1995-96

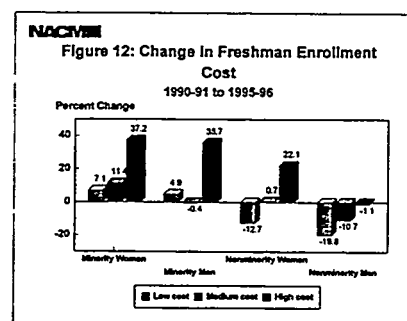
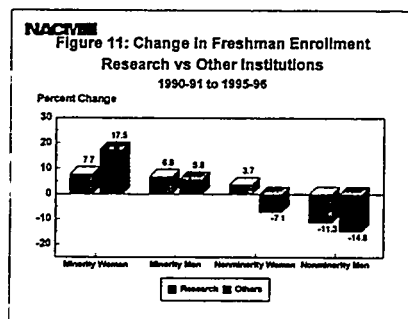
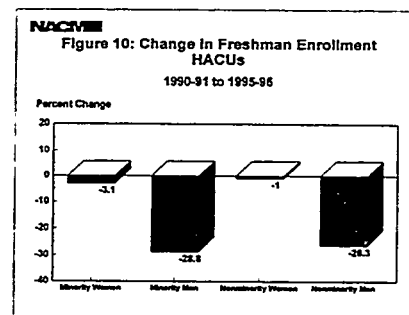
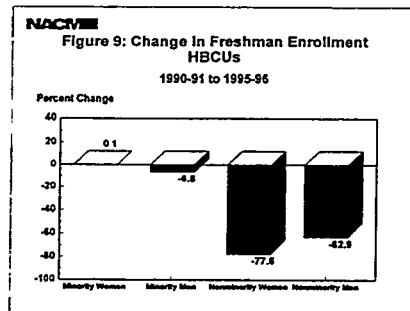
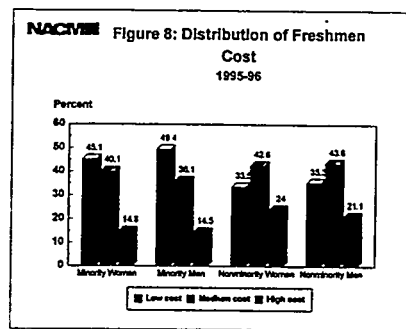
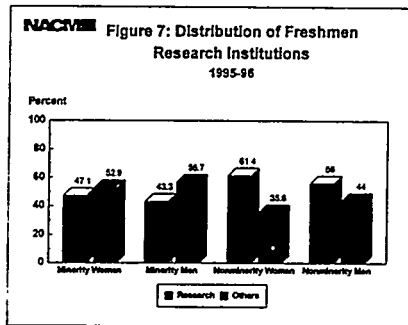
While the current distributions of minority men and women closely resemble each other, changes in these distributions over the last six years show both similarities and differences.

Public and Private Institutions: Over the last six years, the minority male and female populations have increased in the highest proportions in the private institutions.

HBCUs and HACUs: In the HBCUs, the number of minority women remained stable (Figure 9) while minority men declined (6.8 percent). Both nonminority male and female populations declined steeply (by two-thirds). The decline in minority freshmen in the HBCUs, as with the decline nationally, is not occurring in fields outside engineering. The HACUs present a slightly different picture (Figure 10) with both male populations







Source: National Action Council for Minorities in Engineering, Inc., New York, NY

07/08/1996

declining in significantly larger proportions than the female populations.

Research Institutions: The number of minority women and men increased by approximately 7 percent in research institutions, while the nonminority female population also increased but to a lesser extent (Figure 11). The nonminority male and female populations decreased in the non research institutions.

Institutions By Cost: Despite a concentration of the minority populations in low cost institutions, the highest increases in both the minority male and female populations (of more than 35 percent) have taken place in the high cost category (Figure 12).

Institutions By Selectivity: Despite few differences in the distribution of the four population groups across selectivity categories, the changes in these distributions show significant differences (Figure 13 and 14). The number of minority women increased by the largest proportions (54.8 percent) in the most competitive schools and in the noncompetitive schools (51.5 percent). Minority men increased to a lesser extent in the most competitive schools (5.0 percent) and most in the noncompetitive schools (37.1 percent). The nonminority female population, like the minority female population, increased the most in the competitive schools (36.9 percent).

Over the past six years, minority men and women have declined in numbers in the minority serving institutions, while increases in the minority freshman population during this time period have taken place in the more expensive private institutions and in research institutions. Minority women have increased in large proportions at the most selective institutions.

## Conclusions

Data on enrollment in the engineering freshman class shows a strong relationship between the distribution of minority men and the distribution of minority women. The distribution of minority women in the freshman class relates closely to the demographic distribution of the minority population across the United States.

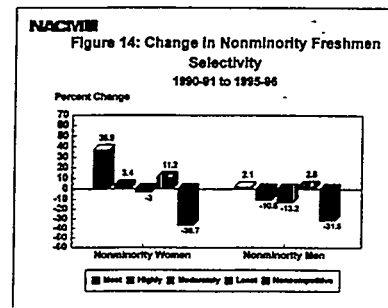
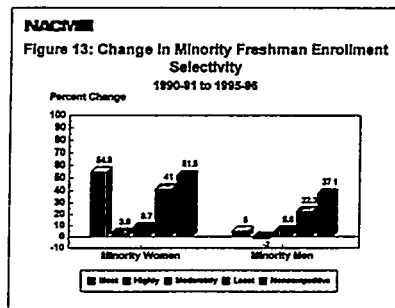
The symmetry between the distribution of minority women and the distribution of minority men emerges when we analyze these distributions on a university by university basis and across institutional categories. Both populations are concentrated in low cost, public institutions, minority serving institutions and non research institutions. The nonminority populations, on the other hand, are contained in medium cost, public and research institutions.

Over the last six years, changes across institutional categories showed different trends for minority men, minority women, nonminority men and nonminority women. Minority women, while initially concentrated in low cost schools, have increased in the

largest proportions in the more expensive, private schools. They are also increasing in numbers in research institutions and the more selective institutions. Simultaneously, they have decreased in numbers at the minority serving institutions. Similar trends hold for minority men with several exceptions. They increased in substantially smaller proportions than minority women in the more selective schools and their numbers have fallen more steeply in the minority serving institutions. However, minority men also increased in numbers in the research institutions and in the private, high cost institutions. The nonminority female population shows similar trends to the minority female populations increasing in numbers, though in smaller proportions, at the research institutions and the private institutions. All women, minority and nonminority, are increasing in large proportions at the more selective institutions. This points to shifting engineering freshman populations within these institutional categories with fewer students attending the minority serving institutions and more attending research institutions and the highly selective, more expensive, private institutions.

Cost appears to be a major factor influencing the enrollment of minority women, with the largest numbers concentrated in the least expensive schools. Changes in the last six years lead us to ask whether the more expensive institutions are offering minority women better financial aid packages or whether an increasing number of minority men and women can now afford the more expensive schools. National increases in the amount of student borrowing raise further questions about whether minority men and women are now willing to incur more debt to attend the most expensive schools. In the light of rising tuition costs at all universities, another area for research would be to examine the differential financial aid packages being offered by public and private schools.<sup>8</sup>

Among minority women, the declines in freshman engineering enrollment in the last six years have been mainly in the African American population and increases have been led by Latinas. The decline in the number of African American women was paralleled by a decline among their male counterparts. This decrease took place to a large extent within the HBCUs. The decrease in African American freshman enrollment in engineering runs counter to the national enrollment trends for African Americans and counter to trends in other departments in the HBCUs where freshman enrollment continues to grow. This points to a declining interest in engineering among African Americans and therefore, the need for more outreach and information aimed at this community on the opportunities available to those who earn a degree in this field.



## ENDNOTES

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5. *1993-94 Directory of Hispanic Serving Institutions and Associate Members*, Hispanic Association of Colleges and Universities (HACU), San Antonio, TX., 1992.
6. Jean Evangelauf, "A New Carnegie Classification." *The Chronicle of Higher Education*, April 6, 1994. These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. In addition, they receive annually more than \$15 million or more in federal support.
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# FACTORS THAT AFFECT A COLLEGE STUDENT'S ACADEMIC AND CAREER PATH IN SCIENCE/ENGINEERING-RELATED FIELDS

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## INTRODUCTION

The alumni of the Research Science Institute are composed of over 600 highly gifted young men and women who each have been chosen to attend a special summer program of independent research and teaching. Each year since 1983 approximately fifty rising high school seniors from the United States who have already distinguished themselves as potentially outstanding future scientists and mathematicians are chosen in a highly competitive application process to work with outstanding scientists at a leading university. This program is presently based at the Massachusetts Institute of Technology and students are placed for research at universities throughout the Boston area. The RSI alumni represent intellectually equal groups of men and women who at an early age indicated a keen interest in pursuing a career in science and mathematics. Because of their importance to future national prominence in science and mathematics, the Department of Energy funded in 1992 a three-year study of the RSI alumni and their continuation and success in mathematical and scientific careers

## A STUDY OF RSI ALUMNI

In October of 1992, the Center sent the first factually-based questionnaire to all RSI alumni. This was an exceptional cohort group of males and females because of their evenly matched exceptional talent and abilities, their early interest in science, early achievement in math and science, and a common summer research experience at the Research Science Institute. By spring of 1993, the first data assessing the achievements of the members of this special group and their continuation in science was completed.

1. The most striking discovery was that more than one RSI alumni in ten chose a nonscience major. Out of this group, women were responsible for almost all of the movement away from science. Thus, despite equivalent abilities, RSI women were leaving science and math at a rate many times that of their male counterparts.
2. Within those remaining in science fields women choose biology as a major



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twice as often as men while male interests were evenly distributed among all scientific fields. However, from an original interest in biology on entering college, only one in three women finished an undergraduate degree in the biological sciences.

3. The critical years in deciding to leave science for RSI females began after the sophomore year of undergraduate studies and continued unmitigated through the years of graduate study. In contrast, the decision of RSI males to switch from science was at a low rate throughout the undergraduate and graduate years.

Since there was no measurable difference in native ability, experience, or scientific interest between RSI men and women, reasons for this unequal attrition of women from science/math studies and careers would have to be examined in factors of differences in environment and social milieu of men and women and/or their personal factors of value systems, perceptions, and life goals. Secondly, since the movement away from science by women once begun after the sophomore year continued, it appeared that the final decision to leave a scientific path was not a single precipitous event but rather an evolution of a series of earlier, less final critical points at which continuation on such a path was questioned. The questions to be asked then became: 1) when did this decision process begin? 2) what were the causative factors for a decision to turn from science and math at any particular point? and most importantly, 3) what would have altered this decision process? Stated simply, what factors are needed for continual commitment to a science/math career. The study of the RSI alumni then moved into Phase II, definition of the factors involved in the attrition of RSI women from science and math careers and formulation of recommendations to prevent this attrition.

## **RESEARCH ON RSI ALUMNI ATTRITION AND RETENTION IN SCIENCE**

Four methods research were used to unravel the reasons why RSI women have a higher attrition rate than RSI men from science careers and the key factors needed to retain more women and men in these careers: 1) relevant findings from other studies; 2) testimonial letters from RSI alumni; 3) cognitive interviews of RSI alumni; and 4) construction and analysis of Questionnaire II that probed the environmental and personal factors identified by the first three methods as significant factors in continuation of a science career.

### **Letters of Testimony**

Findings from other researchers on reasons for the higher attrition rate of females than males from science careers were reflected in testimonial letters from RSI alumni. In the fall of 1993, RSI alumni were asked to respond in writing about their view of science and math studies and careers and factors necessary for a successful career.

They were also asked if they were to leave science, what would be the deciding factors. Responses from both men and women had several unifying themes:

1. The minor number of women in science/math mentor and academic faculty roles was most often cited. Phrases such as “the professors are a bunch of old men”, and “the tutorial teacher is the only women I see and I seldom see her”. Isolation and observing only men faculty or in authority was cited as the reason for women leaving majors in mechanical engineering, electrical engineering, physics and chemistry.
2. The atmosphere of science was the second most cited reason for leaving describing it as “unfriendly”, and “highly competitive”.
3. The quality of science courses and teaching was also a factor in losing interest in a science career. Described as “boring”, and with “too much rigor with too little imagination” students lost interest in the subject matter.
4. Reasons for a choice of a nonscience field of study were often related to the new majors “emphasis on importance of people”, its “more natural and easier” subject matter, and conflicts of family and career.

### **Cognitive Interviews**

To further develop an understanding of the reasons for attrition from science/math careers of RSI alumni and methods to possibly prevent this attrition individual and small group (3-6) cognitive interviews were done with a representative sampling of RSI alumni at the undergraduate and graduate level both within and out of science-related studies and careers. Each interview probed reasons for the individuals initial choice of a science career and then moved to a general question of “why persons leave science?” to “why women leave science?” and finally to “why would or did you leave science?”. Comparisons were made between male and females responses. Several striking factors were evident.

1. Although men and women cited the negative perception of scientists as a reasons for leaving science only men mentioned not being at the top or little independence as causative factors. Only women mentioned the “struggle” and “social isolation”.
2. When asked “why women leave science” both men and women answered “women are social, science is asocial”. Only women again cited being “beat by the system” and being “insecure in their ability”.
3. Finally, when asked “why would you leave science” only men spoke of “no available job” while only women mentioned “other interests”, “family needs” and again “loneliness”. When challenged with a difficult course(s) that may suggest leaving science as a career, only men responded with “letting the material wash over them” while only women responded with feelings of being “overwhelmed” and the material being “impossible”.

## Questionnaire II

Findings of other studies on the attrition of women and information from RSI alumni testimonial letters and cognitive interviews were assembled to construct Questionnaire II of the study under the guidance of Mathematica Policy Research Institute of Princeton, New Jersey. The objective of the instrument designed was to define the important factors in the attrition of RSI alumni from science and math careers especially for the women of RSI. Significant differences in responses between men and women could be used to design interventions for future RSI students and perhaps specifically for RSI females that would stop the higher rate of attrition of RSI females from science. The instrument designed asked the RSI alumni to respond to issues in a multiple choice, graded response, or scenario format. The general areas queried were a) reasons for the initial choice and final choice of majors, b) perceptions of science and math as career choices, c) reasons for future career choices, and d) responses to difficult academic situations presented in a case-study format.

Questionnaire II was sent to all RSI alumni from 1984 through 1995 in December, 1995. Presently, 60% of RSI alumni (294) have responded to Questionnaire II, 186 males and 106 females. Although, the sample of RSI alumni is not complete nor the analysis of the data, striking and interesting differences and trends in responses of men and women to questions based on key factors involved in continuation in science are already noted in the preliminary data.

### Reasons for early choice of a science career

Although 90% of RSI alumni both male and female choose a science major upon entering their freshman year, the reasons for this choice differs according to gender. RSI women more often cite encouragement by family members and teachers and a greater opportunity to help others by science. RSI men in contrast more often cite their own native ability and interest as the primary reasons for choosing science. Correlated with this are gender differences in the initial choice of career setting and working environment. Women cite a setting in which there is an opportunity to help people while men choose a setting because it provides an opportunity for creative initiative.

### Science versus a nonscience college major

Sixty percent of RSI women and sixty-four percent of RSI men have changed their freshman plan of study by the time they declare their first major. For men, although they may change their field of science approximately 90% still remain in science at the time they declare their final major while women's numbers increase progressively toward nonscience choices as they change majors.

### Perception of difficulty of science careers and lives of scientists

RSI students, male and female, are equally interested in science careers during high





school and early college as evidenced by their performance, hobbies, and self-selection for RSI. During the course of undergraduate and graduate studies, the perception of science and scientists may change from positive to negative for those choosing another career path. When the RSI alumni were queried as to their perception of the practice of science, women were notably more negative about the extreme competitiveness of science than men. Both men and women agreed on the perception that a scientific career is more difficult for a woman but only women strongly agreed that a scientific career creates family conflict, leaves women isolated, and is more discriminatory to women. Women strongly agreed that science is as difficult for men as it is for women.

#### Reasons for choosing graduate school and career settings

Ninety percent of both RSI men and women strongly agreed as to the importance of attending graduate school. After completing their graduate education, women in choosing an area in which to work and its setting choose team work and an opportunity to help people as important factors. For men the level of income was more important than for women in the choice of type of work and setting

#### Ways to cope with difficult academic situations

RSI alumni were asked to choose the best response to six common though difficult situations that arise during the undergraduate and graduate years. The ability to successfully cope with such difficult situations without losing self-confidence may be key factors in the continuation in a science career path. Faced with a difficult course women more than men choose to find a tutor rather than work in a group or speak to the instructor. For someone struggling with the relevance to humanity of mathematical or scientific studies during university, women more often than men suggested an immediate practical solution and decision based on present experiences such as a summer internship. Males focused on long range goals and suggested more than women that the person "not worry, relevance will come with time". In a difficult graduate school situation when a relationship and dual positions in the same location cannot be found, males more strongly than women suggested that they should decide who will be the primary earner and then compromises should be made by the other party. For someone who considers themselves a minority and is having trouble with that status, women more often than men responded by suggesting the person find a role model and network with other minorities.

Although not complete, the RSI study is a singular and highly significant study. Its cohort of ability-matched males and females facilitates gender comparisons of personal attributes essential for career success and differences in gender responses to environmental and social challenges in a math/science career path. This study is equally applicable to the challenges, social and personal that high-ability women face in pursuit of an eminent career in business, politics, and industry as well as academics. Findings of this study will lead to recommendations for interventions for retention of

high ability women in the nation's talent pool and insurance of achievement of their full potential. It is the hope of the interventions and training designed as a consequence of this study that women will be protected from imbibing self-defeating socialization patterns and that in time the increased numbers of highly-talented women as are in the RSI will achieve at high levels in math and science and change the environment in which they must operate.

## **GUIDING ATTITUDES IN CAREER CHOICE: A GIRLS' SUMMER SCHOOL**

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### **Abstract**

January 1996 saw the running of the University of Southern Queensland Girls in Maths & Science Summer School for the seventh year. This Summer School brings 96 fourteen year old girls from all over Queensland for a six day residential school covering engineering, science and mathematics activities. As sponsorship is received from the Queensland Department of Education and the University of Southern Queensland the Summer School is completely free to all participants. All travel, meals and accommodation are covered.

The aim of the school is to encourage these girls from diverse backgrounds to develop and maintain their interest in mathematics and science for their remaining years at school, and then to pursue careers in engineering, science and technology.

Queensland, geographically, is the second largest state of Australia covering in excess of 1.7 million square kilometres (667 thousand square miles) and a population of just over 3 million. Thus the school gives girls from isolated and rural communities, as well as the larger cities, the chance to interact and participate in activities which they may not have had the opportunity to do before.

Approximately 350 girls apply each year and rigid selection criteria are applied. Girls are selected on the basis of their academic history, career aspirations and family background, with the aim being to select those girls who, because of environmental and social circumstances, may not have the opportunity or get the encouragement to consider non-traditional careers. Girls are chosen from both state and private schools with only one girl from each school being selected per year. Thus it is hoped that these girls will return home producing a 'ripple effect' generating interest and enthusiasm amongst their peers.

The range of activities offered includes hands on engineering and science, excursions, careers workshops and group cohesion workshops to name just a few.

This paper gives an outline of the school discussing detailed aims, selection criteria and activities undertaken as well as some quantitative and qualitative analysis of statistics pertaining to the students' participation.

## INTRODUCTION <sup>1</sup>

Since 1989 the University of Southern Queensland has been running an annual Girls in Maths and Science Summer School. To date almost 700 girls representing some 400 schools from around Queensland have participated in and benefited from the activities and philosophy of the Summer School.

During the 6 day school, the girls who are about to enter year ten are accommodated on campus and participate in a wide range of science or mathematics based activities such as electronics, Computer Aided Manufacture and firing rockets as well as excursions and workshops. These activities are run not only by University of Southern Queensland staff but also a diverse group of outside experts ranging from consulting engineers, CSIRO research officers (Commonwealth Scientific and Industrial Research Organisation) and The National Centre for Science and Technology to a professional acting group.

The girls, in groups of eight, are supervised by a facilitator who is an undergraduate student of USQ, usually from the Science, Education or Engineering and Surveying Faculties. The facilitators begin the Summer School the day before the girls arrive so as to familiarise themselves with the surroundings, timetable and committee members before the girls begin to arrive. Workshops are also run for the facilitators on such areas as supervision and group dynamics.

On the last day of the Summer School, parents are invited to join the girls on campus. A number of workshops and seminars are run for the parents including "Helping at Home - You, Your Daughter & Mathematics" and " 'Suitable' Careers - Where's She Heading?". This is to give some advice and information to parents who may be a little uncertain on the suitability of some non traditional careers that their daughters may be interested in pursuing.

## SELECTION PROCESS

Although the Faculty of Engineering and Surveying at the University of Southern Queensland traditionally has one of the lowest female participation rates in Australia <sup>2</sup>, the Summer School is not primarily used to recruit potential students. The selection process is undertaken by the Summer School committee and "aims to identify those girls who, for a number of reasons, would obtain the most benefit from the activities, stimulation and encouragement provided by the Summer School. "<sup>1</sup> As the Summer School can accept only 96 participants from nearly 400 applications the logistics themselves are daunting and present somewhat of a challenge.

Information is requested from both the girls and the principals of schools they attend on areas such as academic achievement, proposed career paths and extra curricular activities in the maths and science areas. However, such information is considered in the light of opportunities that girls already have and care is taken to focus on those girls whose current situation suggests limited opportunities and support. The committee tries to select girls who have sound academic skills in the maths and science area, but who might be lacking either the motivation, or role models to maintain and foster this ability.

These could be girls who have no close relative who has attended university and hence it might not be seen as an achievable goal, or a girl who is in the top ten to fifteen percent in maths and science but is not receiving the encouragement from either the school or the family to maintain these subjects. Many also come from rural areas or from "financially disadvantaged" situations.

### LONGITUDINAL STUDY

Over that last seven years there has been a huge amount of data collected on individual activities, pre and post attitudinal surveys, proposed career paths and actual courses undertaken at a tertiary level. The data on individual activities has always been collated yearly, to help plan the activities for the following year, however analysis of other information has never been undertaken fully. In fact, part of the project remains the collection of data to ascertain the long-term effects of the Summer School.

As data was collected over a long period of time and its analysis presented such a huge task an initial investigation was undertaken in 1995. This was to identify available data and determine the research questions to be answered given the resources.

This report recommended that the research concentrate on identification and description of patterns of behaviour/intended behaviour, associated with choices of school subjects, post-compulsory study, and/or employment of the groups rather than on attempts to find cause/effect relationships between Summer School participation and subsequent behaviour/attitudinal changes.

As the established aims of the Summer School state that it will endeavour to:

- encourage more girls to enrol in engineering, science and technology courses at the tertiary level <sup>3</sup>
- influence the subject selection of girls in Years 11 and 12 <sup>3</sup>

it is desirable that the longitudinal study investigate whether the school was in fact, meeting these aims. Thus, considering available resources it was decided to study the following set of research questions as priority number 1:

1. What are the career and course paths of the participants?
2. What are the career and course paths of non-participants?
3. Do career and course paths differ between participants and non-participants?

A detailed analysis of the data has revealed a number of deficiencies which has limited the extent to which definitive statements can be made. For example, the collection of data over seven years had been unsystematic due to staff changes over that time. Difficulties in interrogation include:

- problems in identifying clear criteria for differentiating participant/non-participant groups <sup>4</sup>
- problems in identifying complete cohorts <sup>4</sup>
- problems in “following” student cohorts through high school systematically <sup>4</sup>

The available conclusions from the longitudinal study report were, understandably disappointing. Because of the limitations with the available data, there were no clear conclusions about the effects of participation in the summer on career or course paths. Given the duration of the Summer School, this may be a perfectly plausible and logical conclusion to reach. Nevertheless there is a strong case for a qualitative study to be designed in order to understand what influences student decisions concerning career and subject selection, and what effect the Summer School, if any, plays in this selection process.

On the surface it is unreasonable to think that a one week experience in a fourteen year old girls life is going to have a profound effect on her career choice. The girls are selected because it is felt that they need an extra incentive to maintain an interest in ‘non-traditional’ areas. These girls are not ‘top’ academically, they have not indicated a great desire to pursue a technical career, nor do they have a family role model on which to base an aspiration for a university education, let alone a non-traditional career. They are girls to have the ability but through circumstance may be ‘lost to the system’ and not utilise those abilities. Whilst parents are mostly very supportive of their daughters and recognise the potential that they have, some of the literature suggests that they basically return to the same environment which may or may not nurture the goals of the Summer School. This begs the question - would a support system or network amongst the girls to help maintain the enthusiasm generated at the school? Would it help maintain the attitude that engineering, science and technology were realistic and worthwhile career goals?

Another inconclusive point of the longitudinal study was the actual and intended year 11 subject choice. Whilst data showed no difference between participants and non-participants in terms of numbers of mathematics and science subject undertaken at this level, no information was available for subjects actually available at the schools. Many rural and remote schools in Queensland do not have the variety of subjects due to small numbers of students attending the school. This is one point to be addressed in future studies.

Although there is limited quantitative data, feedback from the girls involved indicates that the Summer School does have an impact. This was captured by a quote written by a 1996 participant in “The Daily Buzz”, a newsletter produced daily by the girls. “This



week has given us an inside look at the versatilities (sic) of science and maths in everyday life. It has shown us the many ways that we can use it to help... We have been taught the World is changing and that females are being accepted for the work that we can do and that we are just as good as males, (if not better!!!!).”

Obviously changes in attitude even if they don't lead to a technical career are worthwhile, and in future must be monitored much more closely. Attitudinal surveys are conducted in the areas of science and mathematics however there was no information was available on the validity of the measures of the constructs used. Perhaps the route to take in future is to follow the paths of the girls much more closely, with personal interviews and a rigorously designed and implemented study.

## CONCLUSIONS

The Summer School has, for the past seven years tried to open the eyes of girls attending, showing them the diversity and depth of careers in engineering and science. The organising committee has tried to overcome the stereotypes of engineers in hard hats, scientist in white coats and that these careers are far removed from the reach of 'ladies'. But the attitudes and community knowledge of these careers makes this an immense task. Can the Summer School, in one short week, inspire the attending girls to reach for goals not thought of before? Maybe it can - “It was great to listen to (her) talk about real life experiences as a civil engineer and really inspired me to pursue a career which requires a university degree. Actually I never even knew what any type of engineer was until I came to this summer camp. I always thought that engineers were people who had their head jammed in a car motor, day in, day out. It's great to know that engineering involves many fun, interesting and dramatic experiences.”<sup>5</sup> The Summer School opens doors to career prospects that will remain open even if the student never chooses to walk through that door.

Obviously there is much to do in terms of quantifying our success, but (still based on the qualitative) evidence the committee and people involved in the Summer School, both past and present, are succeeding in changing the attitudes of the attending girls. “The participants left with an experience of diversity, challenge and enjoyment in relation to the topics of maths and science and their related careers.”<sup>6</sup> In the long term this can do nothing but benefit the community which has so generously supported the Summer School.

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## PERSPECTIVES OF FEMALE EXECUTIVE SCIENTISTS & ENGINEERS

### Moderator

Antionette Grayson Joseph  
Director, Office of Laboratory Policy and  
Infrastructure Manufacturing  
Office of Energy Research, Department of Energy

Antionette Grayson Joseph has directed the Office of Laboratory Policy and Infrastructure Management for over a decade. She supported the Director of Energy Research in developing policies and overseeing the institutional health and management of DOE laboratories, and in carrying out university, science education and technology transfer programs. Ms. Joseph also served in the field as Executive Director, San Francisco Operations Office from 1976-1978.

Previously, Ms. Joseph served as Chief of Operations and Facilities, in the Office of the Assistant Administrator for Field Operations in DOE's predecessor agency-- the Energy Research and Development Administration (ERDA). There she was responsible for the overview of operations offices, laboratories, and energy research centers. She undertook special management and organizational studies, affecting broad ERDA policies toward its field facilities and scientific resources during this period.

Ms. Joseph served with the Atomic Energy Commission (AEC) as Executive Director, Laboratory and Field Coordinator and in the Office of Special Assistant for Disarmament. From 1967 to 1970, she worked on international and political aspects of arms control and disarmament. She won several awards, including the 1989 Rank of Meritorious Executive from President Bush.

Ms. Joseph received a B.S. in Education from Indiana University of Pennsylvania in 1962, an M.A. from the University of Missouri in 1963, and an M.P.A. in Public Administration from Harvard University Kennedy School of Government in 1971. She and her husband, William C. Grayson, Jr., daughter Kathy and son Billy, are residents of Bethesda, Maryland.

### Recorder

Michele D. Fish  
Director, Women's Programs in Engineering  
Cornell University

**Presenters**

Beverly K. Hartline, Ph.D.  
Associate Director and Project Manager  
Thomas Jefferson Accelerator Facility

Linda C. Cain, Ph.D.  
Director, Office of University and Science Education  
Oak Ridge National Laboratory

Cherri J. Langenfeld  
Manager, Chicago Operations Office  
US Department of Energy

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

## PERSPECTIVES OF FEMALE EXECUTIVE SCIENTISTS & ENGINEERS—PANEL DISCUSSION

Michele D. Fish

Cornell University  
Ithaca, New York

This panel was assembled to inform others about the Department of Energy (DOE), describe what the panelists do within the DOE, and convey some of their experiences relating to programs for women, as well as their personal experiences as women climbing the corporate ladder.

**Moderator and Panelist: Antoinette Grayson Joseph, Director, Office of Laboratory Policy and Infrastructure Management, U. S. Department of Energy, Washington, DC**

Toni Joseph began her career 30 years ago as a management intern at the Atomic Energy Commission (AEC), now the Department of Energy. Before doing so, she attended graduate school and received teaching credentials in chemistry, history, and Spanish. She decided to work for two years before beginning a teaching career. (She admits that her career path was determined more by the graduate fellowships she received than by any career plan.) It was the time of John F. Kennedy who had asked the question, "Ask not what your country can do for you . . ." Being socially minded, Toni decided to work in Washington to help President Kennedy. Unfortunately, there was a government hiring freeze at the time, and the only offices hiring were the Department of Defense, the Central Intelligence Agency, and the Atomic Energy Commission. She had offers from all three, but chose the management intern position at the AEC and has never regretted it.

The DOE is a large investor in basic and applied research—more than the National Science Foundation. There is also a large emphasis on physics, more than the National Aeronautics and Space Administration or the Department of Defense. There are currently 28 facilities used by 278 colleges and universities, a growing number of companies, as well as other federal laboratories and agencies. These are examples of major science and technology partnerships that help keep the U.S. on the cutting edge in many scientific fields.

The main challenges of the DOE include maintaining scientific productivity, sustaining the research infrastructure—the scientific cutting-edge facilities that they build—and retaining, training, and using the best science and engineering performers. In addition, given the current budget situation, there is a real need to retain, maintain, and increase public support for science, and science education, which seems to be decreasing substantially.

From an historical perspective, in the 1950s there was an attitude in the country that women needed to be included out of fairness. In the 1960s it was because the law said you could not discriminate against women. Now it's not just that it's law, but a belief shared by the Secretary of Energy, Hazel O'Leary, that diversity, including women, helps to bring new and better solutions to science and technology problems.

Toni worked for the first woman to chair the Atomic Energy Commission, Dixie Lee Ray. She described Dr. Ray as a self-made woman who believed anyone who wants to succeed can succeed if they work hard enough. She believed that there was no difference between

men and women, that mentoring and networking were “silly”. However, Toni believes that Dixie Lee Ray was one of the greatest communicators of science in the AEC, and she was an excellent role model and a real mentor even though she never admitted it.. But even more often, men served as Toni’s most important mentors.

For some time there has been a commitment of diversity in science across the government. It is a heartfelt, high priority commitment of Secretary of Energy Hazel O’Leary who says, “Diversity still matters.” Her organization chart and her specific actions in support of diversity efforts are evidence of that continuing commitment. This commitment is demonstrated by the fact that there are several prominent high-level women in the Clinton administration with responsibility for determining high-level R&D policy, administering large science budgets, and managing major science activities. She noted that for the first time in her 30-years of service in the government, she is a woman, who works for a woman, who works for a woman, and half of her professional staff are women

Toni believes that women and men have to work together to make progress. They must form partnerships, have real, open communication, and learn to work in teams. She owes much of her success to her willingness to work on major task forces and working groups and to write the first draft.

**Panelist: Cherri J. Langenfeld, Manager, Chicago Operations Office, U. S. Department of Energy, Chicago, Illinois**

The Chicago Operations Office, one of ten field offices of the Department of Energy, works with laboratories and contractors to get research done. The laboratories include Argonne, Fermi, Ames, Brookhaven, Princeton Plasma Physics, Environmental Measurements, and New Brunswick. The government owns the laboratories, the physical property and equipment, everything except the people. Most of the people are employees of universities and there are contracts between the universities and government for operating the laboratories. These contracts are managed through the Chicago office with a budget of \$2.4 billion, mostly funded by the Office of Energy Research. The contracts employ over 6,000 laboratory researchers and visitors, 5,000 university researchers, 1,000 researchers from international institutions, and a small number of industrial researchers. There are 520 federal employees to oversee the more than 1,600 contracts.

Cherri was 37 when she took the position as only the second woman manager of an operations office (the first left after 10 months). Her qualifications for the position were developed through earning an undergraduate degree in civil engineering from Georgia Institute of Technology, working for Exxon for six years where she built off-shore platforms, earning a business degree from Harvard Business School, working as a member of The Boston Consulting Group, and working for General Motors in corporate planning and then as assembly plant foreman. For personal reasons she relocated to Washington, DC, and eventually decided to work for the Department of Energy. She spent three years in the policy arena working on technology transfer, the interface between the laboratories and industry. Through her work experience, she learned how to be an effective manager, gained the technological background necessary to talk with PhD scientists and engineers, and developed an understanding of the scientific culture, all necessary for her position. After working as the field office manager for awhile, the staff soon forgot that she was female. “. . . it took them longer to forget that I was 37 years old.”

Cherri believes that there are “people’s issues,” not “women’s issues” any more. First, she believes there are a lot of good guys—white males. When she arrived at the Chicago office, the entire management team of 13 was male. However, 50% of both the professional and

clerical positions were filled by women—these 13 men had done a good job. Cherri's challenge was to get these women prepared for upper-level positions.

Second, women sometimes hold themselves back. Today it is felt that women have more choice—many choose not to take more the challenging, stressful, demanding senior-level positions, which is acceptable in our society. Men, on the other hand, are expected to always take the promotion, and are looked upon negatively if they don't. Both need to be moderated. Third, child care is not just a woman's issue, it is a parents issue. There is increasing number of men who are single parents. Employers need to stop discriminating against any single parent.

Fourth, filling top-level positions with women is much easier in growing organizations or when political appointments can be made. Cherri does not have the luxury of either, so it will take time before enough positions are filled by women. And, sometimes a man is promoted because he is more qualified than a woman.

Cherri cited some advice on how to go about making changes given the above impediments and concerns: eliminate biases in hiring (e.g. women may not have as much hands-on experience as men because they haven't been in the workforce as long); don't make assumptions about what challenges men and women will or will not take; and provide mentoring for women to help them learn how to take on the challenges.

**Panelist: Dr. Linda C. Cain, Director, Office of University and Science Education, Oak Ridge National Laboratory, Oak Ridge, Tennessee**

The Department of Energy relies very heavily on an a well-prepared workforce. The Office of University and Science Education (formerly the Office of Science Education) works to ensure that there will be a science and engineering workforce reflective of the population in the future, as well as a general population that is literate and informed about scientific issues. Part of Linda's purpose is to help the public in general understand the importance of what the various federal agencies are doing and to encourage people to understand the impact that funding cuts can have.

The DOE employs scientists and engineers (6,000 in 1993), supports research out in the field in the area of energy, and supports students. For example, in 1991 70% of the 20,000 doctoral scientists and engineers in energy research and development were supported by the DOE. In 1994, 6,800 graduate students were supported by the DOE and its laboratories through funding given to colleges and universities.

In 1994, almost 1M students and teachers were touched by DOE laboratory education programs. Linda's responsibility is for the education programs across the Oak Ridge complex, including programs for K-12 students and teachers, as well as opportunities for faculty, undergraduate students, and graduate students.

One of the tasks that a group of DOE laboratory women have been involved is gathering data from the research facilities in order to look at the number of scientists and engineers and determine how many are female. While the group found that some facilities have good percentages of women researchers—18% at Oak Ridge, 32% at ORISE, and 21% at Pacific Northwest in 1993—the average is around 15%.

Linda is part of a group called the Laboratory Review of Programs for Women which was started about 5 years ago and meets about every year and a half. The review group came about through an interest of the technical staff at Argonne National Laboratory where they

saw that a lot was being done to encourage women at the laboratories, and by and large these efforts were informal. They decided to look at these efforts at Argonne and other laboratories periodically to identify the education programs going on at the DOE laboratories, and to assess the climate for women at the laboratories. Through this review, programs and activities at the laboratories are monitored (e.g mentoring programs, day care centers, alternate work schedules), and it seems that the competition among the laboratories works well. Lab A wants to be sure that it's doing as well as laboratories B and C in terms of providing these choices. As a result, improvements for women have been made.

Linda grew up in a small paper mill town in Maine, where her father was a chemist. She studied chemistry as an undergraduate at the University of South Dakota. This is also where she met her husband. She believes that as one moves into a career it is important to pick the right spouse. While attending graduate school in chemistry, she got pregnant. "I think at that point I was the only woman that went the hospital to deliver her baby taking her physical chemistry book because I knew I had to take my p-chem exam as soon as I got out."

Linda has had an interesting background, has done a lot of different things, and has studied a lot of different subjects. However, she believes that what is most important in her current success is the ability to work with a wide range of people. In any given day she may talk with a third grade student, a fifth grade teacher, a staff member from minority institution, and a distinguished scientist who has won the Nobel Prize. She adds to the panelists' list of what is important the ability to work and get along with people—to be able to communicate effectively, to not let your ego get in the way, to not take offense when offense may or may not be intended, and to stay focused and use the skills you need to meet your goals.

**Panelist: Dr. Beverly K. Hartline, Associate Director and Project Manager, Thomas Jefferson Accelerator Facilitator (formerly Continuous Electron Beam Accelerator Facility—CEBAF), Newport News, Virginia**

Beverly joined CEBAF in 1985 as a scientific assistant to the director. By March 1989 she had become the CEBAF associate director and project manager where she was responsible for the technical cost, schedule success, and construction phase of a \$600M laboratory. She notes that despite having managed a \$600M project, she still doesn't have 15 years of project management experience (referring to the fact that there have been ads for project managers that require 15 years experience, which eliminates a large percentage of women since most have been in the workforce a relatively short time as compared to men).

The DOE laboratories are known for using multi- and inter-disciplinary research teams that work across many fields. These teams have scientists, engineers, computer scientists, technologists, programmers, and technicians on them—every kind of person needed. The more kinds of people the better the problem can be solved. The DOE has a very broad scientific scope including high energy nuclear plasma and astrophysics, materials and chemicals sciences, condensed matter, atomic and molecular physics, and biological science/medicine/human genome, all using major state-of-the-art facilities.

The complex of DOE scientific facilities are the envy of the world, but the budget for operating them is going down 30% in the next three years, based on projections. That is trouble. Some people say that science will get whatever budget it deserves, which means, it will get whatever budget it can justify in the political climate the decisions are made. For this discussion, Beverly divides science into two areas: fundamental science and applied science (which the Republicans call "industrial welfare"). The argument with regard to funding seems to be about the balance between the two. Defense-related science, under the

Republicans, fares quite well. Unfortunately, they don't understand fundamental science. And, while applied science (e.g. energy efficiency, solar energy) is exciting and important to the country, but is not on the Republican agenda. As the decisions are made by a bi-partisan group, everything tends to suffer.

It's not clear that science does any worse with Republicans, but it is clear that science and engineering will do a lot better when we become better advocates with our congresspeople, when they get better science experiences when they go to college, and when all of us write our congressperson and senators letters to tell them the exciting activities we are involved in personally and how the federal government has made this possible. "It's individuals who are going to save science, if it gets saved."

As mentioned earlier, people work in teams at the DOE laboratories. As a woman member of teams, and as a woman in power, Beverly states that she believes one has to have a sense of humor and a reasonable threshold of what is considered sexual harassment. She worries less about herself, and more about the intent of the other person—some people are rude to everyone, not just women. Beverly has noticed that she does not seem to have the same credibility as a man with equivalent education or experience—she needs to prove herself, whereas what a man says is taken for granted—which is frustrating. However, she finds that women volunteer more and participate more in things that are good for the environment of the institution, e.g. employee recreation group, site-wide open house.

Beverly is married with two boys, and her husband's support has been essential since he has done a great deal of the child care. Beverly doesn't have daughters, but she has nieces. When it comes time for choosing gifts for them, or any young girl, she gives them volt meters, soldering irons, and other untraditional gifts. She decided this was important when she went to a class at the university level where no one, not even the boys, knew how to use soldering irons. Her goal is to help these girls get to the technological side of things.





## THE EXPERIENCE OF BEING A WOMAN ENGINEERING STUDENT: PERSPECTIVES AND COPING

### Moderator

Carmen B. Cannon, Ed.D.  
Assistant Dean for Student Services  
Howard University School of Engineering

In her position as Assistant Dean for Student Services at the Howard University School of Engineering in Washington DC, Dr. Cannon is responsible for managing the office which provides comprehensive support services to engineering undergraduates. She received her Ed.D. in Higher Education Administration from the George Washington University and her Bachelor's and Master's degrees from Howard University. Prior to joining the School of Engineering in 1972, Dr. Cannon served at the U.S. Library of Congress as a technical writer/editor for the NASA chronology, Astronautics and Aeronautics. Dr. Cannon has had extensive experience in all aspects of undergraduate student services, has published and presented on topics related to student development and diversity issues, and currently serves on the Board of Directors for both WEPAN and NAMEPA.

### Presenters

Linda Carlin  
Doctoral Candidate, Women in Engineering  
University of Washington

C. Jan Carpenter, Ph.D.  
Adjunct Professor, Psychology Department  
The Pennsylvania State University

Karen L. Tonso  
Doctoral Candidate, School of Education  
University of Colorado at Boulder

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# STRATEGIES OF WOMEN PURSUING DEGREES IN ENGINEERING & SCIENCE

Linda Carlin and Suzanne Brainard, Ph.D.

Women in Engineering Initiative  
University of Washington, Seattle, Washington

## ABSTRACT

This paper discusses two studies of academic self-confidence of undergraduate students pursuing engineering or science degrees at the University of Washington. The first, a longitudinal study of female students, has consistently revealed that these women experience a noticeable drop in their academic self-confidence during their first year of college, from which they never completely recover. Nonetheless, many of these women are able to develop and rely on other resources in order to persist in completing their degrees. Drawing on what these women have told us themselves, as well as analyses which have produced factors correlated with persistence, we describe the changes in self-perception these students undergo as they interact with the engineering and science environments of the university. The second study, a more intensive short-term investigation comparing female and male students, concluded that, although both groups experience initial drops in self-confidence, the patterns of loss and recovery differed slightly.

## INTRODUCTION

Over the past 15 years, there has been an increasing awareness of the lack of women in the fields of science, mathematics and engineering (SME), and a movement to encourage young women to enter traditionally male-dominated fields. Recruitment seemed at first effective (peaking in 1983 at 17% enrollment), but women continue to be underrepresented in SME fields.<sup>1</sup> Although women in the U.S. currently earn 51% of all bachelor degrees, they earn only 16% of degrees awarded in engineering, 11% of degrees awarded in physics, and 29% of degrees awarded in chemistry. Further, women make up 44% of the total workforce, yet they account for only 8.5% of the engineering professions, 9% of physicists, and 1% of chemists.<sup>2</sup>

Why is it that women do not pursue degrees in SME at the same rate as men? Initial attempts to investigate the reasons behind the lack of women in SME used biological evidence to support the conclusion that women are simply unable to meet the intellectual demands of these fields.<sup>3</sup> As most research eventually turned away from seeking explanations in biological differences, investigators began to focus on factors that create

and perpetuate gender role stereotypes, and the influence these stereotypes have on academic self-confidence and achievement.<sup>4</sup>

Rosser<sup>5</sup> refers to this research as a deficit model of female achievement. In this model, women are seen as lacking the skills needed to succeed in a male-dominated culture and told they must adapt to fit in with the traditional male gender roles in order to be successful. This conflicting message often produces detrimental results for high-achieving young women, such as low academic self-confidence and fear of speaking up or seeking help in male-dominated environments.

From the beginning, lack of self-confidence and influence of gender role expectations are reinforced by a variety of factors, as demonstrated in studies of child development. There is evidence that children as young as five years old hold strong gender role stereotypes, and begin to model their behavior according to those traditionally viewed as male or female.<sup>6</sup> Parents and teachers transmit their expectations to their children by encouraging differences in play patterns, and differentially reinforcing expectations of sons and daughters about academic performance and social activities.<sup>7</sup> Fathers, who often have the most influence on their children's career choices,<sup>8</sup> tend to spend more time on achievement-related activities with sons than with daughters.<sup>9</sup> The media has had a powerful effect on parents' expectations of their children. Eccles<sup>10</sup> observed that mothers' beliefs about their daughters' mathematics abilities dropped significantly after a widely-publicized 1980 scientific journal publication claiming significant sex differences in mathematics ability.

Classroom interaction studies have also shown that teachers reinforce gender-role stereotyping. Studies of student-teacher interactions consistently show that teachers spend a greater amount of time with boys, ask them more challenging questions, reward their interruptions,<sup>11,12</sup> and generally have higher expectations of boys than girls.<sup>13</sup> One study found that although teachers judged boys' competence based on age and IQ, judgments of girls competence included their level of compliance with teachers.<sup>14</sup> Boys are encouraged to speak up in class, but girls are actually discouraged. This differentiation in expectations is furthered by school counselors who neglect to tell girls about non-traditional career opportunities.<sup>15</sup>

Students reinforce these stereotypes in their interactions with each other. Negative stereotypes associated with giftedness are stronger for girls than boys. The view that mathematics is a male domain is generally held more strongly by males than by females.<sup>16</sup> The exception to this finding is high-school girls enrolled in high-level mathematics courses, who share the opinion that mathematics is a male domain.<sup>17</sup> Sherman speculates that this apparent contradiction may be another manifestation of the deficit model, which gives conflicting messages about what it means to be "successful" and what it means to be "feminine."<sup>18</sup> Females tend to feel less satisfaction with their performance on tasks defined as masculine,<sup>19</sup> yet, tasks defined as feminine are less valued, and not usually equated with success in our culture. Thus, high-achieving girls may see themselves as different from the norm and, as a way to resolve the conflict of gender roles, see themselves as being personally able to handle male domain tasks.

Despite findings of equivalent male and female achievement in high-school math<sup>20,21</sup> an abundance of published research exists about why "girls can't do mathematics." The news media publicizes these studies, thus reinforcing the persisting deficit stereotype.<sup>22</sup> As a result, research showing that females exhibit equal achievement to males in mathematics must take a defensive stance in order to challenge the stereotype.<sup>23,24</sup>

Research is beginning to focus less directly on questions of female abilities as the primary reason women do not persist in math- and science- related fields, and more on issues of academic climate.<sup>25</sup> The *chilly climate* of high-school math and science classrooms<sup>26</sup> and in particular the SME classes in college,<sup>27</sup> are significant topics of research.

To date, few studies have examined the intersection of academic climate, self-confidence, and academic performance in science- and math-related classes at the college level. Two such studies examining academic self-confidence of students pursuing degrees in SME are currently ongoing at the University of Washington. The goal of the first longitudinal study is to identify barriers, examine self-confidence levels over time, and develop a profile of the characteristics of women who persist in SME. The other, a short-term in-depth study of academic self-confidence in the first quarter of college, examines self-confidence in a different manner, and provides a male control group.

## STUDY 1

The Women in Engineering (WIE) Initiative at the University of Washington Undergraduate Retention Study, a 6-year longitudinal study, has been ongoing since 1991.<sup>28</sup> To date, five cohorts of SME students, totaling 554 women, are participating in this study. As first-year students, participants are contacted in Autumn and Spring for individual interviews. This personal contact can be a critical factor in retention since students are most at risk during their first year in college. Sophomores, juniors, and seniors are contacted by email throughout the year to notify them of various WIE programs, and in the Spring are sent an annual questionnaire. The interviews and questionnaires contain, among other things, questions designed to determine changes in academic self-confidence, persistence factors, and perceived barriers to obtaining a degree in engineering or science.

### Results

#### Self-Confidence

Academic self-confidence in math is measured each year for each student on a self-rating 5-point scale of ability in math and science. Math self-confidence, analyzed by repeated measures ANOVA, decreases significantly ( $p < .05$ ) between the Autumn quarter and Spring quarter of the first year in college (Figure 1). Self-confidence ratings begin a gradual increase in the sophomore year, and continue increasing through the senior year, but never return to the initial level. Self-confidence ratings for science show a similar

pattern. In addition, when asked whether they thought their self-confidence level had changed during their time in college, 25% of 4th- and 5th-year students reported a decrease in math self-confidence, and 21% reported a decrease in science self-confidence.

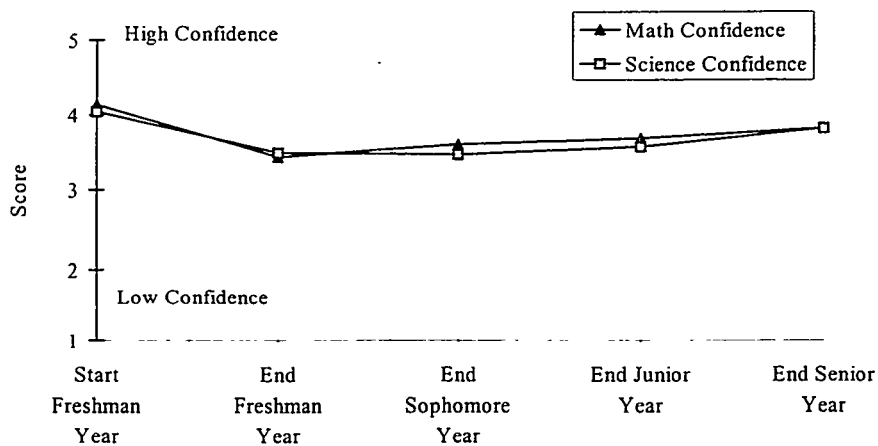


Figure 1. Mean levels of self-confidence by year

### Barriers

As anticipated, the most frequently reported perceived barriers for first-year students and sophomores are lack of self-confidence and concern about not being accepted into their department when they apply at the end of their sophomore year (Table 1). Approximately one-fourth of the first-year students, sophomores, and juniors report that they feel no barriers to completing their degrees. Surprisingly, by the time they are seniors, all of the remaining women in our study, many of whom had earlier reported no barriers to their academic progress, report at least one barrier. The percentage who report low self-confidence as a barrier has almost doubled since their first year.

Table 1. Most Frequently Reported Perceived Barriers

Barrier	First-Year	Sophomore	Junior	Senior	Average
Not being accepted into department	29.4%	29.4%	3.0%	N/A	20.6%
Lack of self-confidence	32.1%	21.8%	18.2%	57.1%	32.3%
Lack of interest	15.7%	21.8%	18.2%	68.6%	31.1%
Financial problems	17.4%	19.9%	21.2%	42.9%	25.4%
Poor advising	8.4%	12.7%	15.2%	51.4%	21.9%
Intimidation/competition	17.6%	20.4%	12.1%	34.3%	21.1%
None	28.9%	24.6%	30.3%	0	21.0%

### Persistence Factors

There are a number of common factors which bear a strong relationship to a student's decision whether or not to persist in SME, whether to switch to another major, or to drop out of school altogether. Table 2 summarizes factors, by cohort, which have shown, based on chi-square analyses for independence, a correlation ( $p < .10$ ) with persistence in SME. Factors in the first two years center on academic achievement and concerns about acceptance into a department. In the junior and senior years, persistence factors turn more to interest in coursework and support from faculty and family (particularly mother).

Table 2. Persistence Factors for Women in SME

<u>First-Year Students</u>	<u>Juniors</u>
Enjoyment of math and science	Interest in coursework
No problem adjusting to difficulty of college courses	Positive influence of WIE
No problem adjusting to lack of one-to-one help	Positive influence of advisor
Competition seen as a motivator	Positive influence of mother
<u>Sophomores</u>	<u>Seniors</u>
Registered pre-science or pre-engineering	Positive influence of WIE
Influence of math and science classes	Positive influence of mother
Acceptance into a department	Positive influence of advisor

### STUDY 2

As shown in Study 1, the initially high level of academic self-confidence of women pursuing an SME degree drops precipitously during their first year in college. In order to further investigate this finding, and to compare it with a male control group, a second study focused on the experiences of these students during their first quarter in college.

Participants in this study were 130 high-achieving students (mean high-school GPA of 3.8) who were self-identified as pursuing an SME degree. All of the students were enrolled in the same courses (calculus, chemistry, and English or a social science), which enabled an analysis of performance across a variety of academic areas. Each student completed a questionnaire which included family description, educational background, initial self-confidence, educational interests and goals, and performance expectations. Students completed a series of questionnaires throughout the quarter which asked them to estimate their academic performance at that point in time. Each student then participated in an in-depth individual interview focused on perceptions of academic ability. Finally, at the end of the quarter, all students' grades were obtained from the registrar's office to determine if there was a relationship between judgments of academic ability and actual performance.

## Results

Academic self-confidence was measured in the calculus and chemistry classes before and after mid-term exams and before and after final exams. Similar measures were taken for English or social science class at the time that mid-term and final papers were due. A repeated measures ANOVA revealed a significant decrease ( $p < .05$ ) in self-confidence in all three classes for both males and females. Although there was no significant difference in self-confidence between males and females at any measurement point, there was a consistent pattern evident in the mean self-confidence scores of males and females. Across all three courses, males reported a higher initial self-confidence which would drop significantly, and then begin to return toward the initial level. Females would report a more conservative initial self-confidence which would then drop slightly and continue at the lower level.

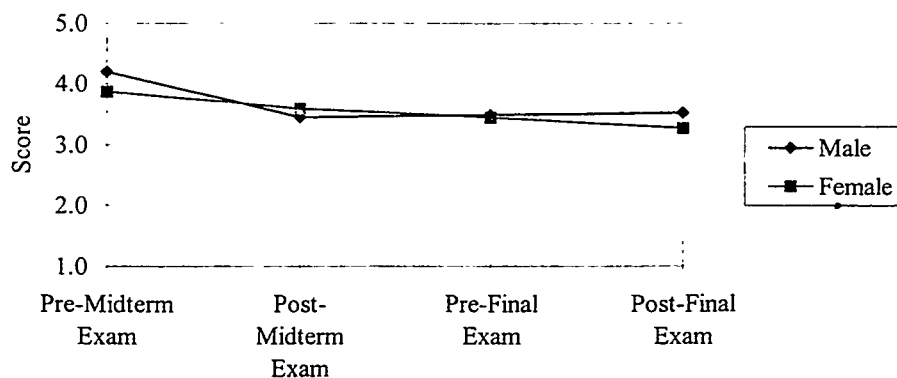


Figure 2. Self-Confidence Scores in Calculus

## DISCUSSION

Because of the rigorous nature of SME curricula, we would expect academic self-confidence to be a mainstay of anyone completing an SME undergraduate degree program. However, this is not the case for the women in our study. Our data consistently show that the high level of self-confidence these women have in their math and science abilities upon entering college drops precipitously during their first year in college. Although self-confidence levels begin to rise again throughout the remainder of their education, they never return to initial levels. A comparison of self-confidence levels, grade point average (GPA), and persistence in SME shows no significant relationship; i.e. the decision to switch out of SME is independent of GPA and academic self-confidence. Further, the women who do persist, although maintaining an average GPA of 3.2 suffer from a decrease in academic self-confidence.





When examining this issue of self-confidence from two perspectives, we come up with some similar findings and some differences. The findings of Study 2 suggest that both male and female high-achieving students experience a significant decrease in their academic self-confidence during their first quarter in college. The surprising result was that males begin and end with a higher estimate of their abilities. Females tend to report more conservative estimates, which take an initial drop and remain low throughout the quarter. These patterns of reported self-confidence were consistent across calculus, chemistry and English (or social science) courses, despite the fact that there were no sex differences in final grades in any of the classes or in the overall average first-quarter GPA of 3.0.

This finding leads to an interesting question: how much are these students' responses influenced by the "social acceptability" of their beliefs about their academic ability? As one female math major put it, "*I would rate myself a 4 or even a 4 1/2 (on a 5-point scale), but rating myself a 5 would be bragging.*"

Admittedly, the level of discrimination of our measurement instruments was not fine enough to answer this question. The questionnaires were simply measuring what they say, not necessarily what they think about their abilities. This finding suggests a need for an instrument that could measure what *students actually think* about their self-confidence in order to further explore the issue of self-confidence.

In addition to these finer measures of self-confidence, good measures of climate are needed in order to examine the relationship between climate and self-confidence for both males and females. As developmental studies have shown, it is the climate of the classroom that shapes a child's perception of her/his abilities. The academic climate in SME is decreasing, rather than increasing, students' self-confidence. Although the long-term implications are unknown, our findings show that this decrease in self-confidence is more of a barrier to women than men in their first year in SME. Possibly this outcome is due in part to the isolation women feel already when pursuing a still male-dominated area of study. Until there are enough women in SME to reach *critical mass*, the term being used for equity in numbers in education as well as the workplace, and the source of this decrease in self-confidence is determined and rectified, retention programs for women that focus on persistence factors play a crucial role in assisting women to complete their SME degrees.

Finally, it is important to continue tracking the relationship between climate, self-confidence and performance as women move into their careers and examine what happens to self-confidence and its relationship to corporate climate and performance.

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## CREATING ENGINEERS: PROCESSES THAT EXCLUDE WOMEN

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### INTRODUCTION

There is something about engineering that makes it difficult for women to become full-fledged members of the engineering community. Mason (1991) reported that U. S. women earn 15% of undergraduate degrees in engineering and occupy only 7% of engineering jobs. Seymour and Hewitt (1994) investigated the reasons undergraduate science, math, and engineering students leave these disciplines. They found that the "weed-out" system disproportionately impacts women students, resulting in their feelings of personal rejection, discouragement, and reduced self-confidence. McIlwee and Robinson (1992) compared the work experiences of similarly educated men and women engineers and found that women engineers were over-represented in lower status jobs (e. g., marketing and sales engineers, production engineers) and under-represented in higher status jobs (e. g., design engineers, engineering managers). They documented the extent to which women's reduced levels of organizational resources (e. g., aggressive self-promotion, confrontational interaction styles) contributed to their downward mobility over time. Vetter (1992) studied factors that "hold up the glass ceiling" in scientific and technological workplaces. She found that women's lower salaries, higher unemployment rates, over-representation in temporary positions, and fewer opportunities for advancement resulted from social prejudices, customs, and societal myths about the appropriate roles of women.

Because Vetter, Seymour and Hewitt, and McIlwee and Robinson drew their data from government statistics, surveys, and interviews, certain *in situ* realities could not be investigated. To bridge this gap, I moved my research into the day-to-day lives of (sophomore) student engineers working on design teams and augmented participant-observation field notes with face-to-face interviews. In Tonso (1996a), I reported that women students and faculty must appear to accept cultural norms of discourse that valorize men's use of profanity, semi-sexual humor, and violent metaphors. If women students and faculty were to be accepted in engineering, to fit in and not stand out as different, they could not openly resist or challenge these norms. This suggested processes for creating engineers that systematically exclude women.

To further investigate the processes at play in engineering education where construction of an engineering identity begins, subsequent research (Tonso, in progress) focused on design teams at freshman and senior levels. For the design-team research, I attended classes for the duration of the design course (one semester for the freshman and sophomore classes, two semesters for the seniors), as well as attending out-of-class team meetings of from two to four hours per week per team. Altogether in the freshman, sophomore, and senior design classes, I followed seven teams closely, a total of 33 students (15 women and 18 men). I interviewed each student engineer twice and each professor once (four women and seven men). These data from four semesters of classroom ethnographic research are extensive

In this paper, I concentrate on a very narrow subset of my data - the responses of freshmen (7 women and 5 men) and senior (4 women and 6 men) student engineers to a pair of questions from the first interview, done midway through each class. I asked students "what does it mean to be a man (or woman) student on this engineering campus" and its follow-up "how would it be different if you were a woman (or man)." By comparing women's and men's responses between freshmen and senior levels, I found clues to the systemic processes (or institutional cultures) on an engineering campus, processes that contribute to the circumstances that exclude women from full participation as engineers. From this vantage point, I begin a conversation about what we, as women interested both in increasing the success of women in engineering and in developing an engineering culture better suited to modern exigencies, might do to promote changes in the "traditional" culture of engineering.

## SITE SELECTION, DATA COLLECTION, AND ANALYSIS

This research site is a public engineering college in the Rocky Mountains where women students comprised 21% of the undergraduate student body (Registrar's Report, 1993). Women's proportion of the campus population is somewhat higher than the 15% reported for women earning engineering degrees nationwide. The numbers of women student engineers continues to increase steadily on this campus. The 1994-95 freshman class had 33% women. Admissions standards are selective and typical of other engineering colleges.

On this campus, incorporating design classes throughout the curriculum began over ten years ago and currently all students take three years of design classes, at the freshman, sophomore, and senior levels. In each of their first three semesters of design work, all student teams solve the same design project for the same client. In their fourth semester (sophomore) and senior design classes, each student team completed a project for a different industry or government-agency client. These projects are typical of those that many novice engineers will be assigned on their first jobs. For instance, one of the sophomore teams performed a survey of historical buildings in a local mountain town and made recommendations for renovating buildings to bring them into compliance with the Americans With Disabilities Act. One of the senior teams designed and installed a PC-based data acquisition system to monitor the outlet pressure on sludge disposal pumps for a local power plant operator.

At the first meeting with one team, students immediately asked me how I would contribute to the team's work if they were "going to be fodder for my research." I agreed to work alongside the student engineers on the teams. However, because I was not a novice student engineer, but had worked as an engineer in the petroleum industry for 15 years, the students also expected me to serve as an engineering advisor to the team. By the time of the first interview, the student engineers were used to my participation on their teams and (during interviews) spoke with unusual candor about the circumstances on their campus.

Analysis of the ethnographic data used Spradley's (1979, 1980) systematic procedures of semantic domain analysis and Van Maanen's (1988) literary ideas about constructing vignettes. In this research, I did not take the perspective of a disinterested researcher, but used my experiences as an engineering student (over 25 years ago) and as an engineer (for 15 years) to provide a vantage point of one informed about both engineering work itself and marginalizing facets of engineering, and engineering education, for women. Repeated,

careful readings of the data strengthened the findings and served to rule out competing conclusions or theories.<sup>1</sup>

## RESEARCH RESULTS

Overall the students responded to the questions about what it means to be a man or a woman on this campus by saying that to be a man here means that you fit in comfortably, but that to be a woman means that you must learn how to fit in, you must prove that you belong. This suggests that on this engineering campus men's images of themselves are reinforced, while women's are rebuilt. Women seem able to ignore the differences to a somewhat greater extent than their male colleagues. Women may use this as a survival technique. I would prefer that women were engaged in thriving, and not just surviving, in engineering.

### Being a Man on an Engineering Campus

Being a man on this engineering campus meant that you would be surrounded by people just like yourself. Despite considerable evidence of men's privileged circumstances, by the time students reached their senior years, some of the men thought that they were the victims of reverse discrimination. Six students remarked that there were no differences between men's and women's circumstances, a comment that they each subsequently contradicted.

Most freshmen (0.80)<sup>2</sup> and senior (0.86) men student engineers recognized that they were surrounded by others just like themselves and that they fit in. Though none characterized this circumstance as "privileged," they were aware of the extent to which this made their lives as student engineers easier. For instance, it meant "just being one of the guys" (freshman man), "fitting into a role where you're more accepted" (senior man), and "not being subjected to the pressure of people thinking men can't do engineering" (senior man). In the words of a freshman man, "it's about as conducive a situation as you could hope for...because it retains the white males' approach...[and] you're welcomed with open arms." And another freshman student said "I would much rather be a man going to a campus like this, [because] that's what I've been prepared for,...to be a male in society." These two freshmen men were nontraditional students, returning for undergraduate degrees in engineering after some years working in construction. Their deeper sense of the realities is likely due to their being older and having a more comprehensive view of society. In fact, neither of these two nontraditional freshmen students thought that this was the way engineering education *should* be, just the way it happened to be at the moment. Rather surprisingly, only one freshman (0.14) and one senior (0.25) woman student noticed this, implying that men have it easier was "normal."

Two of the senior men (0.29), but none of the freshmen men, felt that they were the victims of reverse discrimination in the hiring process on this campus. Since both of the senior men made several interview trips and accepted attractive job offers early in their final semester, these comments seemed ludicrous. I was struck by their characterization of affirmative action as discrimination. As with most arguments of this sort, their appreciation

<sup>1</sup> See Tonso (1996b) for a more thorough discussion of ethnographic methods in engineering education.

<sup>2</sup> Numbers enclosed in parentheses indicate the number of students in the category who expressed this result, given as a percent of the total number of students in the category. I include these numbers to give an indication of the extent to which my student respondents held these views.

of the realities failed to take into account that men take more interview trips (per capita) than women and that men receive more job offers, which I confirmed in conversations with the campus placement office. The information that the students used to reach this conclusion appears to be limited to the on-campus interview lists where women were, in fact, over-represented - at the request of interviewing companies. The argument that they were discriminated against contradicted these two students' sense of themselves as fitting into engineering better than women.

Not all of the students recognized differences between men's and women's circumstances during all parts of their interviews. When asked about being a man on this campus, six students (Freshmen: 0.20 of men, 0.43 of women; Seniors: 0.14 of men, 0.25 of women) thought there were no differences in the circumstances of men and women. However, every one of these students subsequently gave examples of differences between men's and women's circumstances on campus. This suggests that students learn to selectively ignore some differences. For instance, one senior man student said there were no differences, but in another place in his interview told me that "there are a lot of people just like [me]." He did not recognize that women had fewer opportunities to associate with other women. This suggests that some men may not be able to see things from women's perspectives. Since men hold most of the senior faculty and administration positions on engineering campuses, this raises questions about the extent of men's blind-side on women's circumstances on engineering campuses and about men's abilities to change engineering to make it more inclusive of women.

### Being a Woman on an Engineering Campus

Being a woman student on this campus meant that you had to learn to "deal with" men, that you had to work harder to fit in, and that you would associate with many more men than women. Some of the women, but none of the men, thought there were no differences between the circumstances of men and women students. Some of the men, but no women, thought women received preferential treatment.

Women on this campus are expected to learn to "deal with" men and to put up with bias (Freshmen: 0.40 of men, 0.57 of women; Seniors: 0.29 of men, 0.50 of women). Women were more acutely aware of this than men and men's awareness declined somewhat with time. Women's remarks included that they "have to get along with men" (freshman) and "have to deal with guys that think women shouldn't be here" (senior). However, one freshman woman student thought that "being associated with men more is good for women" since that is what a woman can expect on the job. Men recognized negative attitudes toward women, commenting that "women are kidded about getting extra 'girl points'" (senior) and "women [have to put up with] standard-issue stereotypes [of women in engineering], such as being unattractive, overweight, and picky about men" (senior).

Students thought women had to work harder to receive the same amount of respect (Freshmen: 0.40 of men, 0.29 of women; Seniors: 0.29 of men, 0.25 of women). Men stated that women "have avoided society's push toward art, sociology, and psychology" majors to study engineering (freshman), must "learn a new language [to become engineers], a language developed by men" (freshman), and are "more determined and have to prove everybody wrong" about women's lack of aptitude for engineering" (senior). Women commented on "professors grading women's work harder" (freshman) and on "having to try twice as hard to be heard" (senior).



Women students noted that they associated with men more than with women, though none of the men students noticed this. Opportunities for women to associate with other women seldom existed. Only one woman student identified such a place, her sorority. Thus, it seems that not affiliating with other women is part of the accepted order on this campus.

Surprisingly some of the women, but none of the men, said that there were no differences between the circumstances of men and women (0.43 of freshmen women, 0.25 of senior women). In a fashion similar to the responses about men's privilege on this campus, learning to ignore the realities may be one of women's survival techniques.

Three of the men students (0.40 of freshmen, 0.29 of seniors) thought that women received preferential treatment. Comments included opposition to affirmative action (seniors), as well as perceptions of professors "cutting women slack" (freshmen).

### Dating on Campus

Because of the discrepancy between the numbers of men and women on this campus, some students expected men to have fewer dates (Freshmen: 0.20 of men, 0.43 of women; Seniors: 0.14 of men, 0.25 of women) and women to have more (Freshmen: 0.40 of men, 0.14 of women; Seniors: 0.29 of men, 0.25 of women). Holland and Eisenhart (1990) detailed the ways that college students "learn gender" from their peers during extra-curricular peer-group interactions. In what Holland and Eisenhart call the culture of romance, "even though men and women paired up according to an equivalent level of attractiveness, and though women and men exchanged tangibles and intangibles of equal value, their relations turned out to be unequal. They were unequal because women's attractiveness - and in some sense, social worth - was a function of their appeal to men, whereas men's attractiveness and social worth were reckoned according to their appeal to women *and* their success in sports, music, business, and other fields" (p. 211-212, emphasis in the original). On the engineering campus, the imbalance between men's and women's numbers disrupted these societal norms about pairing up according to equivalent levels of attractiveness.

One man freshman student engineer gave an involved explanation about dating on this campus, an explanation I had heard before. According to this student, since there are fewer women than men, even the not-so-good-looking women get asked out by the best-looking men. He thought that "when you go to a school where most of the people are guys, all the girls automatically get like bumped up into a higher social class" and the girls become "stuck up." Since this young man did not consider himself in the good-looking-guys category, he did not expect to date on this campus. His lack of money and a dependable car contributed to his not dating women from other colleges. Of particular interest to me was the way he turned his argument into "what's wrong with women" and avoided thinking about what might be wrong with an engineering education culture that by-and-large guarantees more men than women.

## CHANGING ENGINEERING CULTURE

There is substantial evidence that being a woman on an engineering campus requires swimming against the current. Many of us have done this and been proud of our efforts, but the fact remains that this sort of culture discourages women from participating. Women's numbers will be lower. Changing the women seems unlikely to lead to the kinds

of changes in the culture that are needed. The time has come to turn our conversations away from how to change women and to undertake conversations about what is wrong with engineering and engineering education and how to change the culture.

Discussions in educational philosophy about an "equality worth having," provide a useful starting point for the kinds of conversations I believe are needed. Howe (1993) describes a participatory interpretation of equality of educational opportunity that moves beyond formal<sup>3</sup> and compensatory<sup>4</sup> interpretations, where many of our women-in-engineering efforts reside. He borrows from the critical theorist Iris Marion Young who observed that "groups with different circumstances or forms of life should be able to participate together in public institutions without shedding their distinct identities or suffering disadvantage because of them. The goal is not to give special compensation to the deviant until they achieve normality, but rather to denormalize the way institutions formulate their rules by revealing the plural circumstances and needs that exist, or ought to exist, within them" (1990, quoted in Howe, 1993, p. 333-4). Or in Howe's words, a participatory interpretation "takes into account that *the shape of change must be negotiated in a way that takes seriously competing voices that historically have been silenced*" (Howe, 1993, p. 334, emphasis added). I recommend that we concentrate our future efforts on demonstrating that women are not the problem, engineering is, and on guaranteeing that all persons be heard in forums where participants can speak openly without fear of retaliation.

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<sup>3</sup> Formal - advocating equal access, only the "absence of formal (especially legal) barriers to participation based on morally irrelevant criteria such as race and gender" (Howe, 1993, p. 329)

<sup>4</sup> Compensatory - "to help shape desirable educational careers [for children] by compensating for characteristics of individuals that disadvantage them in educational institutions" (Howe, 1993, p. 331)

## NAVIGATING CAREER AND FAMILY PATHS

### Moderator

Susan Staffin Metz  
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Susan Staffin Metz is the Director of the Office of Women's Programs at Stevens Institute of Technology and co-founder and Vice President of WEPAN. She has been successful in bringing to Stevens and WEPAN, major grants from the National Science Foundation, U.S. Department of Education, and the Sloan Foundation, to increase access for women in engineering. Special WEPAN projects include, chairing the National Conference; editing *What Do Engineers Do?*, a book of hands-on labs for pre-college students; designing *Career Encounters: Women in Engineering TV/Video program*; and implementing the WEPAN Regional Training Seminars. Her most recent project funded by the Fund for the Improvement of Post Secondary Education (FIPSE) is a two volume publication entitled *Increasing Access for Women in Engineering*.

As Director of OWP, Susan is responsible for all staff and budget management, program design, fundraising activities, pre-college, undergraduate and graduate programs. Stevens' nationally recognized pre-college initiatives have involved over 16,000 students, teachers, counselors and parents since 1978.

### Presenters

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## NAVIGATING CAREER AND FAMILY PATHS: AN INTRODUCTION

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Navigating career and family paths continue to be a major challenge in the US. There is no ideal approach and our occupational structure and occupational culture does not adequately support spouses engaged in two careers who are raising children. The panelists in this session will be discussing their career and family paths by identifying obstacles, challenges and personal strategies for success. The issues facing female faculty in engineering and science appear to be even more complex according to Gerhard Sonnert's and Gerald Holten's *Project Access* study which looks at careers of women who earned elite postdoctoral fellowships.<sup>1</sup> I will begin by first giving you an overview of *Project Access* which I anticipate will provide a foundation for our subsequent discussions.

Sonnert and Holten mailed surveys and received responses from 460 (361 men and 99 women) who were former awardees of a National Science Foundation post doctoral research fellowship during the years 1952-1985. An additional 239 (147 men and 92 women) responses were obtained from former recipients of a National Research Council postdoctoral associateship during the years 1959-1986. The 699 responses represented all female recipients and a control group of men. In addition to the survey data, the sociologists conducted two to three hour personal interviews with 92 men and 108 women. The findings pertinent to this session are discussed below. I would encourage you to read the entire study which has many interesting findings related to gender differences in socialization, scientific and professional styles, methodology and career psychology of these scientists and engineers.

The women in this study fared well on the institutional prestige scale. Twenty-nine percent (29%) of the women in academe and 27% of the men were employed at institutions ranked among the top 15% (Jones, Lindzey and Coggeshall, 1982).<sup>2</sup> However, according to the *Project Access* data, "the women paid for prestigious affiliation with disadvantages in rank achievement, whereas men did not experience such a trade off." There was substantial variation among academic fields in rank achievement. In biology, there were no statistical differences in the career progress of women compared with the career progress of men through the academic ranks. However, Sonnert and Holten found great gender disparities in the physical sciences, mathematics and engineering. The younger cohort of female scientists held positions one full rank below the men in the same cohort. Forty-one percent (41%) of the men in this younger cohort had achieved the rank of full professor while only 23% of the women held that rank.

*Project Access* did not find any strong relationship between marital and parental status and career outcomes for men and women. Yet the authors believe that the relationship does exist, only "the interactions have become too complex to be captured by

broad variables as marital or parental status. If a career in science is considered a path that takes many turns, it is clear that at certain points family factors do have an effect on the path."

In support of this assumption, Sonnert and Holten present data on their respondents who selected a postdoctoral fellowship in a specific location to be with a spouse. These scientists were less successful in future academic rank achievement than those who did not site location as a motivation for accepting a particular postdoctoral fellowship. Women (24.5%) were more likely than men (8.5%) to take their postdoctoral fellowships for this reason. Furthermore, if the family had children, the spousal role's tended to shift toward more traditional gender roles resulting in the husband's career becoming the priority. Sonnert and Holten found that, "women with children were more likely to take the postdoctoral fellowship to be with a spouse than were women without children 30.1% vs. 22.0%." The opposite effect was observed for men with 3% of the men with children compared with 12% of the men without children taking a postdoctoral fellowship to be with their spouse.

Another interesting finding that is supported by a study conducted by Weiler and Yancey<sup>3</sup> indicates that female scientists are more likely to be married to another scientist often in the same field. Sonnert and Holten found that 62% of their married female respondents but only 19% of their married male respondents had a spouse with a doctorate. Therefore, women are more often faced with the "two body problem", finding two academic science jobs in one location.

Family leave for pregnancy is another issue that is all but clear-cut. The Federal Pregnancy Discrimination Act of 1978 requires employers to treat pregnancy no different than other disabilities. The Family and Medical Leave Act, signed into law in 1993 covers approximately 50% of all employees, allowing up to three months unpaid leave. Yet, how many female faculty members engaged in science and engineering feel comfortable enough with their professional status or development to take advantage of this policy?

Women's experiences with maternity leave are influenced by more than policy. In this male domain, a woman's decision to take time off for pregnancy, childcare, or eldercare are affected significantly by the general culture of the workplace.<sup>4</sup> Cooney and Uhlenberg<sup>5</sup> maintain that though faculty members of all ranks believe the family leave for pregnancy should be given as a benefit, rarely if ever do men take family leave for the addition of a new child and female faculty don't usually take even the allotted allowable leave time. They cite peer perception of their non-commitment to their field as the greatest reason for not doing so.

In another article based on *Project Access*, Sonnert suggests an approach to begin to address these complex issues. "The subtle nature of gender disparities implies that a quick fix is unlikely. What is called for is diversity and flexibility in policy initiatives. Rather than a neat master plan, the US science community needs a large number of varied even parallel programs that expose all of the budding and active scientists to different opportunities, increasing the changes that a scientist will find one he or she can take advantage of."<sup>6</sup>

We will begin this session by introducing the speakers. The panelists, Dr. JoAnn Silverstein, Dr. Carol McConica, and Dr. Carol Muller have all paid considerable attention to their career and family issues, albeit some in retrospect, and are graciously willing to share what they have experienced and learned.

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## NAVIGATING CAREER AND FAMILY PATHS: A PERSONAL PERSPECTIVE

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There are few challenges requiring more long term sacrifice, endurance, and perseverance than that of balancing work and family. When a working woman becomes a mother she inevitably trades away focus for balance. Some would say she has traded excellence in one thing for mediocrity in several. I believe such judgment is the result of a white, western, male culture that worships telescopic views over wide angle lenses. In my view, fully developed human potential can only come from fully balanced challenge, and nothing presents fully balanced challenge more than children and career.

Now that I am 44 years old and the mother of a 20 year old son and a 17 year old daughter, I find myself looking back over my past choices as I try to guide my grown children. I made some good choices and some poor choices. I would like to share the ones that worked and make suggestions with regard to the ones that did not.

Initially, I would like to emphasize that my challenges, options, and choices are unique to who I am. I can offer no formula, for each person must work out their own. Your path can only be dictated by your soul. Take input from all sources. Where you cannot find people, use books. Autobiographies, women's literature, and modern behavior literature have been especially valuable to me in my search for validation and understanding.

The keystone to managing family and career is in the choice of an appropriate spouse. Your ultimate role will be dictated by the roles your spouse will willingly accept. As a teenager growing up in Colorado, I quickly learned that one of the best ways to choose suitable dates was by sharing a mountaineering weekend with a young man. It quickly became obvious if I had a partner or a self centered achiever on hand. Go mountaineering, especially winter mountaineering, with young men and you quickly know who will cook, wash dishes, lead, and more importantly, who will let you lead. By my sophomore year I had a quick litmus test: a jog around the park. If the guy left me behind as he did his 5 minute mile, I dumped him. If he went my pace until I was done, I continued the relationship... and then went mountaineering with him. I married one of these patient people my junior year of college and have found it to be a perfect predictor.

My husband of 23 years cleans, does laundry, pays bills, works hard and tries to put the family above his own selfish interests: both with respect to career and athletics. He always let the children set their pace, while he adapted. Whether it was hiking, skiing or dating, he responded to their needs. In 20 years of parenting he has never missed a school event, a swim meet, gym meet, a scout meeting or a neighborhood gathering. He served as a community scout leader for 10 years, taking boys camping one weekend a month throughout most of those years. Where he could, he incorporated me as a leader and included our daughter.

It has been of greatest reassurance to me that I have a husband who is as capable in the home as I. I could travel with ease, take time for my own career, and was always supported in my decisions. While it is true that the split of work was never 50/50, my husband has dedicated more than most men at his level of career success. He willingly gave up a management position because he preferred engineering, and preferred to have time with us. The challenge for a young woman is to find a man who is driven enough at work to retain her respect and yet still puts her professional needs at the same level as his own. If I had to guess, look for that B+ student who is not afraid to "have a life" and yet still values his field.

It is critical that young women realize the forces at work on a man in this culture. The white, western culture dictates that a man's identity come from his work, not his home. As a consequence, the culture forces him to choose work above all other needs. A man who is driven to be the top male in his field is completely bought into this culture, and will probably not make the career sacrifices a woman will need him to make in order to support her as a working mother. The exception would be a man in a strong religious organization which puts high priority on family. The male network will then insure his efforts in this arena. It is difficult to predict which young man will support a woman over her career. One recommendation would be to visit his parents to observe the roles they have adopted. If the mother's life outside of the home is respected and supported, her son will probably be supportive. If the father frequently gives up work time to do groceries and to cook dinner, he was an excellent role model.

After finding the best spouse, the next most frequently asked question has to do with children and the timing of those children. I would never, ever give up having had children. My career has been my biggest headache and heartache. My children have been my greatest joy. While children have been my joy, my timing was terrible. I chose to have children while working as a full time teaching/research assistant at Stanford. I had been told by an engineer from AT&T that engineering companies had no policies for working mothers, and if I wanted children, I had to do this while I was in college. I chose to overlap two of the most challenging tasks known to humankind: graduate school at Stanford and having babies. It was hell. Stanford had no leave policy (unpaid) for student employees, so I was given one day off for each childbirth. Thank goodness I had a flexible and supportive research adviser. Most faculty were not so tolerant.

While at Stanford I looked all over campus for a married female professor with children. There were none. They were either divorced or without children. The male faculty often lived lives where their families were neglected or at worst, abused. More than one male faculty member was openly having affairs with students. I felt completely without identity, for I could not value most of those professors. As a woman, I did evaluate their personal lives, and I simply could not respect many of them. It is very hard to get excited about a career when you have little personal respect for the faculty. Fortunately my advisor is an honorable man, a man I could and can admire without question. I believe that engineering schools often discount the importance of the personal lives of the faculty to the female students. It is a factor which needs to be considered when hiring faculty. As an undergraduate, my favorite faculty member was the one with seven children who rode his bike to work because he left the car with his wife. As a graduate student, my favorite faculty were the ones who volunteered at the day care center when I was there with my children.

Young women know they will not have a wife at home to serve them, so when they only see faculty with wives at home, there is little belief that they, as women, will actually be able to be engineers. It is also interesting that the harder the faculty are driven to obtain prestige as

engineers, the greater the gap becomes between the faculty and a young woman's anticipated reality. A man who works 60 to 70 hours a week is living proof that she cannot have his job and expect to be a mother. Personally, I want my daughter to attend an engineering school where the faculty leave at 5 pm, have working wives, are community leaders, and spend hours with their children. The impact will be far more positive than 100 referred publications, research dollars or Nobel prizes. I was very fortunate in that my undergraduate education was at Denver University, an institution which values teaching over research and community over fame. It was an ideal environment for a young female engineer.

In the 5 years I was at Stanford, I spent 18 months pregnant, and throwing up six times a day due to a severe insulin imbalance, and I spent another 18 months nursing babies around the clock. So for 3 of my 5 years I felt like I was running the Boston marathon with 50 pound shackles on my ankles. I spent most of my evenings in tears. My scars from Stanford run very deep and will never fully heal. The blessing is that it is those very scars that have allowed me to become the most empathic and encouraging of faculty members. I never want a student to suffer the isolation, fear, loss, and anger that I felt as a graduate student. Sometimes the challenges God gives us are so that we can grow and guide others through the same challenges. I do not want my daughter to live what I lived.

How would I recommend that this phase of life be handled? Well, I would spend a few years earning money at a low stress BS level engineering job while enjoying my new marriage and paying off loans. I would save some money, travel, and excel in the sports my husband and I share. If my husband wanted to work, I would then find a very "family friendly" faculty and begin graduate work at a reduced rate. Yes, I would still give birth to children while in school. It is much easier to throw up between classes than in a cubical in industry. I would participate in the highest quality of learning that I could possibly find. I would look for a faculty that recognizes that the distribution in learning should be in time, not in grades. Everyone should learn to the "A" level, some people have more time now, and some have more time over many years. Education quality should never be sacrificed for a time table. There is no reason it should all have to be "right now". In fact I wonder if the present system of "learn it now at hyperspeed" is more an expression of old European faculty power and control than of a dedication to teaching. It certainly is not sensitive to the roles of working parents.

I would take at most one class or work on the degree only 15 hours a week in the summers. I would maintain my fitness and my sports. Weekends would be spent solely on the family. I would take my first real 50 hour/week job when my children were 8 to 10 years old. Then I would go for the job in the location where I want to live, not the job with the most prestige. This is another choice I made which I do not regret. When you are a female engineer, you will have difficulty fitting in no matter where you are, so live where you most want to live. I wanted to be in Colorado with my family and my outdoor life style. I am so thankful I made this choice. On my very worst days at work, I can sit outside and know that I am bonded by six generations to the land, to the location, even if I cannot bond with the job. I have something I belong to.

I am not embarrassed by the "mommy track". Most of the men I worked with at HP would love it for themselves. Personally, I have never found a work environment so rewarding or so important that it cannot be sacrificed for family. I look at my compulsive, obsessive male faculty colleagues and I see lonely old men sitting in nursing homes some day, muttering about fluid mechanics while nurses shake their heads in pity. I see dedications in the fronts of text books and see hypocrisy. If he really loved her so much why didn't he just go home and clean

the house instead of writing a book? No, I don't buy into the western culture's ideal of achievement. It robs communities of their souls. The disappearance of men from the family and the community is an illness of modern America. On the other hand, I see my slower pace, my empathy for students, and my overwhelming love for my children rippling through humanity each moment of every day. The here and now is the only reality. In my mind the "mommy track" is the human track and is the ultimate achievement for men or women. We could cure so many social ills if men and women limited their career work to 30 hours/week and spent the rest of the time with their community.

My strongest recommendation for any young couple contemplating marriage, careers, and children, is to work through the book "7 Habits of Highly Effective People" by Stephen Covey. Identify your principles, express your goals and determine if the two of you are aligned. It is an effective exercise at any point in a marriage. Working through this book catalyses deep personal discussion which then sets the framework for managing life. Life is not stagnant either. We have found that we need to continually revisit our most personal values and goals in order to keep the family together. This is not an easy task.

Somehow, we muddled through this gauntlet of careers and children. What practical steps would I recommend? Hire as much help as you can. Hire housekeepers, yard workers, eat out or take home, and don't waste time on what someone else could be doing. Once in the job, leverage yourself as much as possible. Hire a secretary from your own pocket if you have to. Every minute you waste on a trivial detail is a minute you could have spent with your children. Hire in-home day care for your children so you do not have to worry about driving them. Hire that person to do your laundry, cooking, and housecleaning if you can. Live close to work. Live where children can ride bicycles to their activities. Commuting is a waste of time. Live-in help hurts relationships, so find a nice grandma to adopt and hire on a daily basis. Realize that at this point your children have a good start and what they need from you is long term consistency more than hours and hours of attention every day. Take care of yourself. Stay in shape, keep your friends. Forfeit a nice house for quality time.

When you are thinking about where to live, think about all of the costs. When I considered taking a faculty position at MIT, I soon realized that the cost of private schools and housing in Boston would be so high that I could be a ski instructor in Colorado and be financially ahead. I chose to stay in Colorado, keep my children in excellent public schools, and take my summers off. We still had enough money left over to have traveled with our children all over the world. It has been my general experience that job prestige demands a high price, and often the price is both financial and psychological. It has been my choice to refuse to pay this price. I am very comfortable with that choice, and highly recommend it.

Most of all, try to remember the Confucian philosophy of life stages. We can be many things in life, and there is an appropriate time for each emphasis. There is learning, then family, then community. My children will be gone when I am 45. I am looking forward to 20 extremely productive and active years in my career. Until now, everything has been groundwork. Now I can fly. While many of my male colleagues are starting to burn out, I am getting to remove the shackles. Now I can run, really run, for the first time in my career. I can't wait.

In all of this discussion, I have assumed the presence of children. Having children takes so much time, that it seems trivial to me to be married and without children. Yet for some couples without children, the issue of where to live and what jobs to take becomes a big issue. Having children

dispersed this tension, for it was never who had the better job... but who spent more time focused on the family.

Am I glad I became an engineer? Yes, I love the discipline. The science is fascinating. While I have few personal values in common with my male colleagues, I have gotten used to being unique. For the most part, my friends are spiritually based and are outside of the workplace. I believe that slowly, over the years, engineering will incorporate feminine values and it will be a wealthier profession for it. It will be richer for all of the love, humanity, and feeling that we bring to it and its practitioners. I think women will be the ones to get the modern day "tool makers" to remember the needs of the tribe instead of the needs of the ego. What makes us capable of doing this is our motherhood. Our gift of childbearing is a great blessing and one well worth the effort of managing career and family. Don't give this gift away, for it is the primary factor which makes women unique and modern engineers. In many ways our society is still caught in the industrial revolution, with all of its abuse of human labor. We must outgrow this and reach psychological maturity as a culture. Women can be the catalysts for that maturation. Be proud of it. Go home at 4:30 and know that beyond a doubt what you are doing is the best for the profession because it is the best for humanity. In time, the men will have enough courage to follow our model.



## NAVIGATING CAREER AND FAMILY PATHS

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I am not enthusiastic about the title for this panel discussion: "*Navigating Career and Family Paths*," probably because it suggests to me that this is a "self-help" workshop. Assuming that the goal of women in engineering programs in universities is to recruit and retain women in the technical professions, it is not sufficient to focus on helping/improving/changing ourselves. I do not think that either some gender-linked trait or our devotion to our families is responsible for the fact that there are so few women in engineering. Rather, the reason that more women are not engineering students, practicing professional engineers or engineering professors is discrimination, and women in engineering programs will only be successful if we focus on combating discrimination.

### Personal Experience: Early Years

I am 50 years old. I have presented my own experience not as a model, but as a demonstration that there are many paths for women to enter the engineering profession and many, including mine, are not "typical." Also, I have lived through times of changing and not-always-compatible cultural roles for women throughout the 50's, 60's and 70's which may add some perspective to the discussion today. I first went to college in the 60's. In spite of all the radical questioning of conventional social arrangements, the 60's were not particularly enlightened times for women. The great social movements were male-dominated: civil rights, anti-Vietnam War, and "free-you-name-it" at campuses across the US. We women were the first of the post-war baby boom generation to enter college. Some of us came from families where our mothers didn't work outside the home; for others our mothers worked, but "in the closet" at underpaid and/or part-time jobs. In my own case, my mother was the first person in her family to graduate from high school and then went on to attend the University of California at Berkeley, where she graduated as a member of Phi Beta Kappa. She had a job during the war and then was laid off. She never returned to the workforce. As I think was typical of my high-achieving women friends at Stanford, I had the

wholehearted support of both my parents for my academic endeavors. However, we young women also suspected that socially acceptable after-college roles for women at that time didn't seem to include a challenging career outside the family. Overall, the messages for young women were confusing and inconsistent, and I remember spending a lot of time discussing career versus family, as though we had to choose one or the other.

At 21 I graduated from Stanford with a bachelors degree in Psychology and opted for neither a career nor a nuclear family. Instead I wanted to do grand, unconventional and even risky things: I joined the Peace Corps; I was a community organizer and active in political movements in San Francisco; I went to meetings and I hung out with the guys. I had no plans to marry and have children, which I saw as a constraint to my activities. Fortunately for me, the women's movement of the 1970's exploded the myth that intellectually rewarding well-paid work was a contradiction to my participation in family life (as well as the corollary that marginal, boring and low-paying jobs were somehow more compatible with family life for women). More important, a succession of depressing clerical jobs helped convince me that having a profession was better whether you had a family or not.

With the encouragement of both female and male friends, I dusted off my high school interests in math and my limited college background in science and started back to school, taking calculus and physics at the University of California at Berkeley and San Francisco State University while I was working in the Bay Area. This self-test was very successful and I went back to college full-time at the University of California at Davis in 1975 to earn a second bachelors degree in Civil Engineering. In addition to a full load of engineering courses, I worked 20 hours per week at the California Department of Water Resources. I emphasize that what was not only possible but very exciting for me in 1975 with the women's movement and my women friends encouraging me, would have required more fortitude than I had in college in 1963, when there was one woman undergraduate student in the entire College of Engineering. Also, the willingness of UC Davis to accept an older student and to help me find work was critical to my becoming an engineer. As it turned out, I liked the intellectual part of engineering so much that I went on for MS and PhD degrees at UC Davis. Overall, my seven years in school was a fantastic experience. Although I was only the second woman to get a PhD in Civil Engineering at UC Davis (1982), I did not personally experience any obvious discrimination in graduate school. Looking back, that remarkably discrimination-free education probably had to do with my maturity which allowed me to focus my academic efforts and to simultaneously ignore the social pressures that younger women students felt, and a wonderful support network of women friends which had gathered during my women's movement days in the 70's. I began a faculty job at the University of Colorado in Fall 1982 without giving discrimination at universities much thought, ignoring the ominous reality that fewer than 10% of the undergraduate engineering students at UC Davis in 1978 were women and only a handful of women had received doctorates in engineering by 1982.



Once again after college, I was naive. As 13 years on the faculty in the College of Engineering at the University of Colorado have taught me, discrimination is alive and well here and at universities elsewhere. Susan Faludi documents that the position of women as workers in the US actually declined significantly in the 1980's, compared with the surge of women into once male-dominated jobs in the 1970's, and universities seem to have followed this trend.<sup>1</sup> For example at the University of Colorado, enrollment of women undergraduate students in the College of Engineering peaked in the early 1980's at approximately 24% and then declined, to as low as 16% by 1992. The number of women undergraduate students in engineering has since increased to approximately 18%, but has not yet returned to the level of the early 1980's.

### **Social Pressure on Women Engineers Today**

The other cultural trend that seemed to reemerge in the 1980's was the concern that simultaneously having a family and an engaging profession may be extraordinarily difficult for women. Why? Well, society has retreated from explicit legal barriers to women in the professions, and I suspect that maintaining male dominance in certain careers like engineering requires subtler arguments with the result that women appear to voluntarily opt out of those professions. The cultural arguments including those below seem to be especially effective on girls and young women, leading us to:

*despair that we are not as smart as men, especially about tools/technology:* for example, the right-brain vs. left-brain paradigm which has been used by psychologists to suggest that perhaps women aren't good at math by nature;

*fear that men won't like us socially if we are professionals:* typified by the much-ballyhooed statistic reported in the popular press several years ago and later shown to be completely false, that a woman over 39 who had delayed marriage to pursue a career was more likely to be killed by a terrorist than to get married;

*be guilty that having a profession makes us unable to love our families:* especially evocative is the popular and pejorative description of the plight of career women who would "have it all," somehow implying that women who have careers and families are greedy, selfish, unrealistic. I note that I have never heard that expression applied to men who have both careers and families, nor to women who have to work at marginal jobs.

I would like to focus on women who are discouraged from pursuing degrees in engineering because of fear and guilt, because a significant number of women who know how smart we are drop out of engineering, as undergraduate and graduate students, and later as professionals. It has been suggested that these women are not

put off by intellectual challenge or academic competition, but rather by the negative personal stereotypes imposed on them as women engineers.<sup>2</sup>

### **My Experience at the University of Colorado**

Since I have been on the faculty of the University of Colorado College of Engineering I have gotten married (1985) and had a son (1986). My husband is a professor at the Colorado School of Mines, and integrating two academic careers has been challenging. Having a son was a surprise and delight to us. I was 40 when Joey was born. I apparently could have taken sick leave in lieu of parental leave, which is not offered by the University. I did not on the advice of my Department Chair, who told me that it might damage my chances for tenure. I got tenure in 1989, after a skirmish with the Dean of the College who thought I should postpone the process a year. I was gratified to have the strong support of my Department, and their recommendation for tenure that year prevailed. Apparently the Dean mistakenly assumed that I had taken a year's parental leave, an assumption which he had not bothered to check with my record. I thought at the time, and still do, that this was discrimination stemming from the false stereotype that women faculty who are mothers don't work hard.

As a family we have thoroughly enjoyed our lives, including the emotional uncertainties and the practical difficulties of arranging complex and conflicting schedules, child care, etc. I must praise my husband, who is truly my partner and has been a constant source of support for me as a professional. It would be impossible to detail all his efforts here, but I do know that maintaining any kind of family life would have been a miserable task without his enthusiasm and plain hard work. However, these family arrangements are not peculiar to engineering or to university faculty. I have compared our family activities with neighbors and friends in families with children and all adults working at either professional or non-professional jobs, and our concerns and constraints seem equivalent. I confess that I have not felt a moment's guilt that my profession has interfered with my relationship with my husband or son. However, there are many times when I have noticed that I do not have much time purely for myself, as I did when I was single. For example, I used to run marathons in graduate school; now I am happy to be able to bicycle to work and on weekends.

In 1996, I can state with great pleasure that I love my work teaching and doing research in environmental engineering at the University of Colorado, and I love my nuclear family. I am especially proud of my success at mentoring women PhD students, three of whom are now professors in Civil or Environmental Engineering Departments at other universities (Colorado School of Mines, University of Kentucky and Northern Arizona University). Two others have very successful careers in international environmental engineering and sanitation, in the World Bank and the Peace Corps.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

Unfortunately, the effects of gender discrimination at the University of Colorado also have been apparent during my career here, as can be seen just considering women faculty. There are 15 full-time, tenure-track women faculty in six Departments in the College of Engineering (Aerospace, Chemical, Civil/Environmental/Architectural, Electrical/Computer, and Mechanical Engineering and Computer Science) at the University of Colorado, out of a total of approximately 180 faculty. As of last year, five of us were tenured, four at the rank of full professor. That is good news; at approximately 8%, the University of Colorado has a higher fraction of women faculty in engineering than the national average. However, I am convinced that the unusually high representation of women on the faculty in the College of Engineering is a reflection of the quality of the individual women faculty, not any exceptional efforts by the College to recruit and retain women. Evidence of this are the impressive academic achievements of the women faculty here: four are recipients of prestigious NSF Presidential Young Investigator/Career Development awards and one was awarded the very competitive NSF Presidential Faculty Fellowship; three of us have received NSF awards for faculty women in science and engineering, and several are fellows of their respective professional societies.

More disturbing is evidence of discrimination problems in the College of Engineering: one lawsuit against College faculty and administrators pending for sexual harassment and retaliation brought by a woman faculty member and another women faculty who is leaving for a job in another university after serious allegations of discrimination-related mistreatment in her department. In 1991 I had the opportunity to serve on the Boulder Campus Salary Equity Committee, and I and several others were on a sub-group to evaluate gender and ethnicity-based salary discrimination in the College of Engineering. During that independent evaluation, more than one-third of the women faculty in the College received recommendations for salary increases to reverse gender-based inequities in salary. Since that Salary Equity survey, the University and the College has abandoned that independent process, additional evidence that gender-based discrimination against women faculty is at best ignored by the College of Engineering.

### **Women in Engineering Programs**

What are difficulties faced by women in engineering programs at universities in bringing more women into the engineering career path? I have described two below, and perhaps in the forthcoming conference sessions and discussion, we will present ideas to resolve these difficulties. First, the activities of women in engineering programs I am familiar with are split between services for women students to enhance educational opportunities, provide scholarships, and increase self-esteem and advocacy, particularly to fight gender-based discrimination. In general services are more rewarding and pleasanter to provide, but I think that for women in engineering programs, services to women should not be an end in themselves, but rather serve to build a base for advocacy of efforts to end discrimination. One problem with introducing advocacy into

our activities, is that the organizational methods for confronting discrimination are few and have not been much refined since the 70's. A second very compelling concern for women in engineering program staff who may want to confront institutional discrimination in colleges of engineering is that of "biting-the-hand-that-feeds-you." Most of these programs are financially dependent on the administrators they may have to criticize, and resolving this problem will eventually require some risk-taking.

In conclusion, I return to what I stated at the beginning of this paper: that I fear that a panel discussion on "*Navigating Career and Family Paths*," may revive the old "career *versus* family" dichotomy that I remember from my college days during the 1960's, and distract us from discrimination against women in engineering. I have found that while navigating the career-plus-family path has its difficulties, they are negligible compared with the difficulties I have experienced or observed in just navigating in the career path in academic engineering. Furthermore, I stress that balancing an interesting and well-paid job with family and community life is a far pleasanter task than balancing poverty or boring low-paid work with family life. Finally, I submit that it is difficult for a family in the 1990's to thrive on a single income, so that for most women, the prospect of not working at all has severe economic consequences for her and her family. Thus I see the responsibility of women in engineering programs at universities to help women navigate their career paths in engineering *and* to make sure that "family" concerns are not used as a spurious argument to discourage women engineering students.

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## K-12 PROGRAMS: INNOVATIVE AND COLLABORATIVE APPROACHES

### Moderator

Robyn E. Sandekian  
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Ms. Robyn E. Sandekian earned her B.S. and her M.S. degrees in Aerospace Engineering from the University of Colorado at Boulder. She has been a registered Engineer-in-Training in the state of Colorado since 1992. Ms. Sandekian first became involved with the Women in Engineering Program as a student assistant in 1991. In August 1994, she returned as Coordinator for the Engineering Career Day for high school women program, and took over the role of Program Coordinator in July 1995. Ms. Sandekian acts as faculty advisor for CU-Boulder's student chapter of the Society of Women Engineers and is an active member of WEPAN.

### Presenters

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## PARTNERING A PATH FOR WOMEN IN ENGINEERING

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### ABSTRACT

A partnership between Hewlett-Packard and Northern Colorado school districts was formed to promote systemic change in math and science teaching methods. Hewlett-Packard donates the time of a woman engineer one day a week to train and mentor K-12 teachers in math, science, and technology. The focus is increasing student achievement in, and attitudes toward, math, science and science careers. Results indicate that the partnership is working from three points of view: schools (K-12), HP management, and the engineer.

### INTRODUCTION

Three people needed to solve a problem: Educators are required, through state content science standards, to teach students how science and technology are used outside school; high-tech industry needs a larger and more diverse pool of qualified engineering candidates from which to choose; and a woman engineer left engineering to teach and wanted to be able to combine her desires to teach, influence math and science teaching methods, work as an engineer, and act as an ambassador to girls in engineering.

A position was created which addressed the needs of all three. As part of a hiring contract, Hewlett-Packard agreed to donate the time of the above engineer to Northern Colorado K-12 school districts. On a yearly basis, the engineer provides results to HP that measure the partnership. A K-12 professional staff development coordinator provides staff development opportunities for teachers for training and mentoring by the engineer.

#### Engineering Position

In order to form this partnership, there first had to be an engineering project manager agreeing that for this position, during the school year, the engineer would be available for engineering projects 80% of the time and an opening for a full-time engineering position for which the engineer was qualified had to exist.

There was a requisition open for a full-time engineering position in a manufacturing development organization for which the engineer was qualified. Concerns by the project manager included availability to customers and continuation of other job objectives and schedules. Several things put in place to alleviate concerns included careful selection of a day to donate to K-12 (assuring maximum availability across all production shifts); checking voice mail when off-site with the partnership (and responding to emergency manufacturing problems that arose); and a clause in the hiring contract stating that should business needs change, the engineer can be given 4 weeks to go full time engineering, find another manager willing to support this, or choose to leave. In addition, the K-12 partnership was included in objective reviews along with engineering responsibilities as part of the job requirements for this position.

A tremendous amount of flexibility was required by the engineer, manager, and teachers. Some weeks it was necessary to trade the donated day (because of engineering and/or K-12 needs); some weeks, it was impossible to donate a day. Because of tight technical resources and difficulty hiring in the second year of the partnership, the engineering workload was heavy. While IIP management remains committed to K-12, at times it would have been easier to have the engineer on-site 5 days a week. In the second school year of the partnership, at the most, 15% of the engineer's time was spent in this partnership because of increased manufacturing engineering demands. Overtime hours were spent by the engineer to satisfy requirements of both positions.

### **Teacher Participation**

The Weld County professional staff development coordinator arranged for teachers who were willing to participate. A mix of veteran and new teachers from both elementary and secondary schools was targeted.

A key concern of teachers was that this partnership did not require additional time away from planning or classroom activities. In addition, it was difficult to ask teachers to have a "control" classroom (where no special activities were done) for data collection: it requires the teacher to have two sets of activities, and can be frustrating when some of the activities are reacted to so positively by students.

### **PARTNERSHIP ACTIVITIES**

It was desired that all activities met Colorado state and district math and/or science content standards, and that the majority of activities were actually done by teachers in the classroom. This way, when the engineer left, the teacher still had the tools necessary to do the activity with the class.

Three key activities were a science career workshop for young women, a Science-Technology-Society unit at a middle school, and an spatial reasoning unit at an elementary school.

#### **Science Career Workshop**

A science career workshop, meeting Science Content Standard #5<sup>1</sup>, was organized and presented to girls at a rural middle school in Northern Colorado. There were three science careers represented at this workshop: engineering, microbiology (two specializations), and range ecology. Each girl attended two sessions of her choice. Each 45 minute session was run by a woman engineer or scientist who works in that particular career. In addition to information on what is required to do this job, each session included a hands-on activity for the girls that was representative of this career.

A survey was given to the girls immediately before and after the workshop. The questions in the pre- and post-survey were identical:

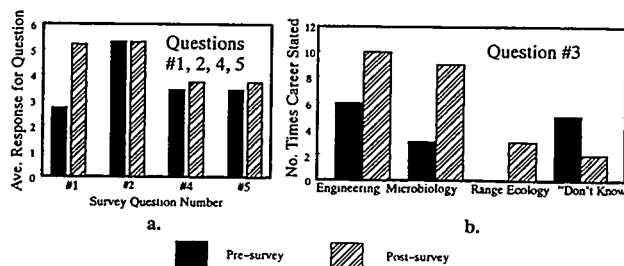
1. Do you know what is required to become a scientist or an engineer? (1 = No, 6 = Yes)
2. Could you become a scientist or an engineer if you wanted to? (1 = No, 6 = Yes)
3. What careers are you interested in? Name as many as you want.
4. How many years of math do you intend to take in high school? (1 to 4 years)
5. How many years of science do you intend to take in high school? (1 to 4 years)

The survey results are shown in Figure 1. Figure 1a shows the average response to each of questions #1, 2, 4, and 5. Figure 1b shows the number of times one of the represented science careers (plus "Don't Know") was written in response to question #3. There was significant difference in Question #1 and in the number of responses of each of the represented career choices before and after the workshop. This indicates that interest in these careers was ignited in the girls during the workshop, as well as their confidence in understanding what was required to work in the sciences and engineering.



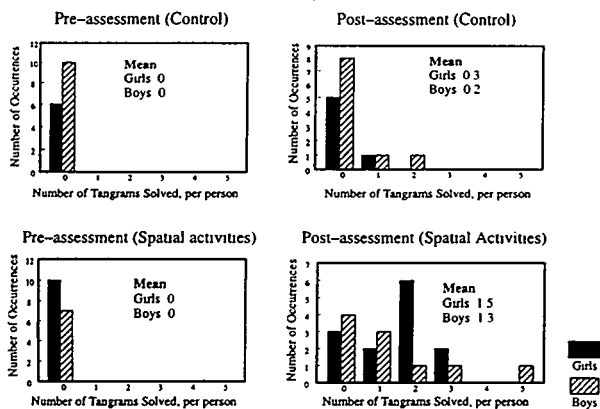
**Figure 1**

Young Women's Science Career Workshop



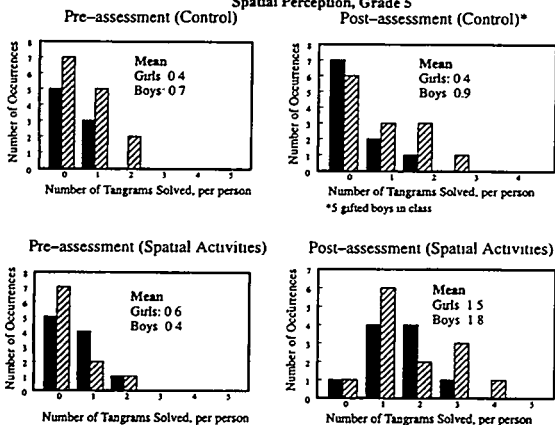
**Figure 2**

Spatial Perception, Grade 3



**Figure 3**

Spatial Perception, Grade 5



## Science-Technology-Society Middle Unit

The purpose of this unit -- to investigate how science, technology, and human activity are interrelated and how they affect the world -- is identical with Colorado State Science Content Standard #5<sup>1</sup>. There was data from an STS program in Iowa that indicated that both boys and girls do better both in science content and in attitude towards science with this approach.<sup>2,3</sup>

The HP engineer, together with two science teachers at a middle school, created the activities and assessments for this unit. During the course of the school year, the two teachers presented STS activities to students. These activities included a lesson on inventions, guest speakers from the community on careers, informational interviewing and other job hunting and budgeting exercises, and an Invention Convention where students invented something and displayed their invention. Students were given a survey at the beginning of the school year and again after all the STS activities. Teachers had tried to maintain "control" classes, in which some activities were not done. All students did the Invention Convention. The survey was similar to that in the career workshop, asking about career interests, amount of math and science in high school, plus questions on how math and science is used in careers.

Results are shown in Table 1. This graph shows the difference (after - before) in response on the surveys after the STS unit. Data indicated no difference between the control class and non-control classes. It was very difficult to isolate classes -- all students participated in the Invention Convention and presented their project to the class. Overall, there was an increase in answers to most questions by all students, particularly those where students listed ways in which math and science were used in careers. A survey was also given to the two participating teachers. They indicated a student enthusiasm and continuation of students on their own researching career opportunities in the non-control classes. The assessment may need to be revisited to measure this.

<p align="center"><b>Table 1</b> <b>STS Survey Results</b></p>				
<u>Question</u>	<u>Control</u>		<u>STS<sup>†</sup></u>	
	<u>Boys</u>	<u>Girls</u>	<u>Boys</u>	<u>Girls</u>
4a	+0.5	+0.4	NC*	-0.1
4b	+0.3	+0.5	+0.3	+0.3
6	+0.1	+0.4	+0.1	+0.4
7	-0.3	+0.6	+0.5	+0.8
8	-0.5	+0.7	+0.2	-0.1
9	-0.7	+0.2	+0.1	-0.2
A	+0.1	+0.7	NC*	-0.1
B	-0.4	+0.3	+0.1	+0.1

4a. Name 5 careers that use math and science.  
 4b. In one of those careers, describe how math and science are used.  
 6. Do you know what is required to become a scientist or an engineer? (1 = No, 6 = Yes)  
 7. Could you become a scientist or an engineer if you wanted to? (1 = No, 6 = Yes)  
 8. How many years of math do you intend to take in high school?  
 9. How many years of science do you intend to take in high school?  
 A\*\*. Of those who listed a career in science, how many years of math do they intend to take in high school?  
 B\*\*. Of those who listed a career in science, how many years of science do they intend to take in high school?

<sup>†</sup> All students participated in Invention Convention. "STS" students participated in career activities.  
 \*NC - No Change  
 \*\*Interpreted from data, not questions on the survey

### Spatial Perception Unit

Partnering with the enrichment teacher at an elementary school, research on spatial perception was done. This topic was chosen for four reasons: (1) Spatial reasoning is useful in the physical sciences (which are heavily relied upon in engineering), (2) Initial data were found, indicating that boys may be better than girls at spatial perception because of practice<sup>4</sup>. (3) Spatial perception is part of State Content Math Standard #4<sup>1</sup>. (4) It was useful to be able to measure, and share measurement techniques, the impact of the school enrichment program on student achievement.

The enrichment program consisted of a special resource teacher visiting classes weekly. Four classrooms were chosen for the study: two third grade classes and two fifth grade classes. One classroom from each was a control. All four classrooms were given identical pre- and post-assessments. The assessment consisted of a sheet of Tangram pictures which the students used with Tangram pieces to complete as many as pictures as possible in an allotted time.

In the two Spatial Activities classrooms, the enrichment teacher weekly led spatial reasoning activities through the school year. These activities included symmetry and pattern practice, creating puzzles, and practicing with Tangrams (different pictures than those used on the assessments)<sup>5</sup>. One Tangram practice activity was done with the Tangram answers so students could see the lines between the Tangram pieces on the picture.

The results are shown in Figures 2 and 3. For grade three, in the pre-assessment, no students were able to complete any Tangram pictures. At the post-assessment, the control class (no spatial activities) completed only three puzzles in the entire class. Students in the Spatial Activities class were able to complete, on average, 1.5 puzzles (girls) and 1.3 puzzles (boys). For the fifth grade, there was no change for the girls in the control class, and a slight increase for the boys. There were, however five boys in this classroom that were in the gifted program (pulled out through the year for extra activities) and may have been exposed to spatial reasoning activities. Students in the non-control grade five classroom, however, more than doubled the number of puzzles they could solve. In addition, there is no significant difference between genders. One of the most interesting "qualitative" pieces of data is the comment by a student (that had spatial activities during the year) that on the post-assessment that they could see the lines between the pieces in the post-assessment picture. There were no lines, but the practice with such lines had made it possible for that student to draw lines in their mind.

These results imply that spatial perception can be learned and there is no difference between genders in the ability to learn spatial reasoning activities. In addition, the enrichment teacher was able to learn how to assess her weekly in-class activities. Even in the 30-45 minute/week time spent with students, there was a noticeable difference in ability to solve Tangram puzzles.

For each of these activities, different measurement tools were used. In addition to the presented data from student surveys and assessments, teachers were also surveyed about their role in the partnership. Teachers were asked about student achievement evidence, activities that would not have occurred without the partnership, and continuous improvement. The teachers were excited that students showed enthusiasm about science careers and were hopeful this program would continue. A big key to making this work for them was the amount of direct communication and mutual respect for everyone in the partnership.

## CONCLUSIONS

This partnership appears to be working from several standpoints: educators, HP engineer, and HP management. Educators have received teaching and assessment tools to increase student achievement; the HP engineer remains VERY excited about systemic K-12 education changes, while working as an engineer; and HP has succeeded in recruiting and retaining the woman engineer, and meeting K-12 goals of increasing student achievement and science career aspirations. A large key to the partnership success has been flexibility and respectful communication between everyone involved. Follow-up in several years with the participating students will provide data for HP's long term goal of increasing numbers of women studying math and science.

## ACKNOWLEDGMENTS

This partnership could not have happened without the support of Hewlett-Packard Integrated Circuit Business Division management and Weld County School District 6. Special thanks to Rich McCombs for his management support and commitment to education and to Chris Caldwell, Gina Fast, and Mark Sedingr for all their hard work implementing this in their classrooms. In addition, the authors wish to thank the entire staff and faculty at Jackson Elementary and Maplewood Middle Schools for their tremendous cooperation, particularly principals Maureen Bowen and Barry Shelofsky. The Eisenhower Grant and Gender Equity Grant from CCCOES have provided funding for supplies, workshop attendance, travel expenses, and educational development.

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**PROJECT 199: A PARTNERSHIP IN ASSOCIATION WITH PUBLIC  
SCHOOLS, INDUSTRY, AND A UNIVERSITY TO TARGET THE  
RECRUITMENT OF ANGLO AND MINORITY GIRLS INTO  
ENGINEERING**

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The underrepresentation of women and minorities in science and engineering remains a national concern which the newly established and NSF funded Engineering Academy of Southern New England is addressing as one of its goals to focus on diversity. This consortium of four New England engineering colleges is designing programs and activities which encourage underrepresented female minorities, and Anglo female students to study and eventually practice in the engineering profession.

The Women in Engineering Program in the College of Engineering at the University of Massachusetts submitted a proposal to the Engineering Academy designed for female Anglo and minority students in grades 8-12. This initiative builds upon the current activities of the Women in Engineering and the Minority Engineering programs in the College, and works towards the development of a new model. This model includes a partnership with industry, a public school system, parents, and a university. The idea for this proposal is supported in the research being carried out by AAAS, Department of Energy and NSF. They have targeted programs on math and science education for females and minority females which no longer focus on these populations as "somehow deficient, in need of alteration, so that they can fit the existing environments in science and engineering." (Dr. Jane Stutsman, NSF, Subcommittee hearings.) Their focus is on eliminating barriers and providing climates which assist girls and women in developing confidence, and academic and professional success which can lead them towards careers normally seen as non-traditional and "male-dominated."

The American Association for the Advancement of Science (AAAS) established a task force in 1989 to examine efforts made by higher education institutions in the U.S. to increase the participation of women, non-Asian minorities, and people with physical disabilities in science and engineering. The findings and recommendations for programs targeted at women and minorities form the basis for Project 1999. (See Investing in Human Potential: Science and Engineering at the Crossroads, Executive Summary, AAAS, 1991.)

\*The term Anglo girls is an official term being used by the Holyoke public school system to identify non-minority girls.

We found the initial phases of Project 1999 to be a valuable experience in helping girls gain introductory understandings of the engineering field while also developing their communication and mathematic skills, and an understanding of the history of women in engineering and science. The pre- and post- tests, and documented anecdotal data (See Appendix B, C). An additional benefit was the elevation in the students' levels of confidence about the possibility of a career in the previously unknown field of engineering.

## OBJECTIVES

The objectives of Project 1999 are to increase the pool of Anglo and minority girls eligible to attend two- and four-year colleges in 1999, majoring in engineering and, ultimately, working in the engineering professions. Project 1999 is designed on the recommendations provided by the AAAS task force study published in 1991, and other studies identified in the references. The objectives include:

- the expansion of educational and recruitment efforts into new geographic areas with Hispanic and African-American populations;
- expanding the understanding of the engineering profession as a viable career option for Anglo and minority girls;
- the participation and collaboration of parents, public schools, industry, state agencies and the university in efforts targeted toward Anglo and minority girls;
- using a hands-on inquiry approach and cooperative group work as a more meaningful and supportive teaching/learning environment;
- providing diverse role models for program participants via a college student mentor network;
- establishing an evaluation procedure as an integral part of the project; and,
- developing a stable funding base within the partnership with the support from established College of Engineering programs such as the Women in Engineering and Minority Engineering Program and their respective college-industry advisory councils.

## DESCRIPTION AND APPROACH

There were seven objectives fundamental to Project 1999, as previously stated (See Appendix A).

Objective I: The expansion of educational and recruitment efforts into new geographic areas with Hispanic and African-American populations.

The Holyoke School district has a large minority population and was targeted because of its proximity to the University. The goal is to continue to build on the efforts of Project 1999 after the original project is completed.

Objectives II and III: Expanding the understanding of the engineering profession as a viable career option for Anglo and minority girls; and, the participation and collaboration of parents, public schools, industry and the University in efforts targeted toward Anglo and minority girls.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

Project 1999 initiated its activities with the collaboration of the Holyoke School system, parents, industry and the University. Planning began in the fall of 1994 to gain approval from the school system. Student participants were identified by the middle school principals, applications were distributed, and candidates were selected. Meetings were held with parents, teachers, guidance counselors, and the industrial sponsor. Each group gave input to the program while also gaining understandings of their unique roles and responsibilities with these middle school students.

Objectives IV and V: Using a hands-on inquiry approach and cooperative group work as a more meaningful and supportive teaching/learning environment; providing diverse role models for program participants via a college student mentor network.

The two-week summer camp program in July of 1995 introduced the students to introductory hands-on experiences in manufacturing engineering through classes in computing design and project development. In addition, classes were taken in Women in Engineering, mathematics, and in multicultural and communication skills development.

Other experiences included field trips to American Saw & Manufacturing Company, Springfield Science Museum and University Museum featuring an exhibit of women's clothing designed by Nicaraguan Village women developing a cottage industry.

The mentor network included the participation of female undergraduate students in engineering who were Project 1999's tutor/counselors. Other role models included female engineers and alumni of our college, who are employed in industrial positions in Massachusetts and Connecticut.

Objective VI: Establishing an evaluation procedure as an integral part of the Project.

With the assistance of a campus evaluator hired by the Engineering Academy, a pre- and post-test was designed to identify understandings students had about engineering and career possibilities. Results have been collated and are included in the Appendix .

Objective VII: Developing a stable funding base within the partnership and the continued support of the Women in Engineering (WEP) and Minority Engineering Programs (MEP) college-industry advisory committees.

This is an on-going effort to assist in the continuance of Project 1999. The WEP and MEP will remain as the mainstays of the project providing University personnel support and some limited funding from industry. The provision of personnel resources will probably be the primary source of corporate support for the foreseeable future as industries redefine themselves for the twenty-first century. Securing funds from the government agencies will also have to be a consideration although those funds are becoming scarce.

### **Current Status**

Project 1999 is currently at the end of the NSF two-year commitment after a successful two years working with the project students, industry, and parents.

A teacher coordinator from Holyoke High School was hired to act as the in-house representative for the 1995-96 school year. She was also a teaching team member for the summer camp program in 1995.

The original student enrollment for Project 1999 was 40 students. Ultimately, 25 students participated in the summer camp, with three leaving due to an injury and illness (2), and lack of interest (1). No effort was made to follow up on the 15 no-shows as the three middle school principals suggested it was normal to have this attrition rate. It suggests, however, that the recruitment process should have included a larger pool of applicants to achieve an enrollment of 40 students.

This academic year has included planning meetings with the teacher coordinator and the industrial representative. A reunion meeting was held at the high school for the girls who participated in the summer camp. And, with the assistance of the high school bilingual guidance counselor, two additional Hispanic girls participated. Recommendations were given for six new recruits.

Activities have included workshops on going to college, a career panel and an on-campus Project Day for the girls under the sponsorship of the University's student chapter of the Society of Women Engineers.

As there has not been an extension by NSF supporting the Engineering Academy, the summer camp will be held in July but changes will be made in Project 1999's future plans. In the fall the Women in Engineering and Minority Engineering Program, SWE, SHPE, NSBE will join to continue the efforts of Project 1999 in a scaled-down version.

### **Pre- and Post-Tests Results**

#### **Awareness**

In the pre-test on Awareness, questions 1-4 demonstrated little to no understanding of what is engineering, and what is manufacturing engineering, and how is it different from other industries. Responses to the same questions in the post-test clearly demonstrated the understandings which had developed about engineering as a profession which made things at reasonable costs, made peoples' lives easier, and designed products using math and science concepts. The students also stated the importance of communication skills and knowledge of computers as foundations for studying engineering.

#### **Interest Level**

The results of the pre- and post-tests indicate a significant improvement in the students' understandings of engineering involving interesting work, and as it being a good career for women and minorities. However, there was a decline in their interest in furthering their education in a discipline that utilizes mathematics. This could be due to the fact that the math teacher designed her course as a preparation for high school math and the students were not prepared for this style of teaching and her expectations.

#### **Self-efficacy: Coursework**

In the Self-efficacy pre- and post-tests there were improvements in the students' understandings that minorities can be as successful as non-minorities in engineering courses and the belief that universities want more women and minorities to study engineering. The areas in which the students experienced a decline in confidence were in math abilities and problem-solving.



### Self-efficacy: Careers

While the students demonstrated more confidence in all questions in this part between the pre- and post-tests, they demonstrated significantly more confidence in their beliefs that companies are as interested in hiring women for engineering as they are in hiring men, and that minorities can successfully compete with non-minorities in the engineering job market.

### PROJECT TRANSFER PLANS

The Engineering Academy of Southern New England Diversity Council model allows for an easy transfer of specific program activities and related materials; the members of the council are automatic resources to each other. The council's initiatives will provide a broader based network of information and ideas to all its participants.

All materials of Project 1999 will be incorporated into a final report in loose-leaf format for easy duplication and will be distributed to the academic institutions on the Diversity council.

Specific activities which are anticipated to evolve from the Project are:

1. educational workshops for middle/high school teachers, administrators and parents;
2. presentations by faculty, students and industrial reps at high schools in Holyoke;
3. use of professional videos produced by engineering societies, community organizations, industry and the University;
4. computer learning modules developed by University and Magnet school;
5. tours of different industrial sites and the University; and,
6. presentations at national conferences such as the Society of Women Engineers (SWE), Women in Engineering Program Advocates Network (WEPAN), National Society of Black Engineers (NSBE), and Society for Hispanic Professional Engineers (SHPE).

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## "MIZ WIZARD'S SCIENCE SECRETS"

### Presenter

Jane Curry, Ph.D.

Dr. Jane Curry is an author, performer, storyteller, and *recovering academic*. She toured for nine seasons with the Minnesota Chautauqua and travels nationally with three solo shows she has written: *Samantha "Rastles" the Woman Question*, *Just Say Know: Educating Females for the 21st Century*, and *Nice Girls Don't Sweat*. Her performance at WEPAN marked the national debut of her latest show, *Miz Wizard's Science Secrets*.



## WOMEN ENGINEERS AND THE NEW FOCUS ON INTERNATIONAL EDUCATION

### Keynote

William E. Kirwan, Ph.D.  
President  
University of Maryland

Dr. William E. Kirwan is President of the University of Maryland at College Park. Before being appointed President, Dr. Kirwan served for 25 years as a professor of mathematics and administrator at the University. During his tenure as President, Dr. Kirwan played a pivotal role in all of the University's most significant initiatives, including: an increased emphasis on undergraduate education, selective enhancement of academic programs, recruitment and retention of distinguished faculty, achievement of diversity goals for underrepresented minorities, and a capital campaign in excess of \$200 million. Dr. Kirwan chaired the Mathematical Sciences in the Year 2000 Committee, a task force created by the National Research Council (NRC) to improve mathematics education at the nation's colleges and universities during the next decade, and he currently serves on NRC's Committee on Undergraduate Science Education. Dr. Kirwan serves on numerous boards, including the American Council of Education's Commission on Women in Higher Education.

### Keynote

F. Suzanne Jenniches  
General Manager  
Information and Automations Systems  
Northrop Grumman

F. Suzanne Jenniches is General Manager of Information and Automation Systems Division for Northrop Grumman. She is a 21-year veteran of Northrop, having served as a computerized test engineer, supervisory engineer of robotics development for electronics manufacturing, and as operations program manager. Ms. Jenniches began her career as a high school biology teacher. She later earned her Master's degree in Environmental Engineering at Johns Hopkins University and has completed extensive post-graduate work in International Affairs at The Catholic University of America, and attended the Harvard Business School Program for Management Development. Ms. Jenniches is a past president of the Society of Women Engineers and served on the Board of Governors for the American Association of Engineering Societies.



## WEPAN National Conference

Dr. William E. Kirwan  
President  
University of Maryland at College Park

Thank you, Marilyn, and good morning to all of you. It is a great pleasure to be here, and I am very grateful to the Women in Engineering Program Advocates Network for inviting me to this important conference.

It is a special privilege to be on the program today because my colleagues and I at the University are so pleased and honored that The Women in Engineering Program at the University of Maryland's Clark School of Engineering has just been selected the best in the nation by WEPAN. I want you to know that on Friday night we had our annual engineering alumni banquet and the dean, Bill Destler, featured this award in his remarks on the year's achievements.

A great deal of talent, energy and dedication has gone toward building this program into the exemplary one that it is today, and I am sure many brilliant young women will be enriching the engineering profession because of this program's initiatives.

Of course, the person who deserves the lion's share of credit for the quality of the program and for this award is Marilyn Berman. As I'm sure all of you know, Marilyn is the program's founder and, since its inception, its primary nurturer, advocate, and leader.

Regrettably for the University, Marilyn is retiring in a few weeks. Marilyn has been such a valuable asset to our College of Engineering and to the University for so many years and in so many ways. I wish I had the authority to issue an Executive Order and prevent this loss from occurring. Fortunately, she has agreed to stay involved with the University. Knowing Marilyn, this means she will reduce her effort to something like 40 hours a week rather than her current 80.

In preparation for attending this conference, I had the occasion to review the mission and goals of WEPAN and was very impressed. I can hardly think of a more important national goal than the development of a multi-cultural workforce in engineering and related professions.

We all know how the demographics of our nation and its workforce are changing. And the pace of that change is accelerating. In the next decade, 85 percent of the net new entrants into the nation's workforce will be made up of what we now call minority groups -- which of course, includes women.

Since slightly more than half of the American population is made up of women, one might think the "minority" status we accord them is hardly appropriate. In fact, however, women are so grossly underrepresented in some of the key professions, like science and engineering, that they are still very much a "minority," subject to the same inequities that many ethnic minorities face. If America is to continue to lead the world in providing solutions to engineering problems and in creating new technology for industry, we need all the talent we can recruit to the engineering profession -- and that means we must draw upon our entire workforce, not just the male half.

There is, of course, a moral reason why we as a nation should be concerned about equity of opportunity in the professions. Regrettably, moral arguments do not often lead to change in our society. Fortunately, there is a very practical argument as to why it is in the nation's interest to see the kind of changes WEPAN advocates. When I entered the workforce three decades ago, there were five people working for every retired person, five people whose productivity helped support each retiree through Social Security, Medicare, and related programs. My parents were the beneficiaries of this system. I don't know who those five workers were in their case but they most likely had names like: Andy, Charlie, John, Mike, and Bill. When I retire a few years from now, there will be three people working for each retiree. Their names are more likely to be something like Ann, Juanita, and Koume. It is certainly in all our interests to insure that Ann, Juanita, and Koume have the best possible education and the opportunity to utilize their talents to the fullest, especially in fields like engineering and technology that are so vital for our nation's economic well being.

Although there have been women engineers since our professional and technical societies were founded in the 19th century, it is only in the past few decades that women have begun to make up more than a tiny fraction of the profession. As recently as the early 1970's, less than one percent of the engineering graduates in the United States each year were women. Even through the decade of the 1980's, the rate of progress was slow. According to figures from the American Council on Education, the percentage of degrees awarded to women in Engineering and related fields grew from 11 percent in 1984-85 to only 13 percent at the end of the decade. Fortunately, because of the efforts of WEPAN and others, the pace of progress is picking up. In 1993, women accounted for almost 20 percent of the nation's first year undergraduate engineering students.

It is interesting to note that since the mid 1980's, about 25% of the graduates in chemical and industrial engineering have been women. And although the proportion of women in other engineering specialties is lower (as in civil engineering or electrical engineering where the women's share of new B.S. degrees is currently around 15 percent), the absolute number of people represented by these percentages is quite large, reflecting the movement of thousands of women into the profession.

Because the entry of a significant percentage of women into the profession of engineering is a relatively recent sociological development, most women working in engineering today are fairly young, and women are still rare at the most senior levels of management. This is clearly a problem for the profession and something that must change if we are going to achieve real equity of opportunity. To reinforce this point, I cite a 1993 study by the Society of Women Engineers that contains some very troubling data. In survey questions for the study about job satisfaction and equity of treatment, men and women engineers under the age of 40 responded in an almost identical fashion and with high rates of satisfaction. For engineers over 40, however, men reported satisfaction rates of around 60%, whereas, women's satisfaction rates dipped into the 30% range. Not surprising, given these data, the survey also showed that it was about age 40 where salary discrepancies began to creep in, rising to a differential of \$10,000 by age 50. I raise this issue not because I have solutions to propose but because I think it is a vitally important matter that I hope WEPAN and the other professional societies will press.



In my remarks today, I will stick to a more immediate problem, one that I and other university administrators have much greater responsibility for addressing: the increase in the number of women with bachelors, Masters and PhD degrees in engineering. For, as long as the university remains the main gatekeeper to careers in engineering and science, we in higher education have a special obligation to ensure that the intellectual resources we have in our female and minority populations are better represented in these critical disciplines.

I will not presume to know more about the issues facing women in engineering today than the members of this audience, but I can tell you about some of the things we at the University of Maryland are doing to encourage more women to take up engineering as a profession.

First let me give you a little context for my comments. The University of Maryland is the so-called flagship campus of the University of Maryland System. It is the state's officially designated center for graduate education and research, and the institution mandated to educate the best prepared students coming out of Maryland's high schools.

The University has 24,000 undergraduate students and 8,000 graduate students. We have roughly 120 bachelors degree programs, 100 Masters programs and about 80 PhD programs.

The University has a long tradition of support for women in higher education. It was one of the nation's first institutions to establish a Women's Studies program and as early as the late 1970's, the University was conducting salary equity studies for male and female faculty. To this day, we have one of the lowest salary differentials between men and women faculty among all AAU institutions.

In the mid 1980's, the University created a task force, chaired by Sandra Greer, a chemistry professor, to study the role of women and the status of their opportunities at the University. The report of this task force, the Greer Report as we call it, has led to a set of ongoing initiatives in support of enhanced opportunities for women. Included among these initiatives are a curriculum transformation project and programs aimed at attracting more women to fields in which they are underrepresented.

Fortunately for us, Marilyn Berman was ahead of the curve. She had already begun her Women in Engineering Program long before the Greer Report was issued. But I think Marilyn would be the first to say that her efforts have benefitted from the campuswide initiatives and climate of support for women.

With this background, let me describe some of the programs in engineering that have contributed to the WEPAN award. First, let me say that, as many of you already know, College Park's A. James Clark School of Engineering is ranked as one of the top schools in the nation. We are convinced that our record in recruiting women and other underrepresented minorities to engineering disciplines is a contributing factor in our high ranking. Thus, we see our success now, and in the future, as directly linked to our ability to include ever greater numbers of minorities and women as students, faculty members, and administrators. Consequently, our efforts in this regard are "mainstream" efforts involving the department chairs and core faculty.

One of the primary reasons for the success of our Women in Engineering Program was the recognition by Marilyn and her colleagues that career choices and prejudices against certain professions are usually formed well before the student reaches college. Many

capable young women with the requisite aptitude and interest for a successful engineering career are dissuaded from considering it early in life. They are conditioned by society and often by their own families to think that engineering is an unseemly or unattainable goal for a woman, that "girls are not good at math" and other specious arguments for not majoring in engineering. This is why our Women in Engineering Program focussed on recruiting women early in their educational career.

For example, since 1975 the College of Engineering has offered a six-week summer program for women students who have completed their junior year of high school. The summer program provides tuition and housing for up to 30 promising, highly motivated high school students who take two engineering courses for a total of 6 college level credits. Once they are on our campus, our faculty and administrators go all out to make them feel they can succeed, and we are very proud to say that an overwhelming percentage of them do.

Statistics from our own experience show that inducements and incentives to recruit women into engineering disciplines can really pay off. The percentage of women students enrolled in engineering at the undergraduate level rose from 7 percent in 1976 to 19 percent in 1996. In 1976, only 3 percent of our engineering graduates were women. This year, women make up 21 percent of our engineering graduates.

One of the most effective ways of encouraging women to go into non-traditional professions like engineering is to make sure there are adequate role models for them at the faculty level, and here again, our Engineering college has made substantial progress: there was only one woman on our entire engineering faculty of 150 in 1976. Today, the number is still way too low but we have 18 in a total faculty of 190, almost 10%. The problem, of course, is the relative scarcity of women with PhD's in engineering.

With help from the Sloan Foundation, our Women in Engineering program is doing something about this problem. Over 30 research fellowships in engineering have been awarded to women undergraduates, allowing them the valuable opportunity to work with faculty on research projects. Currently, there are over 25 women undergraduates at College Park who serve as Teaching Fellows, assisting faculty in teaching basic engineering courses. These expanded educational and practical training opportunities for aspiring women engineers have already started to show results: not only are more women majoring in engineering at the undergraduate level, but more women engineering graduates are considering going on for an advanced degree.

Beyond offering incentives for women in engineering education, and other types of programmatic intervention, we need the input of women already in the discipline to help us make engineering more inclusive, more reflective of the American workforce in general. Many of our women faculty are doing this, by example as well as by active participation in initiatives to recruit and encourage women applicants.

The Women in Engineering Program has launched a Professional Mentoring Program in which women engineering students are matched with alumnae who are professional engineers to help our students gain a better insight into the actual conditions and experiences of women who work as engineers. There are currently 70 women professional engineers involved in this mentoring program and already, our students are benefiting from the strong support system and networking opportunities that the program involves.

I realize, of course, that talking about the value of networking to this audience is like preaching to the choir, but it cannot be said too often that young women need all the support we can give them to succeed in an environment that is still very dominated by men.

Although there are more women engineers now than ever before, the engineering workplace can still turn out to be a pretty lonely place for a woman -- and sometimes downright hostile, as the Women Society of Engineers study that I cited documents. I am always impressed at how well women who dare to venture into the traditional male professions cope with the strongly entrenched biases against their gender.

I am reminded of a story reported recently in the newspaper about an automobile accident in which there was an injured man stretched out on the ground. A woman was bending over him, trying to help him. A crowd started to gather. A man elbowed his way through and pushed the woman aside, saying "I'll take over now, I've had first aid training." The woman looked up and said, "this man needs a doctor and that's why I'm staying right here." As a nation, we have a long way to go in eliminating the harmful stereotypes that hamper the progress of women in the professions.

The engineering profession, which has always been a tough choice for women, has in some ways become even more challenging now that engineers are having to ply their trade in a global economy. A global economy means that professionals from all over the world will be collaborating on projects to an extent we have never before experienced. So in addition to a solid background in traditional engineering subjects, the well-equipped engineer will need the skills and the experience to work very closely with her counterpart from overseas. In a climate like that, qualifications like foreign language proficiency and exposure to other cultures have very special significance for the engineer who wants to excel at her job. International projects and travel to other nations have always been a part of the engineer's job description, but as American industry expands its partnerships with companies from overseas, engineers are finding that they are required to explain, coordinate and negotiate with professionals and technicians of widely differing nationalities at every stage of the project and on a daily basis. That kind of close collaboration requires more than a superficial knowledge of one another's language and culture.

Like many other universities, we at the University of Maryland are encouraging our students to learn a second language and to immerse themselves in other cultures. We do this not only through course requirements but also through co-curricular activities. We have several residence halls that are reserved exclusively for students studying -- not necessarily majoring in -- foreign languages and cultures.

Let me mention just two of the unique programs we have developed to prepare our engineers for the global workplace.

The Japan Technological Affairs Program (JTAP as we call it) offers students in the College of Engineering intensive Japanese language instruction, workshops and activities related to Japanese culture and society in preparation for year-long internships in Japan, in a Japanese laboratory or company. Through this program, which is coordinated between the College of Engineering and the Department of East Asian Languages, students who are enrolled in an undergraduate program in engineering receive intensive Japanese instruction during the academic year and in special summer classes held in the Language House on the College Park campus. The future engineers are thus fully prepared to operate with ease in Japan's research community.

We also offer a Dual Degree in German and Engineering which allows students to develop expertise in German as well as engineering. Under this program, which is jointly administered by the Department of Germanic Languages and the A. James Clark School of Engineering, students go to Germany in their senior year for a two-month intensive German language program. After that, they work for 4-6 months either at a university in Berlin or in industry in Mannheim.

Initially, the globalization of engineering activities and firms poses an additional obstacle for women. As far as we need to travel in the U.S. on matters of gender equity, we are still light years ahead of many European countries and most Asian countries. However, since language skills and communicating with people of different interests and different cultures seem to come easier to women than men, I suspect the movement toward globalization will ultimately work to the advantage of women. Women engineers should make certain that these talents are developed and that they list them as important components of their international expertise in their resumes. Women, on the whole, have proven themselves to be inherently superior to men when it comes to people skills, for communicating effectively, and for their sensitivity in resolving conflict and accommodating other points of view. The global workplace is one in which these attributes are going to be very highly valued.

If I could offer one suggestion, one simple strategy for women in engineering to exploit in their fiercely competitive workplace, it would be to capitalize on their facility for languages and to take advantage of every opportunity to acquire expertise in another language or another culture. All of us are familiar with the stereotype of the one dimensional engineer, too steeped in the technical complexities of his discipline to be at home with other disciplines, other cultures. I think nothing will shatter that stereotype more completely than the entry into the engineering profession of large numbers of women with their natural flair for languages and their aptitude for managing and reconciling multiple interests.

Despite all the disparagement and disadvantages that women still have to endure in some engineering workplaces, we know from the amazing progress of women in the life sciences and other scientific disciplines that the day will come when the profession of engineering is no longer an unusual choice for a female undergraduate, and when the engineering firm with a woman CEO is the norm rather than the exception. Given the competence and the commitment of women already in the field of engineering who are working on that agenda, who knows, one day Americans may even be calculating their productivity in terms of "woman" hours and "woman" power.

Thank you again for inviting me, and best wishes for the continued success of WEPAN.



WEPAN CONVENTION  
DENVER, COLORADO  
JUNE 3, 1996

INFORMAL REMARKS BY  
F. SUZANNE JENNICHES  
VICE PRESIDENT AND GENERAL MANAGER,  
NORTHROP GRUMMAN AUTOMATION & INFORMATION SYSTEMS

### WOMEN ENGINEERS IN THE GLOBAL MARKETPLACE

Good morning. I am honored to be on the same plenary with Dr. Kirwan to talk about such an important subject as women engineers in the global marketplace. When Dr. Marilyn Berman asked me to speak, I jumped at the opportunity because I feel that so many of us enter the business world with outstanding technical credentials, but not a clue as to how the industrial world really operates. Although many schools encourage or even offer as part of their curriculum, a summer or semester workstudy job in industry, it is almost exclusively a domestic assignment.

In France, many of the major engineering universities require that each summer the students take a paid engineering job outside of France where they must work and live in a non-French speaking environment and accomplish increasingly more realistic engineering tasks. I am sure that you all have heard the generalization that the French are very nationalistic about the language and culture, yet clearly they recognize the need for working effectively in many diverse cultures. The Peoples Republic of China is now requiring all children to take eight years of English as part of their basic education. There is no doubt that we in the United States lag far behind the rest of the industrial world in preparing our workforce for the global marketplace.

Ideally, when you enter the marketplace, you should be able to think in at least one other language. Many times this is most easily accomplished by immersion - living overseas, outside of an American compound - for a year or more. Very few of us have had that opportunity. But hopefully the majority of the audience today is better prepared than I am; my second language is two years of high school Latin - and we all know that that hasn't been spoken in the marketplace for nearly 2000 years!

The lessons that I want to share today are very personal experiences of an ex-high school teacher, ex-practicing engineer, now - still learning general manager in a very tough competitive business world. They do not necessarily represent the practices and policies of Westinghouse where I have worked for 22 years or Northrop Grumman who recently acquired the Westinghouse Electronic Systems Group and who I have worked for for three months. But they represent the school of hard knocks and I hope that they can begin to inform you about what it is like to be a woman engineer in a global marketplace.

The first time that I travelled abroad on business was February 1980 for three weeks in Japan. I learned 16 Japanese phrases from an English to phonetic Japanese paperback on the way over on the plane. I had also bought a Fodor's Guide to Japan to get a thumb nail sketch of Japanese culture. Fortunately someone had told us that we needed "Presentos" for the various managers we would meet, so we purchased 20+ bottles of scotch for middle managers and cognac for executives at the duty free shop in JFK and set off to conquer the world. Despite our lack of preparation, the Japanese were incredibly cordial and the business trip was very informative. Later I learned that the Japanese are always cordial, but that doesn't mean that they are pleased with the encounter.

### LESSON #1 - LEARN SOME BASIC PHRASES

As it turns out, the rest of the world has come to tolerate our functional language illiteracy, but they really do expect that we at least take some time to learn the simple courtesy of life. I suggest you learn at least 12 basic words or phrases:

- Hello
- Goodbye
- Good morning
- Good evening
- Please
- Thank you
- Yes
- No
- I do not speak \_\_\_\_\_; do you speak English?
- I am lost; where is the \_\_\_\_\_ hotel?
- Where is the restroom (toilet)? Otherwise people sometimes think you mean a room to rest in like a bedroom.
- Or the ever popular generic - I need help.

And for me I have found another two phrases are very useful.

- How much is this?
- Oh, it is very nice, but that is more than I want to spend. Thank you very much anyway.

### LESSON #2 - ENGLISH IS SPOKEN WORLDWIDE AS THE TECHNICAL BUSINESS LANGUAGE.

But your business partners still want you to try and observe their culture as they have ours and not assume that because they speak English so well that we do not have to make an effort.

I recently visited with the world's largest material handling equipment company which is located in Dusseldorf, Germany. Their president told me that they had just established a company wide policy that all business meetings held within the company would be conducted in English - even if there were only Germans present. He wants them to only think in English when in the business environment because whether they are in the US, Korea, Finland, or Brazil the common language has become English. In a way I regret this because it somehow legitimizes our laziness. But it shows how serious a market leader, who could probably sell in any language because their technology is that good, realizes that they must adapt to the world and not the other way around.

### LESSON #3 - HAVE CULTURAL SENSITIVITY

The Germans are a perfect example. I work closely with four different German companies and they all go out of their way to work within our cultural comfort zone. When we are first introduced, they immediately adopt greeting us on a first name basis. This is a huge concession on their part. They have worked closely with German colleagues for 20 years and the most familiar they become is to drop the Herr or Doctor from in front of their co-workers last name. Yet routinely I see Americans read the business card and begin calling their German acquaintance "Thomas" instead of "Doctor Prasser". We find that people in our own organization have fallen into this trap. I ask them, "did Dr. Prasser ask you to call him Thomas?". Invariably they say "no, but they just wanted to make him feel comfortable". In reality, nothing could be further from the truth. So I tell them to switch to "Dr. Prasser" and see if he corrects them and says "Oh, no, please call me Thomas". They never do and they really appreciate that we understand their practices.

Cross cultural training is really important to pick up these sensitivities. Whether or not to give "presentos", whether to tip or pick up the tab, how close to stand (believe it or not, we friendly Americans need more space between us when we are conducting a conversation than many cultures - so when our international guest stands too close to talk, we back up and they pick up on this

unconscious cultural insensitivity. Whether to shake hands or pat someone on the back in congratulations, all of these innocuous behaviors are indicators that you are not really a cosmopolitan business person.

#### LESSON #4 - HAVE A RESPECT FOR HISTORY - DO NOT BE "NATIONALISTICALLY" ARROGANT

Each culture has something of which they are inherently proud. Be aware and considerate of this. We Americans are young (only 200+ years) and brash; we pride ourselves on our technical achievements and candidly discuss our accomplishments - sometimes only measured in a domestic vacuum. We tend to concentrate on the last quarter or year or decade. Most of the rest of the world operates on a much longer timeline and the geopolitical history of their culture greatly influences their business process. We are really culturally naive about anything that can not be reduced into dollars and cents.

The Germans are particularly proud of their technology and in my industry of mail processing automation and material handling, they are number 1 in the world. The US may buy the most, but the Germans make it possible for us to buy. They expect that we show the proper respect for their accomplishments and not rush in to recommend new technology upgrades; very often they have considered similar features and have discarded them years ago because of technical subtleties that we have not yet come at appreciate.

The French are very adept at social graces and can make a business meeting a very cordial and comforting experience. The Danes exhibit rugged simplicity and they are uncomfortable in aggressive business negotiations. The Japanese have a pride in their thoroughness of planning and thoughtful execution - they are not impressed with our willingness to jump to conclusions. The Brits are prudent risk takers. I have worked closely with these cultures over the last five years and I am only just beginning to appreciate the cadence and special nuances that each culture has. I can say that realizing these "generalizations" and taking them into consideration has greatly reduced my frustration with the path that business discussions take. Once I figured out their work ethic and process, I incorporated their needs into my planning and the whole business deal moved along more smoothly than I ever imagined.

#### LESSON #5 - SHOW ADVANCED PREPARATION

Business cards with your title and other information printed in the appropriate language is a very special touch. It shows that you have thought about the other culture in advance, but in a subtle, caring way. Having your business literature printed in the appropriate language is not only culturally sensitive, but very smart technically as well. Even though your international contacts are very conversant in English, they may only be picking up the "gist" of what you are saying, having the details written in metric and the appropriate language can clearly represent your products and it will certainly be passed on to their colleagues back in the factory who may not be as English literate as the marketing or executive personnel.

#### SUMMARY - COURTESY IS A TOOL THAT WORKS EQUALLY WELL DOMESTICALLY.

Always follow verbal communications with written confirmation. Establish agendas in advance and follow-up the business meeting with a memo highlighting the significant technical points discussed as well as the efforts that your colleague took to make the meeting special such as a factory tour, introduction to his superiors, or a lunch in a restaurant with local cuisine. Obviously, offer a reciprocal visit. Over the last five years of dealing in the international marketplace extensively, I have come to respect their investment in the total business person. They will research the history of the company, be aware of prior meetings even if they are a number of years ago, be aware of your current business portfolio, and will take the time to get to know something about you personally. Most international businesses are built upon broad relationships and not just your specific technical

capabilities this year. They come well prepared and many times we show up prepared to deal only with the opportunity at hand.

The courtesy of understanding the total company and person can serve us all very well domestically. Doing your homework, taking time to make to meeting as informative and specific for your guest as possible, and thorough follow-up which indicates that the time spent in the meeting will have a lasting impact are important lessons regardless in which time zone the meeting is held. It will set you apart as worldly, cosmopolitan, and a person worth building a relationship with - both today and for the long term.

Thank you.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## AN INTERACTIVE DISCUSSION OF INTERNATIONAL PROGRAMS

### Moderator

Marilyn R. Berman, Ph.D.  
Associate Dean  
A. James Clark School of Engineering  
University of Maryland

Marilyn R. Berman returned to graduate school in 1969 after obtaining a B.A. in 1956 in Elementary Education from Brooklyn College. In the thirteen year interval, she married and moved to the Washington, DC area. She has two sons and a daughter, and has been married for 40 years to a patent attorney in private practice. She completed her M.A. in 1973 in Counseling and Personnel Services, and her Ph.D. in 1979 in Higher Education Administration, both from the University of Maryland.

Dr. Berman is known for her pioneering work on the College Park campus of the University of Maryland in the areas of teaching, counseling, and research to encourage returning older students, primarily mature married women, to pursue their education. She has done innovative work in the area of increasing the opportunities for women and minorities in engineering and has been successful in bringing to the campus of the University of Maryland a number of grants for this purpose.

Dr. Berman has been the Associate Dean of the College of Engineering at the University of Maryland since 1988, with responsibilities for undergraduate student affairs and general administration.

### Recorder

Barbara B. Lazarus, Ph.D.  
Associate Provost and Adjunct Professor  
Carnegie Mellon University

### Presenters

Lester A. Gerhardt, Ph.D.  
Associate Dean and Professor, Engineering  
Rensselaer Polytechnic Institute

Thomas Chapman, Ph.D.  
Professor of Chemical Engineering and  
Director, International Engineering Programs  
University of Wisconsin at Madison



## INTERACTIVE DISCUSSION OF INTERNATIONAL PROGRAMS

Barbara B. Lazarus  
Associate Provost and Adjunct Professor  
Carnegie Mellon University

Moderator: Marilyn Berman, Associate Dean, Clark School of Engineering, University of Maryland, College Park, Maryland.  
Speakers: Lester A. Gerhardt, Associate Dean of Engineering and Professor of Electrical, Computer and Systems Engineering, Rensselaer Polytechnic Institute, Troy, New York. W. Chapman, Professor of Chemical Engineering, Director of International Engineering Programs, College of Engineering, University of Wisconsin - Madison, Madison, Wisconsin.

In 1992-1993 circa 71,000 students studied abroad; only 1.6 were in engineering. Fortunately, there are an increasing number of opportunities for engineering students to study abroad. This session focused on two such programs. The Global Engineering Educational Exchange Program (GE3), and The Engineering Alliance for Global Education (EAGLE) program in Japan. Both GE3 and EAGLE are the result of perceived need for the global engineer and the importance of providing cultural and technical international exposure for undergraduate engineering students.

In brief: GE3 is an exchange program for engineers which provides opportunity for study and work abroad. The program ensures credit transfer, and provides opportunities for study in English and in the native language of the country. Students work with the Institute of International Education (IIE) and pay their home institution's tuition. GE3 has generated enormous interest and has tremendous plans for future expansion.

In contrast to the global emphasis of GE3, EAGLE focuses on sending Americans to Japan and providing them with technical Japanese language, as well as courses on Japanese business and development of technology. The EAGLE consortium of school provides for Japanese language study on campus, a 10-week intensive summer program in Japanese language and culture, and an industrial internship in Japan one to three years after graduation. Since its establishment in 1991, EAGLE has developed a network of contacts, recognition in Japan, placed over 200 students in Japan for short courses and circa 130 graduates in long-term industrial internships and residential programs.



# **PRACTICAL ADVICE FOR WOMEN IN ENGINEERING ADMINISTRATORS: WHAT TO DO WHEN AN ALLEGATION OF SEXUAL HARASSMENT WALKS IN YOUR DOOR**

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## **INTRODUCTION**

Sexual harassment law has its basis in the Civil Rights Act of 1964 - Title VII. Title VII states that an employer may not discriminate against employees in hiring, firing, and with respect to terms and conditions of employment on the basis of sex. While Title VII does not explicitly prohibit sexual harassment, courts apply it on the theory that sexual harassment would not occur "but for" the sex of the victim.

For education, Title IX of the Education Amendment mirrors Title VII, thereby prohibiting sexual harassment in the academic context. This gives students the ability to take action in the case of sexual harassment.

These statutes are enforced by the Equal Employment Opportunity Commission (EEOC), Office of Civil Rights, and the U.S. Department of Education, Civil Rights Division, respectively. There are also state statutes that prohibit sexual harassment, and they are enforced by state agencies.

Two forms of sexual harassment have been identified:

- Quid Pro Quo ("this for that") occurs when submission to or rejection of unwelcome sexual conduct is used implicitly or explicitly as a basis for academic or employment decisions affecting the individual. It involves a power differential between the parties (e.g., faculty to student, supervisor to supervisee).

The law is clear, but courts may interpret the law differently in specific cases.

- Unwelcome sexual conduct: Truly consensual relationships are generally okay. Merely voluntary relationships are not necessarily okay. Voluntary does not mean welcome. In disputes, an individual accused of harassment must demonstrate proof of "welcomeness" of the conduct. Judgements may be based on the testimony of witnesses. Often the courts will examine how

provocative the complainant was at work, in dress and speech.

- Paramour preference: Others in an office or a class may complain they were denied benefits (not evaluated or graded fairly) because the supervisor or professor showed favoritism to the person with which he/she was involved in a relationship. Courts have not ruled consistently in these cases.

- Strict Liability: The employer is automatically liable, whether or not it knew or should have known and failed to take remedial action.

- Hostile Environment occurs when unwelcome sexual conduct is sufficiently severe or pervasive that it alters the conditions of employment or education and creates an environment that a reasonable person would find intimidating, hostile, or offensive.

- Perpetrators: Hostile environment sexual harassment may be perpetrated by co-workers, students, subordinates, supervisors, and third parties, such as alumni/donors, vendors, contractors, and research sponsors

- Liability: Employer is liable if it knew or should have known about harassment and failed to take prompt remedial action. An individual harasser may be personally liable.

The legal definition seems fairly clear, but there is a large gray area with which courts and juries struggle in determining what is unwelcome and what is pervasive.

## POLICIES AND PROCEDURES

All universities are required by law to have policies defining sexual harassment and describing procedures to file both informal and formal complaints. Some universities have developed their own policies, while others have hired consultants to assist them. Many share common features, while each has specific policies and resources for its own academy. You should obtain a copy of your University's sexual harassment policy. It is also helpful to compare yours with others from like institutions.

## WHY PEOPLE DON'T REPORT HARASSMENT

How many times have you heard, "Why didn't Anita Hill report sexual harassment when it happened? Why did she wait 10 years?" While we cannot pretend to know what Ms. Hill was going through or thinking, we do know there are a number of reasons people do not come forward with reports of sexual harassment:

- Embarrassment

- Belief that the behavior will end if ignored
- Fear of losing one's job or status
- Fear of retaliation
- Fear of being blamed for inviting the harassment
- Concern about not being believed
- Concern about being labeled a troublemaker
- Fear of harmful rumors and loss of privacy
- Conviction that nothing will be done about the problem
- Fear that the complaint process could be worse than the harassment.

### NINE MYTHS ABOUT SEXUAL HARASSMENT

With experience, good or bad, people develop their own beliefs about sexual harassment. It is important to consider and debunk the following myths about sexual harassment:

- If the "harasser" didn't intend for the complainant to feel uncomfortable, it isn't sexual harassment.
- Everyone understands the difference between "sexual harassment" and what behaviors are "flattery."
- If a person who feels uncomfortable doesn't tell the alleged harasser she/he wants a particular behavior to stop, the alleged harasser cannot be held responsible for committing sexual harassment.
- Everyone knows the difference between "sexual harassment" and flirting.
- When a woman is treated unfairly by a man in a work or academic environment, sexual harassment has occurred.
- Overly-sensitive people can now complain about sexual harassment and receive large cash settlements.
- For sexual harassment to occur, the behavior must be initiated by a heterosexual man against a heterosexual woman.
- There is an "outbreak" of women filing false, malicious charges of sexual harassment.
- One person must have institutional authority or power over another for sexual harassment to occur.

### WHAT CAN AND SHOULD YOU DO?

The Educator's Guide to Sexual Harassment (Sandler and Paludi, 1994) gives the following seven guidelines for handling sexual harassment complaints:

- **Take the report seriously.** Assure the person that the complaint or problem is being taken seriously and that the institution will respond to the problem promptly.
- **Listen, sympathize, but don't judge.** Listen to what the person has to say, sympathize, but make no judgement or commitment regarding allegations or how the investigation will be conducted. Do assure the



person that the institution takes sexual harassment seriously and will not tolerate it.

- Don't delay.** If you are not the individual designated to process sexual harassment complaints, tell the complainant who *is* responsible and offer to help contact that person. If that person is not immediately available, tell the complainant you will follow through immediately after the interview. Then do it as soon as possible. Delays of even a few days can make investigations difficult and may send a signal to the complainant that the institution is not taking the complaint or problem seriously.

- Respond to Concerns.** If the complainant expresses or indicates fear, assure the person that the institution will do everything in its power to ensure confidentiality (*but make no promises*), prevent retaliation and stop further harassment. If you are the person designated to process complaints or investigate them, answer any questions about the complaint process that will not jeopardize the investigation. If you are not the appropriate person to process a complaint, assure the complainant that his or her questions will be answered by the appropriate person.

- Document.** Write a detailed summary of what the complainant told you, including your observations of the person's demeanor. Submit it to the individual who will be processing the complaint.

- Follow up on the complaint.** Check with the complainant the next day to ensure that he or she is getting needed assistance.

- Avoid using "Dangerous Words,"** such as "It's just teasing - no big deal." (See next section for complete list of dangerous words.)

In addition, I offer the following suggestions:

- Understand that once you are told of a potential sexual harassment problem, you are legally liable to act.** Even if you wanted nothing to do with sexual harassment complaints, you now must act, or both you and the university may be held liable for inaction.

- Remain Neutral.** You must entertain the thought that the complainant is correct. You must also entertain the possibility that there is another side of the story. However, it is NOT your job to investigate or question others about the complaint.

- Let the student know that there IS a sexual harassment policy at your University and that sexual harassment is not tolerated.** This is a good time to give the student a copy of your university's sexual harassment policy.

- Indicate to the student that there are both informal and formal options to resolve sexual harassment complaints.** Explain that if the student just wants the behavior to stop, then an informal process might be appropriate. If punishment or sanctions are desired, then in most cases, the formal process MUST be employed.

- Let the student know that you will attempt to keep the complaint**



**confidential, but that you cannot guarantee confidentiality.** There should be offices on your campus that can guarantee confidentiality.

●**Encourage the student to keep a log of incidences of harassment, including making a list of witnesses.**

●**Do not attempt to investigate or resolve the complaint on your own.** There should be people on your campus who are trained and authorized to resolve sexual harassment complaints. Trying to run your own, perhaps biased, investigation could jeopardize the University's legal position, and it can cause you both personal and professional grief.

●**Do not discuss the complaint with colleagues or other students.** You may discuss the complaint with your Ombuds office or other designated offices on campus. Remember, there ARE procedures for determining whether or not something is harassment, and public discussion before a finding is NOT appropriate.

### DANGEROUS WORDS

In the Educator's Guide to Sexual Harassment (Sandler and Paludi, 1994), you are warned to be careful of what Bernice Sandler and Michelle Paludi call "Dangerous Words." They recommend specifically, "When responding to a complaint, be careful that these words don't come out of your mouth:"

- It's just teasing - no big deal.
- The people in our school would never do ...
- I know he/she didn't mean anything like that.
- It's your fault for dressing so provocatively.
- You need to learn to handle these things.
- Just ignore it.
- He puts his arms around everyone.
- Why can't you learn to accept a compliment?
- You must have wanted it, otherwise you would have told him no.
- That's how they do things where he comes from.
- It's just a joke. Lighten up.
- No one's filed a charge, so our hands are tied.
- We've never had a complaint, so we don't have a problem.
- This kind of behavior is all part of growing up.
- It's a matter of hormones; we can't control that.
- If we had to discipline every student who used bad language we'd never get anything else done.
- It's just a prank that got out of hand.
- Oh well, boys will be boys.

### TRAINING

While many faculty respond well to good training programs, there is resentment on the

part of some faculty when such training is "mandated." Each institution's politics and leadership determine whether such a process will work effectively. However, we believe that strong and effective leadership on a grassroots level can help eliminate sexual harassment in individual units, and ultimately at a university.

Regardless of whether or not training is mandated on your campus, be sure you are trained. Know what to do and who to talk to when the inevitable complaint walks in the door. Know your responsibilities and know who is responsible to make sure something happens with the complaint.

Whether your Women in Engineering Program should be responsible for improving the campus climate by helping to stop sexual harassment is certainly a philosophical question. Most would agree that your university's administration should have that responsibility. However, some need help, and we advocate your getting involved in the process and providing your input. Be sure that your training addresses issues on a college campus, and provides explicit information about the complaint handling process. Find out what action your university takes if it finds that sexual harassment is happening, and how it protects its students and employees from retaliation.

### CONCLUSIONS

It is important to acknowledge and understand that sexual harassment case law is evolving. A jury may make a decision tomorrow, which could affect the sexual harassment policy on your campus. Furthermore, each case will present itself such that something that worked in one case might not work for the next. However, always keep in mind the good practices recommended here: NEVER attempt to investigate and resolve sexual harassment complaints on your own. ALWAYS get help from someone on your campus who is trained and authorized to handle these issues. ALWAYS maintain neutrality and confidentiality.

I recommend that you purchase The Educator's Guide to Controlling Sexual Harassment, from which selected material in this document was taken, or a similar book. The CU-Boulder campus has found the Guide to be an invaluable resource.

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Thompson Publishing Group, 1725 K Street N.W. Suite 200, Washington, DC 20006, 1-800-677-3789.

Note: Many thanks to Tom Sebok and Eleese Robbins of the Ombuds Office and Nancy Kornblum of the Office of Legal Counsel, all at the University of Colorado at Boulder. A longer version of this document is available from the author.

## CURRICULUM REFORM: WORKING TOWARDS GENDER EQUITY

### **Moderator**

Judith W. McDonald  
Director, Women in Engineering and Student Services  
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Judith W. McDonald earned her Bachelor in Ceramic Engineering degree from The Ohio State University in 1965. She worked at the Westinghouse's Engineering Research Center until joining the Peace Corps in 1966. Judith returned to The Ohio State University as a lecturer in engineering graphics in 1980. In 1986, she became the Director of the Engineering Cooperative Education Program at Ohio State. In 1989, she assumed the position of Director of Student Services as well as the Director of the Women in Engineering Program.

Judith serves on the WEPAN Board of Directors, is a member of the Society of Women Engineers (SWE) and the Association for Engineering Education (ASEE), having served as WIE Program Chair and most recently, Division Chair. She also volunteers as an advocate in the Rape Survivor Program.

### **Presenters**

Patricia Laughlin, Ph.D.  
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## WORKING TO ACHIEVE A MORE GENDER NEUTRAL ENGINEERING CURRICULUM

Patricia Laughlin, Ph.D.

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Individual career decisions are influenced by such things as ability and aptitude, family background, socio-economic status, culture and peer groups. The decision to pursue a degree and a career in engineering can be influenced by many factors. Certainly an ability in math and science is needed to pursue a degree in engineering, but why is it that students who are academically prepared to pursue an engineering degree choose not to? Why do first year engineering students transfer out of engineering with only limited, (or perhaps no) exposure to engineering? What role does the structure of the engineering curriculum play in retaining academically prepared female students?

There is evidence that the way science is taught at the undergraduate level can influence student retention, regardless of gender. Approximately 40% of first year students who have an interest in careers in science, mathematics and engineering change their plans before completing an undergraduate degree (Astin & Astin, 1993). What is the relationship between attrition and undergraduate pedagogy and curriculum?

This paper addresses the study of the curriculum revisions at Carnegie Mellon, and the impact of change on retaining female undergraduate students. The underlying assumption of this paper is that good pedagogy is good pedagogy and is a positive factor of success for all engineering students, but it can be viewed as especially relevant to the quality of the educational experience of female undergraduate engineering students. Perhaps the most effective way to improve retention of female and underrepresented minority students is to improve the quality of learning experience for all engineering students.

In 1990, the Carnegie Mellon College of Engineering implemented a significant curriculum change that is especially relevant in addressing issues related to the representation of women in undergraduate engineering studies. Much of the impetus for change centered on the preparation of incoming first year students, their interests, knowledge of engineering, career aspirations and retention of students within the engineering college.

The perception underlying the curriculum revision is that first year students are not equally prepared in math and science, knowledgeable about engineering, and often are unsure of their choice of major within engineering. Often they are looking to their first year experience to affirm their choice of profession and discipline.

In considering how to change the curriculum, the following factors most often cited as reasons female students choose engineering were also considered: knowledge of the subject, capability and interest in high school math and science, knowing an engineer, and support systems--most often family. (O'Donnell & Anderson 1978; Baum 1989; Fitzpatrick & Silverman 1989; Barber, Morgan & Darby 1990, Rosser, 1995, Tobias 1990)

Distinguishing characteristics of a curriculum that might contribute to female student achievement and success in engineering and science were also considered. Among these characteristics are a structure that places engineering students in early and regular contact with other engineering students and faculty, including female faculty, and flexibility that encourages and permits exploration and development of secondary or concurrent interests.

### Revised Curriculum

In outlining the structure of the new curriculum, the college came to several conclusions. The first was to teach engineering early through required introductory courses. The profession of engineering is not well understood by many students, so it is unclear if student expectations of the field match the reality of being an engineer. Most of the students in beginning engineering courses are engineering majors who have had no previous exposure to the subject. Many students look to an entry-level course as a way to affirm their interest and to understand the nature of their prospective field. In traditional curriculum structures, first year students take math and science requirements and do not gain much exposure to engineering until much later in the undergraduate experience.

First year engineering students at Carnegie Mellon are required to take two out of a set of six first year engineering courses. These courses are intended to provide hands-on engineering experience, to provide a context for related courses in science and mathematics, to introduce the range of engineering practice and to introduce students to methods for engineering design and problem solving.

Features of the Carnegie Mellon first year required introductory engineering courses: to emphasize the "Big Picture", include a hands-on lab experience with an engaging project, exposing students to engineering design and problem solving. Faculty assigned to these courses are considered to be among the best teachers in the college. Female faculty regularly rotate through three of the six introductory engineering courses, thereby exposing female students to female faculty early in their careers.

In essence, the College of Engineering is taking ownership of all students who express interest in engineering at the time he or she enters the university. This is achieved by placing students in courses with engineering faculty and other engineering students (both first year and upper-class students.) A goal in the curriculum revision is to minimize required core and course load, especially in the first year, partially in response to student concern that the workload was uncomfortably heavy. The purpose here is to create a "student friendly" structure, not one that has less work per se, but rather one that has fewer topics to worry about at the same time.

A unique underlying philosophy is the specific technology taught is less important than teaching students how to learn, how to solve problems, and how to be leaders in industry and government. With this philosophy, eliminating some of the traditional engineering topics that normally are included in a four year undergraduate program becomes feasible. Carnegie Mellon is teaching students engineering, not necessarily teaching them to be engineers. In that vein, engineering education in the 21st century can be thought of in much the same way as liberal arts education is thought of today. Students use engineering as a platform from which they pursue a number of careers, including engineering.

Following the first year revisions, several departments have also instituted curriculum change. The curriculum in Electrical and Computer, Civil and Environmental and Mechanical Engineering have been altered to reduce the number of required courses and the length of required pre-requisite chains. In each case there are from five to eight totally free electives, in addition to the eight general education courses that are required of all engineering undergraduate students. A series of designated engineering minors that can be completed within the structure of the different degree programs were also introduced.

### Assessment

Ongoing impact assessment is being conducted, contrasting the experiences and accomplishments of the 1994 class, the last to graduate under the old curriculum with the 1995 and 1996 classes, the first and

second classes to graduate in the new curriculum. Successive years of graduating seniors will be surveyed, and after five years alumni will also be asked to answer questions of the relevancy of their education. (It is noted that comparing attitudes and experiences over time is fraught with peril since external factors could cause any observed differences.)

The response rate for the three years of the senior surveys has remained fairly constant, averaging 26%. Women represent approximately 15% of the senior class over the three year period. The response rate of female seniors to the survey has been slightly higher than their representation in the class, 22%. The distribution of responses by senior women appears to reflect the distribution in the departments.

The study of curricula impacts includes the following: retention and graduation rates, surveys of graduating seniors, faculty and recruiters. Due to time and space considerations the first two are reported here.

At the time of the curriculum proposal it was hypothesized that exposure to disciplinary engineering courses in the freshman year would allow students to assess the suitability of engineering as a major earlier, so retention would likely decrease between the freshman and sophomore years, shifting a drop that normally occurs after the sophomore year.

However, what occurred with freshman to sophomore year retention was just the opposite. Since the introduction of the new freshman curriculum in the fall of 1991, the retention of engineering freshman to engineering sophomores remained level in that first year (about 80% for both the 1990 and 1991 cohort of entering students) but increased to 82.5% for the 1992 cohort, and leveled off to 86% for the 1993 and 1994 cohorts.

The cause of this surprising increase in freshman to sophomore retention may be that first year engineering students may be more likely to continue in engineering because they are integrated into the academic and social environment of the department and college, feel connected to the engineering faculty, connected to other engineering students and to the engineering program. Personal contact with faculty, immersion into engineering in the introductory courses and contact with their peers, (other engineering students), are all characteristics of effective retention models. (Astin 1984, Tinto 1975).

#### Surveys of Student Opinion

In the month before graduation, seniors were surveyed to report on their experience at Carnegie Mellon and their career preparations. Students were asked to rate the engineering curriculum and various aspects of their educational experience on a scale of 1 (poor) to 5 (excellent). Generally, student satisfaction with their education increased over the period from the old curriculum to the new, although only the changes in "understanding engineering by the end of the freshman year," "sufficient flexibility in the curriculum" and "instruction quality in engineering" were statistically significant at a 95% confidence level. It is interesting that the responses were surprisingly similar when analyzed by gender.

Characteristics	1994 Graduates: Old Curriculum		1995 Graduates: New Curriculum		1996 Graduates: New Curriculum	
	All	F	All	F	All	F
Rating of CIT Curriculum Overall	3.9	3.9	4.1	4.1	4.1	4.1
Rating of student's skills in oral communication	3.8	4.0	3.9	3.9	3.9	4.0
Rating of student's skills in written communication	3.9	4.0	3.9	3.9	3.9	3.9
Rating of student's skills in engineering problem solving	4.2	4.1	4.3	4.4	4.3	4.3
Rating of student's skills in the application of fundamental analysis	4.0	3.8	4.1	4.2	4.1	4.2
Preparation for continued learning	4.2	3.9	4.3	4.4	4.3	4.3
Preparation for teamwork	4.3	4.3	4.4	4.4	4.5	4.6
Understanding of engineering by the end of freshman year	2.2	1.8	3.1*	3.2*	3.1*	3.1*
Sufficient flexibility provided in curriculum for your educational objectives?	2.9	2.7	3.5*	3.6*	3.3*	3.1*
How well did mathematics and science courses prepare you for engineering courses	3.5	3.4	3.5	3.6	3.4	3.5
Rating of the instruction quality in engineering courses	3.8	3.7	4.1*	4.1*	4.0	4.1*
Rating of the instruction quality in non-engineering courses	3.6	3.7	3.5	3.5	3.6	3.9

\*Indicates statistically significantly different means at a 95% confidence level.

Specific comments from some of our female seniors who graduated in 1994, prior to implementation of the new curriculum, and in 1995 and 1996, the first and second classes to begin and complete the new curriculum help to illustrate the impact of the new curriculum.

In response to questions about the best aspect of engineering education at Carnegie Mellon, some of the 1995 and 1996 female graduates mentioned the introductory courses.  
 "The intro classes were helpful in deciding a major."

"I love the introductory courses! The experience really gave me confidence in being able to choose a major that I'd be happy with and successful in."

One 1994 female graduate who entered Carnegie Mellon before the new curriculum commented: "I think the Introductory to Engineering courses are a very good idea."

Efforts to decrease the total number of classes in the first year were noted by a 1994 female graduate who commented: "The crunch of dealing with 5 classes as opposed to my friends at other schools who only take 4 classes" as one of the worst aspects of engineering education at Carnegie Mellon.

Lack of flexibility in choosing courses seemed to dominate comments by many 1994 and some 1995 and 1996 female graduates when identifying the worst aspects of their engineering education at Carnegie Mellon. The 1996 responses begin to note the increasing flexibility in some departmental curricula:



"The flexibility in the curriculum allowed me to pursue other areas of interest other than engineering."

"Time limitations on electives--would like to explore more areas but had to choose"

"At times Chemical Engineering curriculum seemed too structured and rigorous. Not enough freedom to choose what classes you will take."

And another, after sophomore year "I did not have any classes with people outside of my major. There is no flexibility in the chemical engineering curriculum, which is unfortunate."

"I got very little chance to choose my own classes and interests, . . . that once you choose a minor or option you have no choice"

"The rigidity of the engineering core. I didn't get enough opportunity to take other classes that I wanted to take."

"Did not have the time or flexibility to take other classes and pursue other interests."

But curriculum change has its price as noted by one woman, "curriculum changes were too often."

The 1994 female graduates commented on lack of hands-on experience as the worst part of their engineering education at Carnegie Mellon. In contrast, many 1995 and 1996 female graduates commented on their positive feelings towards the hands-on experience and the opportunity to participate in undergraduate research:

Best was "the opportunity to do research and the opportunity to work in the department."

"Problem solving skills and team work were enforced and taught very well. Open-ended group projects were challenging and great preparation for real world problems."

"I could participate in a project as a freshman under one of my department's professors."

"The hands-on experience was great."

"Undergraduate research projects and labs" as the best aspect of the engineering experience, also, "Project classes, senior design classes, senior projects."

### Summary

From student surveys we have found that our first year students remain enthusiastic about engineering. Of the students that entered the college of engineering over the past two years, on average over 92% stayed at Carnegie Mellon. Of these, 95% have remained in engineering.

Students also seem to rely on the introductory courses as a basis for choosing a major. The introductory courses have also allowed our students to become employable in a technical profession after their first year because they have some engineering as a result of the introductory courses.

The flexibility in the new curriculum makes students much more proactive in planning their academic choices. Because they're engaged in planning their curriculum, they seem to be much more interested in what they are taking. Interesting early assessment data of student course selection in the department that has had the most flexibility for the longest time (Electrical and Computer Engineering for six years) indicates that students are choosing more technical courses, rather than fewer, as was hypothesized at the time the curriculum was proposed.

One important factor in the long term success of the undergraduate curriculum revision is that advising in such a flexible program takes on even greater importance than it did under the old curriculum, and this

does place a greater burden on Carnegie Mellon's faculty and on the departments to step up to that responsibility. Flexibility means more choices, which have to be planned.

Assessment will be ongoing, especially as we evaluate the impact of change on the female students in the engineering college. Student satisfaction and retention has increased, we find that engineering students use their engineering background to pursue a variety of careers in other professions. Many engineering undergraduate students have specific career goals in mind, including careers in business, law or other professions. This curriculum accommodates the desire to achieve those goals, while providing an excellent education.

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## HUMANIZATION OF THE ENGINEERING CURRICULUM

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Today there exists a challenge to incorporate new and improved teaching practices which will be more appealing to a diverse engineering student body throughout the engineering curriculum. It is generally believed that application of modified teaching paradigms will lead to increased recruitment and retention among women and underrepresented ethnic groups in engineering, and this is desirable for increasing diversity in the engineering workforce. We present an overview discussion of specific women-related issues important to the transformation of engineering curricula, and we report initial results of student surveys on teaching preferences and effectiveness. The issues which we identify have been determined through a semester long workshop series exposing engineering faculty to contemporary issues and ideas related to women in science and engineering. Our recommended guidelines for curriculum transformation support a more humanistic approach in teaching and a continuation of efforts that will lead to greater diversity. These are suggested as a means to insure greater satisfaction and enthusiasm for all students. Initial survey results for a freshman level engineering population have confirmed that diversity in terms of gender and ethnicity are desirable for all students. However, the level of importance is greater for women students.

### ENGINEERING CURRICULUM TRANSFORMATION PROJECT

An engineering curriculum transformation project has been initiated at the University of Maryland through the support of the A. James Clark School of Engineering's Women in Engineering Program (WIE) and the University of Maryland Center for Teaching Excellence (CTE). The project included a semester long series of workshops and seminars featuring experts in the field of women in science and engineering. Additionally, a parallel series of guided, small group discussions was facilitated under the direction of Dr. Deborah Rosenfelt, Professor of Women's Studies and Director of the campus curriculum transformation project. The workshop participants included 9 school of engineering faculty and 6 Undergraduate Teaching Fellows who were women. Each faculty member (or faculty pair) was assigned an undergraduate teaching fellow, and based on information gained through the workshops, seminars, group discussions, and personal experiences of the faculty/fellow team, modifications to 6 school of

engineering courses were implemented, ranging from freshman to senior level.

The participating faculty group created a list of specific women-related issues that were deemed important in realization of the project goals. The issues generally revolved around a theme of inclusion: regard for the relevance of course material to topics of interest for all student populations represented, regard for the level of competence of all student populations represented, education of students and faculty in basic human interaction skills, and on-going evaluation of teaching effectiveness and student satisfaction<sup>1,2,3,6</sup>. The recommendations are as follows:

1. Provide context to the course material, including historical, social, and contemporary relevance and application.
2. Promote the contributions of women and ethnically underrepresented scientists and engineers.
3. Use diverse teaching methods including visual, verbal and other multimedia techniques.
4. Create and apply a variety of teaching analogies, including a mix of gender neutral analogies, analogies relating to a typically female experience, and analogies relating to a typically male experience.
5. Include group assignments and group activities in student responsibilities.
6. Selection criteria for members within a group should not be random and should be based on the needs of the students, as well as the needs of the problem.
7. Provide training in basic interpersonal skills, including diversity training, group dynamics and conflict resolution for faculty and students.
8. Include freshman and sophomore level courses that provide encouragement for students.
9. Develop workshops, seminars or short courses which provide remedial level instruction in laboratory and computer skills.
10. Maintain an on-going critique of teaching effectiveness through student-student and student-faculty interactions.

These recommendations should be regarded as a set of guidelines which may be applied in developing a curriculum which is more appealing for all students. However, many of the issues outlined are particularly important for women students and also for students from underrepresented ethnic groups in engineering. This has been confirmed through external studies of women and underrepresented groups in general science fields<sup>8</sup>. However, we are now conducting student surveys and focus group interviews to gauge the validity of these statements for engineering students. Initial results of written surveys for a freshman class selected for participation in the curriculum transformation project are presented below.

## ENES 100 FRESHMAN INTRODUCTION TO ENGINEERING DESIGN

The ENES 100 engineering design course was implemented through the Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL). The course is designed to provide a complete product development experience, including product design, construction and evaluation for first year engineering students. The course objectives include cultivation of skills in the use of CAD tools to produce engineering drawings, use of spreadsheet software to calculate simple expressions and in graphing and data display, simple free-body diagrams and equilibrium analysis, written and oral presentation skills, basic manufacturing and wood working skills, product testing and evaluation, and teamwork skills. The only prerequisite for the course is high school level physics.

The ENES 100 course is considered a contemporary model for introduction of design oriented classes early in the engineering curriculum. The students are separated into teams of 6 and are given a product specification. The students must then design a product that will meet the design specifications. The curriculum transformation modifications which have been applied to this course relate directly to items 1, 6 and 7 from the list given above. The modifications were as follows:

- additional criterion was placed on the product specification to add a useful context to the project goals.
- a modified set of criteria was used in the selection of team members
- a workshop on group dynamics was held

### MODIFICATION OF PRODUCT SPECIFICATIONS

The product specifications assigned to each of the ENES 100 sections included design and construction of a vehicle which could capture the energy created by a 15 mph wind source and carry a 40 lb. payload a minimum distance of 30 feet in a reasonable time frame. Several size constraints were also placed on the final product. In addition to the standard specifications, the students were given several incentives for constructing a product that would be useful for human entertainment. For example, bonus points were given for carrying a payload more in line with the weight of an adult. Additionally, incentive points were available to the team which constructed a vehicle judged visually most appealing by a group of 4<sup>th</sup> grade students.

### Observations

Incorporation of the design modifications greatly increased the level of enthusiasm of each of the teams. Product designs were generally dominated by the drive to improve payload capabilities, and to develop a product theme that would appeal to children. Special product features such as bicycle-style hand braking systems, additional safety equipment to protect young riders and decorative pictures and illustrations were included on various designs. At the conclusion of the semester, a few teams donated their designs to local high school and community centers. However, when questioned

about the usefulness of the project, most students did not recognize a practical use for the vehicles.

#### CRITERION FOR TEAM MEMBER ASSIGNMENTS

The criterion used in making team selections included three components as follows:

1. Each team must have at least one member with a reliable car.
2. No team will have only one female or African descent member.
3. No team will have subsets of members who describe themselves as being friends.

Using this criterion, women students were assigned to three of the five teams in the class. One team had three women members, two teams had two women members and two teams had no women members. One of the seven initially enrolled women students subsequently dropped the class. This student had been assigned to the team containing three women students. There were four students of African descent, and none of these students dropped the class. Of the six women students completing the class, one was of African descent and one of Hispanic descent.

#### Observations

One of the more interesting topics of debate during the curriculum transformation project group discussions involved faculty prerogative in selection of individuals to be grouped for a group assignment. In spite of empirical evidence which supports the stipulation that women students typically experience frustration and dissatisfaction when isolated in team situations<sup>2,3,6</sup>, many of the participating faculty felt strongly that creating a false environment by increasing the presence of underrepresented students should not be pursued. The educational experience gained from a more realistic environment is of more value and would be more appreciated following graduation. A few faculty members felt that this was not as critical for particularly lower level students.

In past offerings of the ENES 100 class, gender and ethnicity have not been considered in making team selections. For those past cases, it has been observed that women students (when isolated) often complain of not being taken serious for analytical activities. Also, it has been observed that women students become frustrated when team members are reluctant to complete assigned tasks in a timely manner. Moreover, male students often complain of women team mates who are overly concerned with completing tasks on time and maintaining adherence to a planned schedule of activities. Using the criteria of no isolated women students, and no isolated African descent students, this type of situation was not observed by the instructor or teaching fellow. Also, the overall morale and cohesiveness of each of the teams was much improved over past experiences for the same instructor.

### GROUP DYNAMICS WORKSHOP

The group dynamics workshop was hosted by Ms. Symone Colquitt, a volunteer elementary school parent who has gained experience in coaching team design projects by managing a group of six, 4th grade students in the construction of a battery powered vehicle. The activity was part of a national competition titled "Odyssey of the Minds". The workshop involved a short introduction outlining effective team characteristics followed by a series of brainstorming activities. Finally, a hands on activity that required brainstorming, group decision making and allocation of tasks was performed. The workshop was held early in the semester, but was not done prior to the first group homework assignment.

During the workshop, brainstorming activities were assessed by judges who determined the level of creativity in responses of individual team members to a general question. Bonus points were awarded to teams whenever particularly creative responses were given by one of the team members. However, pre-game comments given by the workshop facilitator placed a clear emphasis on achieving a large quantity of responses, and on withholding judgment of responses by team members.

### Observations

A few general observations noted from the workshop included the following:

- Almost all of the students spent an inordinate amount of time concentrating on the judge's assessment of responses given by team members.
- A few male students openly challenged the worth of emphasizing quantity of responses over the quality of responses within the context of a brainstorming activity.
- Evidence of team camaraderie developed as the activity progressed.

In addition to the observed improvement in team satisfaction for women students, the team dynamics for the overall class was also greatly improved over past experiences. All of the teams demonstrated an ability to resolve conflict without intervention on the part of the instructor or the teaching fellow. This has previously not occurred. Also, when students were questioned about the number of teammates they respected, the average response was 4.8 for women students and 4.1 for men students.

### **ASSESSMENT AND EVALUATION**

As a means of evaluating the effectiveness of the modified team selection criteria and the group dynamics workshop, and also to begin compilation of data on effective teaching practices and methods, two surveys were written and distributed to the students. The surveys were written with the assistance of faculty and graduate students in the department of psychology and the ENES 100 instructor and teaching fellow. The first survey was distributed after completion of approximately 40% of the semester and the second survey was distributed after completion of approximately 90% of the

semester. The first survey was completed by 19 male and 7 female students, and the second survey was completed by 18 male students and 5 female students. Additionally, a third survey was distributed by the WIE office after completion of approximately 60% of the semester. A few statistically significant trends for the population sampled have been identified.

## SURVEY RESULTS

The surveys were structured so that students were asked to quantify how well they agreed with a statement on a scale from 1 to 5. 1 is strongly disagree, 5 is strongly agree and 3 is neutral. The statistically significant results are listed and discussed below.

- All students prefer an ethnically diverse environment for academic work. However, this is more true for women students (avg.=4.6 in survey 1, avg.=5.0 in survey 2) than for men students (avg.=4.1 in survey 1, avg.=3.6 in survey 2).
- All students prefer a gender mixed environment for academic work. This is more true for women students (avg.=4.6 in survey 1, avg.=5.0 in survey 2) than for men students (avg.=4.2 in survey 1, avg.=4.2 in survey 2).
- Women students agreed that it is important to use examples and give assignments which are inclusive of different groups of people in terms of gender and ethnicity (avg.=4.5 in WIE survey). Men are more or less neutral (avg. =3.3 in WIE survey).
- Men students tend to agree that team meetings improved following the group dynamics workshop (avg.=3.8 in survey 1). Women students were neutral (avg.=3.1 in survey 1).
- Women students tended to strongly agree that team meetings improved over the course of the semester (avg.=4.6 in survey 2). Men students tended to agree with this statement also, but less strongly (avg.=3.7 in survey 2).
- In the initial survey, white students were neutral when asked if team meetings had improved following the group dynamics workshop (average=3.1). Other students tended to agree with the statement (average=3.9)
- Although the teaching fellow was not overly utilized, white students were slightly more likely to approach the teaching fellow for assistance (avg. #visits=1.6) than other students (avg. #visits=1.1).

Other statistically significant results indicate that men students consistently disagreed that gender or ethnicity will affect an instructor's teaching approach or the student's ability to learn. Women students strongly disagreed with statements to this effect. Also, all students disagreed that teaching methods and examples presented in class prepared them for completion of the class project or enhanced their conceptual understanding of the material. Lastly, all students felt their team exhibited positive characteristics. Men students tended to agree with these statements, and women students tended to strongly agree.



## CONCLUSIONS

A curriculum transformation project in engineering has been initiated which will seek to improve the attractiveness and appeal of the engineering curriculum for women and ethnically underrepresented students in engineering. A group of 9 engineering faculty have convened and identified specific woman-related issues that should impact realization of the project goals. The issues identified revolve around the theme of humanization of the engineering curriculum through a philosophy of inclusion, education of students and faculty in basic human interaction skills, regard for the relevance of course materials to topics and applications of interest to all student populations represented, regard for the initial level of competence of all student populations represented, and on-going evaluation of teaching effectiveness and student enthusiasm. Initial results from student surveys indicate women students place more emphasis on team oriented activities, and while all students tend to prefer diverse academic environments in terms of gender and ethnicity, these issues are more important for women students. We also have observed that control of academic environments based on the needs of the participating students is more likely to result in increased levels of satisfaction and enthusiasm for women students. Specifically, avoiding isolation of women students for group assignments and group interactions is recommended. Finally, conventional methods used in teaching engineering principles and concepts do not meet the needs of students in general, regardless of gender.

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## GENDER COMMUNICATIONS: HE SAID...SHE SAID

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Women and men sometimes, and generally do, communicate differently. Although neither communication style is better, sometimes the results can be strained relationships, stress, lack of trust, poor job performance, and in some cases, even lawsuits. These differences are becoming more widely recognized and publicized. In the November 20, 1995 Wall Street Journal under the title of *They Just Don't Understand Gender Dynamics* two interesting quotes are:

"...Intergender workplace tensions often result from nonmalicious misunderstandings caused by differences in communications habits."

"...Training in a few interaction skills can eliminate the majority of miscommunications."

This workshop addresses this training need and will explore six gender communication style tendencies. The information provided will help you better understand your communication tendencies so you can acknowledge gender differences. As a result, you will gain a better understanding of others by identifying these differences. You will then be on your way to adapting your communication style to be better understood. Interested readers can find more information in the references.

## WORKSHOP OUTLINE

- I. Introductions
- II. Program Design/Development - "How the workshop came to be"
  - Part of Hewlett-Packard Atlanta Site's Diversity Curriculum
  - Differences in gender communication styles were seen
  - Co-designers male and female perspective
- III. Workshop Objectives:
  - Acknowledge differences between men and women's communication styles that can potentially cause conflict
  - Understand the gender-specific motivations behind communication
  - Adapt communication style when necessary to create successful communication and relationships
- IV. What Research Says About Gender Communication Differences:
  - Communication Style Tendencies
    - Showing empathy versus solving the problem
    - Using questions
    - Compete details versus the "Big Picture"
    - Agreement versus confrontation
    - I'm Lost, Can You Help Me?
    - Building rapport
- V. Summary
  - Cross-over effect
    - To recognize these tendencies in yourself and to adapt to make communication more effective

## **Communication Style Tendencies**

### **Showing empathy versus solving the problem.**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **Using questions.**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **Complete details versus the "Big Picture"**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **Agreement versus confrontation.**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **I'm Lost, Can You Help Me?**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **Building Rapport**

Male Tendencies:

Male Adaptation:

Female Tendencies:

Female Adaptation:

### **Personal Action Plan**

1. What are some insights you have gained as a result of this program?

About men?

About women?

About yourself?

2. What can you do to work smarter together with co-workers of the other gender?

3. What can you do in your personal life?

4. What will you do to begin the process?

At work?

In your personal life?

For those of you who were unable to attend the conference, here are some quick highlights of the workshop. Perhaps after reviewing this material, you might have sufficient interest to refer to the referenced material for more information.

Showing empathy versus solving the problem. Most women are good listeners and will hear out the other person, usually showing concern, interest and emotion as the speaker talks. They will ask questions to show interest and help the speaker describe the issue.

Men often feel that if someone comes to them to describe a problem, then they feel the speaker is coming to them for direction on how to resolve the issue. Men will readily offer a solution, many times before the speaker has even finished outlining the issue.

Using questions. As mentioned above, women usually use questions to show interest, to gain a better understanding of the topic of conversation. Through the use of questions, women build rapport with others.

Men tend more toward making statements and use questions sparingly. Many feel that asking questions is a sign of weakness. This can create confusion in the workplace where women are asking questions to truly understand the issue and men might misinterpret this questioning as a sign of weakness.

Compete details versus the "Big Picture". Men tend to look at the larger scheme of things and find looking into too fine a detail as irritating.

Most women look into the details to show concern and interest. Many times through exploring the details other issues that might have been overlooked are uncovered.

Agreement versus confrontation. Women will tend toward finding areas of agreement with others and avoiding hurting others feelings.

Men do not hesitate to show disagreement and will quickly point out those areas to others. The intent is not to injure the relationship but simply a desire to illustrate the difference of opinion.

I'm Lost, Can You Help Me? It would appear that women value time and will ask others for help to avoid wasting it.

Men also value time but find it difficult to ask others for help. Perhaps this is seen as a sign of weakness.

Building Rapport. Women tend to use a participative, indirect style of communication and strive to be liked which all lends itself to creating rapport with others.

Men tend to be more direct in their communication and strive to be recognized as the authority on the subject.

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OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## CAMPUS CLIMATE ISSUES

### Moderator

Norman L. Fortenberry, Sc.D.

Executive Director

The GEM Consortium

Dr. Fortenberry is Executive Director of the National Consortium for Graduate Degrees for Minorities in Science and Engineering, Inc. (GEM). GEM is a \$4.2 million enterprise with offices in three states and a staff of 13. Dr. Fortenberry received his undergraduate degree in Mechanical Engineering from Massachusetts Institute of Technology. He is a GEM Fellowship alumnus. He has worked in industry, government, and the academy.

Prior to joining GEM, he was a staff associate and a program director (engineering) in the Division of Undergraduate Education (DUS) of the National Science Foundation. While at NSF, he was responsible for the Resource Directorate. He also served as Coordinator for the Instrumentation and Laboratory Improvement (ILI) program. The ILI program receives more proposals (over 2,200) than any other program of the Foundation, and has a budget of \$23 million. Before joining NSF he was an assistant professor of Mechanical Engineering and Associate Director of Minority Engineering Programs at Florida A&M University/Florida State University College of Engineering in Tallahassee, Florida. At the FAMU/FSU he has sponsored research programs in the areas of design theory and methodology as well as recruitment, retention, and professional development of students.

### Presenters

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OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES

1996 WEPAN National Conference



# A Study of the Campus Climate for Diversity: The Impact of Campus Climate on Engineering Women Students

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## Introduction

In this paper we will compare responses of all female and male undergraduate students to responses of female and male engineering students on a campus climate survey. The survey was one of three conducted to assess respondents' personal opinions and experiences regarding diversity and their perceptions of the campus climate for people of diverse backgrounds.

## Methodology

The surveys were conducted during the fall semester, 1993. A stratified sampling design was used with students being defined by ethnic minority status and gender. The overall student response rate was 33.5%. Of the 137 engineering respondents included in this sample, 21.2% were female (n=29) and 78.8% were male (n=108). Weights were constructed to account for differences in sampling rates and response rates.

## Climate Issues

Students were asked to respond to several items about the climate for diversity within their department and the university. Table 1 summarizes this information.

Table 1. About the faculty: How many faculty are...

% Responding	All Female	Eng Female	Eng Male	All Male
<b>Sensitive to student needs in general</b>				
None/Few	19.1	22.8	6.7	11.2
Most/All	50.7	49.1	64.3	61.2
<b>Sensitive to issues and concerns of women students</b>				
None/Few	21.9	33.0	9.5	11.9
Most/All	39.3	31.4	53.2	56.8
<b>Sensitive to issues and concerns of ethnic/racial minority students</b>				
None/Few	21.3	43.8	12.0	13.9
Most/All	41.8	39.6	52.7	47.9
<b>Sensitive to issues and concerns of gay, lesbian, and bisexual students</b>				
None/Few	34.0	48.0	40.1	31.0
Most/All	24.2	25.1	30.5	30.7

For each item in the scale, a higher percentage of female engineers than any other group responded that "none" or "few" faculty were sensitive to the needs of students in general or to students in special populations. On the other hand, on three out of four items, a lower percentage of male engineers than any other group responded that "none" or "few" faculty were sensitive to the needs of students. A higher percentage of male

engineers did agree with their female classmates that “none” or “few” of their faculty were sensitive to the concerns of gay, lesbian, and bisexual students.

Table 2 summarizes information about students' experiences with faculty.

Table 2. Interaction with faculty: Since coming to ISU, how frequently have you . . .

% Responding	All Female	Eng Female	Eng Male	All Male
<b>Had difficulty scheduling an appointment with faculty?</b>				
sometimes/often	41.2	54.9	36.0	32.7
never/seldom	58.6	45.2	64.0	67.3
<b>Received advice about your major or career from a faculty member?</b>				
sometimes/often	60.4	50.2	55.7	57.2
never/seldom	39.3	49.8	44.2	42.8

A higher percentage of female students (41.2%) than male students (32.7%) and higher percentages of female engineering students (54.9%) than male engineering students (36%) indicated they “sometimes” or “often” had difficulty scheduling an appointment with faculty. Over 57% of all male and female students have “sometimes” or “often” received advice about their major or career in comparison to 50.2% of female engineering students and 55.7% of male engineering students.

Students were asked to evaluate the climate for diversity at the university using pairs of antonyms such as friendly or hostile. Respondents selected a number between 1 and 5 on a Likert scale for each of these antonyms with 5 representing the most positive response. Table 3 presents this information.

Table 3. The climate for diversity at [the university] is:

(Mean Response)		All Female	Eng Female	Eng Male	All Male
Five	One				
Non-Sexist/Sexist about males		3.84	3.97	3.54	3.27
Accepting/Unaccepting of religious differences		3.56	3.65	3.94	3.67
Friendly/Hostile		3.51	3.55	3.83	3.55
Respectful/disrespectful		3.33	2.84	3.50	3.40
Improving/Worsening		3.31	3.00	3.31	3.14
Concerned/Indifferent		3.21	2.82	3.37	3.26
Sensitive/Insensitive		3.18	2.81	3.45	3.29
Accepting/Unaccepting		3.18	3.10	3.45	3.35
Communicative/Reserved		3.07	2.99	3.18	3.12
Non-racist/racist		3.05	2.93	3.43	3.19
Non-sexist/Sexist about females		2.78	2.79	3.19	3.15
Non-Homophobic/Homophobic		2.60	2.84	2.74	2.66

In general, the mean responses of engineering female students were lower than those of all other groups. By contrast, the mean responses of engineering male students were the highest. These results suggest that, compared to male engineering students and all female students, female engineering students perceive the campus climate to be more negative. The mean response of 2.79 on the sexist/non-sexist about females item was the lowest score on the scale for female engineering students.

Table 4 summarizes information on students' attitudes toward diversity and diversity-related issues.

Table 4. Thinking of the University as a Whole

% Responding	All Female	Eng Female	Eng Male	All Male
<b>There is a need for more diversity at the University.</b>				
Agree	62.0	60.9	46.1	45.5
Disagree	18.5	18.6	33.7	34.9
<b>I feel that there are role models for me at the University</b>				
Agree	61.8	48.4	68.4	59.8
Disagree	25.0	36.2	6.9	16.5
<b>Academic Counselors in my major are sensitive to my needs and concerns.</b>				
Agree	67.1	74.7	63.2	70.7
Disagree	20.1	10.1	18.0	13.9
<b>The University actively recruits students from under-represented groups.</b>				
Agree	46.5	68.5	55.9	44.9
Disagree	11.2	3.3	9.7	11.4
<b>The top administration should be genuinely committed to promoting respect for group differences at [the university].</b>				
Agree	82.8	79.9	72.6	66.5
Disagree	5.9	7.0	12.2	12.6

In general, we found that women students were more likely to agree that there is a need for more diversity at the university. Female engineering students were the least likely to agree that there are role models for them at the university. On the other hand, female engineering students were most likely to agree, and male engineering students least likely to agree, that academic counselors are sensitive to their needs. The majority of all groups agreed that the top administration should be genuinely committed to promoting respect for group differences at the university.

Students were asked to indicate how strongly they agreed or disagreed with a series of statements about diversity at the university. Table 5 lists the percent of students who agreed somewhat or strongly with these statements.

Table 5. About diversity at the university...

% Agreeing	All Female	Eng Female	Eng Male	All Male
Diversity is good for us and should be actively promoted.	87.5	92.2	75.6	73.1
The top administration should be committed to diversity.	85.7	92.3	82.3	79.8
The top administration is committed to diversity.	44.5	38.9	51.6	47.3
Results in admission of too many underprepared students.	39.6	30.4	53.3	65.1
ISU has achieved a positive climate for diversity	37.7	39.2	70.0	43.2
We have placed too much emphasis on diversity at expense of				
- enhancing its prestige as a top research university.	37.3	45.7	44.9	50.8
Affirmative action leads to the hiring of less qualified faculty and staff.	28.9	23.0	45.7	53.3
Feel I must change some of my personal characteristics to fit in.	24.4	38.6	29.4	25.4

The majority of all students agreed that diversity is good for the university and that the top administration should be genuinely committed to promoting respect for group differences; female engineers agreed with these statements more frequently than other groups. Compared to the other groups, a higher percentage of engineering females

agreed that diversity is good and should be promoted (92.2%) and that top administration should be committed to it (92.3%). Female engineering students were more likely to agree that they feel the need to change some of their personal characteristics in order to "fit in" at the university. Fewer engineering females agreed that the top administration is committed to diversity (38.9%) and that diversity results in the admission of too many underprepared students (30.4%). They were less likely to agree that affirmative action leads to hiring less qualified faculty and staff (23%), or that the university administration is genuinely committed to promoting respect for group differences (38.9%). In comparison to other groups, engineering males were more likely to agree that the university has achieved a positive climate for diversity (70%).

Respondents were asked to rate the campus and community climates for diversity. Table 6 presents this information. While female engineering students' mean scores on both items were lower than those of comparison groups, male engineering students' mean scores were higher on both items.

Table 6. Rating Climate for Diversity

	All Female	Eng Female	Eng Male	All Male
Mean Response: (1) Poor, (2) Fair, (3) Good, (4) Excellent				
<b>In your opinion, how would you rate the climate for diversity here at Iowa State?</b>				
	.402	2.18	2.74	2.54
<b>How would you rate the climate for diversity in the Ames community?</b>				
	2.24	1.86	2.68	2.50

Respondents were asked about experiences with discrimination and harassment at the university. Table 7 summarizes this information.

Table 7. Discrimination and Harassment

	All Female	Eng Female	Eng Male	All Male
<b>In the past five years, have you been discriminated against (denied access or equal opportunity) in any way while at [the university]?</b>				
% Responding Yes	28.1	35.0	32.4	24.8
<b>How frequently have you been discriminated against at ISU in the last five years because of each of the following reasons?</b>				
% Responding Sometimes or Often				
gender	14.9	23.8	2.8	4.7
ethnicity/race	8.7	9.7	9.7	9.2
age	9.4	6.6	5.4	4.4
<b>Who was it that treated you this way?</b>				
% Responding yes				
Students	20.3	25.0	15.4	15.0
Faculty	18.1	31.4	9.9	9.6
Administrators	5.2	1.4	14.4	7.3
Staff	8.3	3.5	4.9	4.0
<b>In the past five years have you been sexually harassed at ISU?</b>				
% responding yes				
	17.7	17.6	0.2	2.3
<b>Who was it that sexually harassed you?</b>				
% responding yes				
Students	13.6	14.7	0.2	2.2
Faculty	2.8	1.9	0.0	0.8
Staff	1.3	0.0	0.0	0.0
Administrators	0.2	0.0	0.0	0.0

Approximately 35% of female engineering students, 32% of male engineering students, 28% of all female students, and 25% of all male students reported they had been discriminated against at the university. While females were more likely to report discrimination due to gender, males were more likely to report discrimination due to ethnicity/race. Students were identified as those who discriminated against participants by 25% of female engineers, 20.3% of all females students, 15.4% of male engineers and 15% of all male students. While the three comparison groups were more likely to identify students as their main source of discrimination, female engineering students were more likely to identify faculty members as those who discriminated against them most frequently.

Almost 18% of females in both groups reported they had experienced sexual harassment at the university, most often from other students, while less than 2.5 percent of males reported the experience of sexual harassment.

Students were asked to respond to a series of questions regarding hearing insensitive remarks about diverse groups. Table 8 summarizes this information.

Table 8. Indicate how frequently you have heard insensitive or disparaging remarks or comments about each of the following groups in the past 5 years?

% Responding Sometimes or Often.	All	Eng	Eng	All
	Female	Female	Male	Male
Racial/Ethnic by Faculty	10.5	7.8	7.5	6.3
Racial/Ethnic by Staff	11.2	7.9	7.7	8.9
Racial Ethnic by Students	74.8	69.4	70.7	75.0
Internationals by Faculty	10.7	7.5	11.4	11.4
Internationals by Staff	10.1	2.1	6.5	11.7
Internationals by Students	66.7	67.2	61.4	68.6
Women by Faculty	15.6	20.8	1.4	6.8
Women by Staff	12.0	8.6	3.6	8.5
Women by Students	56.1	58.9	36.6	52.0

Respondents from all groups were most likely to hear insensitive or disparaging remarks about racial or ethnic groups, internationals and women from other students. Between group differences on most items were small. The one exception was that both female groups reported hearing more insensitive remarks about women by faculty, staff and students than did their male counterparts.

Students were asked about their participation in diversity activities and their interest in learning about this topic. Table 9 presents this information.

Table 9. Interest in learning about diversity.

% Responding yes.	All	Eng	Eng	All
	Female	Female	Male	Male
In the past year, have you participated in any organized activity (conference, workshop, etc.) designed to promote sensitivity toward issues of diversity?	23.9	37.4	32.7	24.3
Would you be interested in attending a workshop on issues pertaining to each of the following groups?				
Racial or Ethnic groups	54.3	46.8	40.4	42.4
Women	67.5	66.0	24.9	30.6
People with Disabilities	43.5	18.7	24.8	30.2
Gays, Lesbians, Bisexuals	33.8	25.2	14.9	18.6

Both male (32.7%) and female (37.4%) engineering students reported more participation in an organized activity to promote sensitivity to diversity, while over 40%

of all groups expressed interest in learning about different ethnic or racial groups. Fewer males expressed interest in learning about women or gays, lesbians and bisexuals in comparison to female respondents.

Students were asked about their satisfaction with the university and if, given the choice, they would return. Table 10 presents this information.

Table 10. Situation at this university

% Responding	All	Eng	Eng	All
	Female	Female	Male	Male
<b>In general, how satisfied are you with your situation here?</b>				
Dissatisfied	19.6	24.3	20.9	24.2
Satisfied	63.3	54.8	60.4	57.2
<b>If you had to choose again, would you come here?</b>				
Yes	63.2	60.1	74.7	63.9
No	12.3	16.8	7.8	11.2
Maybe	24.1	23.2	17.5	24.6

Approximately 63% of all female students, 60% of male engineering students, 57% of all male students, and 55% of female engineering students reported they are satisfied with their situation at the university. The majority of all students also reported that they would return to the university, if they had to choose again. Male engineering students were most likely to report they would return (74.7%), while fewer female engineering students chose this response (60.1%).

#### Discussion

In general, this study found that the majority of students from all four groups understand the need for diversity and agree that diversity should be promoted within the university. However, female students display more sensitivity to diversity than male students. The greatest disparity in responses is between male and female engineering students with males in this group demonstrating less positive views than the other three comparison groups.

Female engineering students are more likely to report that faculty are less sensitive to students' needs, or to issues of women and racial and ethnic minority groups. They have more difficulty scheduling appointments with faculty, or receiving advice about their major or careers with faculty. Female engineering students also feel there are not enough role models for them at the university. While a significant number of both males and females believed they have been discriminated against, females were more likely to experience discrimination based upon gender, while for males, discrimination was based upon ethnicity/race. A similar percentage of all females and women engineering students experienced sexual harassment on campus. Finally, while the majority of students were satisfied with their situation at the university, male engineering students were most likely, and female engineering students were least likely, to state they would return to the university, if given the choice.

While a third or more of the engineering students have participated in an organized activity addressing sensitivity to diversity, these results suggest that there is a need to develop educational programs about diversity that are more effective than those currently being offered. Educational strategies should also be developed that will inform faculty members of the ways they contribute to feelings of discomfort for female engineering students and what they can do to improve the campus climate for all students.



## CROSS-CULTURAL & CHILLY CLIMATE ISSUES IN ENGINEERING

Susan Cavin, Ph.D. & Amy Siskind, Ph.D.

### Positive Opportunities for Women Engineers' Retention New Jersey Institute of Technology Newark, New Jersey 07102

In the spring semester of 1995, 624 faculty surveys were collected for a National Science Foundation grant called P.O.W.E.R. (Positive Opportunities for Women Engineers' Retention) at these five New Jersey colleges: the New Jersey Institute of Technology (NJIT) and four community colleges which historically transfer students to NJIT's College of Engineering. Hudson County College in Jersey City and NJIT in Newark are urban campuses in the New York metropolitan area, while the other three county colleges (Middlesex, Ocean, and Brookdale) are suburban campuses located in central New Jersey. The P.O.W.E.R. study primarily focused on faculty/student attitudes toward women in engineering, science and technology. However, the Humanities and Social Sciences were also surveyed to test conventional stereotypes about how "liberal" the liberal arts really are compared to engineering and science. Additionally, race, ethnicity, and nationality were studied in relation to faculty attitudes toward women, as well as campus hate speech. This paper will discuss faculty results only.

### Method

The P.O.W.E.R. questionnaire was designed (Fall 1994) by reviewing other university faculty surveys in order to build on previous research, then culled down to the three most relevant surveys to fit a state engineering institute: a) Dr. Sue Rosser's survey questions on classroom climate targeted at the University of South Carolina science faculty; b) Ball State University's questions on faculty collegiality; and c) Northwestern University's campus climate questions on racism and sexism. We conducted 28 faculty interviews at all 5 New Jersey colleges (Fall 1994) and held 3 faculty focus groups (an all male group; an all female group; and a mixed gender group of faculty) at Middlesex County College, to hone faculty survey questions. The faculty survey was pretested at Brookdale Community College (January 1995), then administered to the entire full-time and some part-time Faculty in the Engineering/Science/Math/Humanities/Social Sciences at the other four colleges (January-March 1995) at their first faculty meeting of the Spring semester.<sup>1</sup> The faculty surveyed are broken down by college in this way:<sup>2</sup>

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<sup>1</sup> The POWER survey was administered by the POWER PI and POWER Faculty mentors: at Middlesex by Engineering Technology/Physics Professor Josephine Lamela and Math Professor Lucy Gullo; at Hudson County College by the Coordinator of Engineering Science, Professor Mojdeh Tbatbatbaie; and at Ocean County College by Math Professor Judy Lenk. At NJIT it was administered at Engineering Departmental meetings in February and March 1995 by the POWER PI, Dr. Roxanne Hiltz, and Dr. Judy Valyo with the help of Engineering Department chairs. The survey was administered by Associate Dean Anne Wiley to the College of Science and Liberal Arts at NJIT by campus mail. Thanks to the following POWER NJIT graduate students who worked long and hard coding this data: Oksana Manzhura and Ed Hudak; as well

NJIT 166 (27%); Brookdale 161 (26%); Middlesex 161 (26%); Ocean 76 (12%);  
Hudson 50 (8%); Women Engineering Professors from other universities 10 (1%).

## Results

This paper summarizes faculty perceptions of the campus climate and classroom focusing on three variables: a) Gender differences and b) Nationality differences among N.J.I.T. faculty ; and c) Differences between disciplines/divisions: social science, humanities, math/science, and engineering/technology at all five colleges in the aggregate.

### campus climate

The following campus climate trends were reported by faculty at all 5 colleges surveyed:

**Increased Urbanity= Less Hate Speech against U.S. Minorities ( Women, Blacks, Jews & Gays)**

Less hate speech (warmer climate) is reported on urban campuses while more hate speech (chillier climate) is reported on suburban campuses by faculty in New Jersey. The majority (about 2/3) of suburban college faculty report occasionally hearing sexist language, sexist and racist jokes whereas the majority (about 3/5) of urban college faculty report never hearing racist or sexist speech by faculty/staff/ administrators. Consistently throughout the study, more faculty at suburban schools report chilly climate incidents of all degrees, ranging from hate speech to violent action, than faculty at urban campuses. In fact, the farther south geographically one goes away from New York into New Jersey, the percentage of faculty reporting hate speech against American women, racial minorities, Jews, and gays increases. (Table 1.5)

#### Urbanity & Nationality

**Suburban College Faculty Report More Students Make "Derogatory Remarks About Someone's Nationality" Than Faculty ; Whereas Urban College Faculty Report The Reverse.**

Urban faculty in New Jersey hear more derogatory remarks about one's nationality made by faculty than students. This trend may be explained by a larger international population of both professors and students at the urban schools in the New York metropolitan area than in

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as the undergraduates: Nikki Robinson, Frances Ermi, Tali Morgan; and the POWER secretary, Sharon Williams.

<sup>2</sup> **NJIT Faculty Sample:** The N.J.I.T. Faculty sample consists of 166 male and female professors, from the Newark College of Engineering and College of Science & Liberal Arts (CSLA). Most of the faculty sample were full-timers in Engineering or Math/Science, but for comparative purposes, a small number of social science and humanities faculty and part-timers at N.J.I.T. were also surveyed. N.J.I.T. only had 6 full time women engineering professors during the Spring of 1995 when the survey was administered.

**Women Engineering Professors from Other Universities:** Because 85% of the entire 166 N.J.I.T. faculty respondents sampled were male, and the female engineering professor n at N.J.I.T. was so small, the POWER PI made public announcements asking full time women engineering professors from other universities attending the Summer 1995 WEPAN National Conference and the Fall 1995 WEPAN Northeast Regional Conference at Stevens Institute of Technology to fill out POWER questionnaires to give the POWER study a larger female engineering professor n. Ten women engineering professors obliged and returned completed POWER questionnaires by mail from the following universities: 1 from Yale University, 3 from University of Maryland, 4 from Virginia Tech, and 2 from the University of Central Florida. The ten women engineering professors from four other universities have been added to the N.J.I.T. female professor group. All of the male professors in the sample teach at N.J.I.T.; so do the majority of the women in the sample. Henceforward, we refer to "male N.J.I.T. professors" and women professors.

the suburbs. Nationality appears to be more an issue at the urban colleges among faculty than the suburban colleges--though it is not irrelevant there either.

**Faculty/Staff/Administrators Are Just As Likely As Students To Be Overheard Telling Sexist And Racist Jokes And Using Sexist Language At All Colleges Studied.** Faculty report little difference among faculty/staff/administrators & students regarding overhearing racist and sexist jokes. However, at all five schools, sexist language and sexist jokes are heard by more faculty than racist jokes. Racist and sexist jokes are pervasive in New Jersey colleges surveyed in 1995. Sexist language and jokes are reported by the majority (2/3) of all suburban college faculty and by about 2/5 of urban college faculty and thus constitute part of core college sub-culture in New Jersey. Sexist language and jokes rank Number One; racist jokes rank second in frequency at the 5 New Jersey colleges surveyed.

**Faculty Witness Students Threatening & Using More Violence Than Faculty:**

At all colleges surveyed, more faculty report occasionally witnessing students threaten violence and use physical violence than they see among faculty/staff/administrators. The occasional incidence of faculty observed student physical violence varies by college campus: ranging from 11% to 33% of faculty, depending on the college. There is no clear pattern of student violence based on the urban-suburban continuum, which defies conventional stereotyping about the violence of inner city life.

**Homophobia - 2** New Jersey trends: Homophobic remarks are more common among students than faculty; but are far more common among both professors and students in New Jersey suburbs than in the cities of Newark and Jersey City. More students are overheard making Anti-Gay remarks than Faculty at all colleges studied. This may be co-related to age. Faculty/staff/administrators occasionally make anti-gay remarks overheard by nearly half the faculty at suburban colleges compared to less than one third of urban faculty.

**Gender & Hate Speech**

**Gender makes little difference in Faculty Reports of Sexist Speech on Campus.** That is, men were equally as likely as women to report overhearing sexist language or sexist jokes on campus. Gender made little difference in faculty reports of all forms of chilly climate issues except in two areas: racist jokes and stalking.

**Gender Affects Faculty Reports of Racist Jokes**

**RACIST JOKES:** The majority of male faculty at all 5 Colleges surveyed report hearing racist jokes on their campus while the majority of female faculty (55%) have not heard racist jokes. Interpretation: This may mean that men tell each other racist jokes more than women do to each other. Perhaps more importantly, it appears that men do not tell racist jokes in the presence of women faculty as often as they do in the presence of male faculty on these 5 New Jersey campuses.

**Gender Affects Faculty Reports of Stalking Incidents**

**STALKING:** No male faculty report knowledge of any stalking incident where the perpetrator is faculty/staff/administrator. Only female faculty do. All reports of stalking by faculty/staff/administrators thus come from female faculty. However, male faculty are aware of student stalking incidents.

## How Gender Affects NJIT Faculty Perceptions of the Classroom

Looking at the engineering/science classroom, some interesting gender differences emerge among N.J.I.T. Faculty around the various topics of sex ratios, women graduate students and male students. The majority of N.J.I.T. male professors answer differently from the majority of female professors regarding these variables:

### 1. female graduate students have a difficult time.

The majority of N.J.I.T. male professors surveyed (52%) disagree, while the majority of female professors (52%) agree that "I think that female graduate students have a more difficult time than male graduate students."

### 2. student sex ratios affect classroom dynamics.

An overwhelming majority (70%) of women professors agree while 40% of N.J.I.T. male professors (the mode) disagree that "The ratio of male to female students affects classroom dynamics."

### 3. whether female graduate students have a difficult time.

The majority of N.J.I.T. male professors (52%) disagree while the majority of women professors (52%) agree that female graduate students have a more difficult time.

### 4. whether male students talk more in class.

The majority of N.J.I.T. male professors (56%) disagree, while the majority of female professors (58%) agree that "Male students are more active in responding to questions than females."

### 5. whether sex discrimination charges are unfounded.

Sixty three percent of women disagree that "Charges of sex discrimination are frequently unfounded," while 61% of N.J.I.T. male professors say they have no opinion on this subject.

### 6. men comfortable with women bosses.

The majority (76%) of women professors disagree that "Most men would be comfortable working for a woman boss" while the mode (46%) of N.J.I.T. male professors say they have no opinion on this subject.

### 7. socializing with colleagues advances career.

The mode (44%) of women professors agree that "Social interactions with my colleagues have been important to my career advancement" while the mode of male professors (39%) disagree. We also found that more minority professors believe that socializing with colleagues helps career advancement than white professors do. This suggests that white men either do not see or believe that "the old boy network" operates as much as women and minorities.

## Where Male & Female Professors Agree On Faculty-Student Relations

The gender of a professor made little or no difference in their answers to most survey questions. Engineering and science professors surveyed in New Jersey generally agree on far more faculty-student issues than they disagree. The majority of both female and male professors agree on the following classroom issues:

### 1. most professors comfortable with graduate students.

The majority of N.J.I.T. male professors (72%) disagree that "I am uncomfortable when meeting graduate students of the opposite sex because of the possibility of charges of sexual harassment." So do an overwhelming 94% of women professors.

### 2. women students don't contradict professors.

The majority of men (60%) and the majority of women (75%) professors disagree that "Female students in my classes contradict me."

However, when we ask whether male students contradict N.J.I.T. professors, we find an interesting phenomenon. The percentage of male professors holds steady around 3/5; the majority of

male professors (59%) say that male students do not contradict them. Yet the percentage of women professors drops almost 30 percentage points between the two questions: from 75% of women professors who said women students do not contradict them to 48% who said men students do not contradict them. Also, one quarter (26%) of women professors say their male students do contradict them in class. While gender makes little difference regarding faculty perception of women students challenging professors in the classroom, gender may affect faculty perceptions of male students.

### **3. male students do not challenge most professors' classroom authority.**

While the majority of both N.J.I.T. male (79%) and women professors (56%) disagree that "Male students regularly challenge my authority in the classroom," many more males feel this way than women. Also, a quarter of women professors (28%) say male students *do* challenge their authority in class. This phenomenon needs more research.

### **4. professor's classroom questions.**

Ninety one percent of women and 81% of men agree with the statement: "I ask male students the same types of questions I ask of females." Thus faculty of either gender do not feel that they treat women students differently from men.

### **5. women rarely appear in my textbooks.**

The majority of women professors (55%) and the mode of men (46%) agree that "Women rarely appear in the textbooks I use." Over a quarter of men (27%) disagree, however.

### **6. most faculty support university childcare.**

Sixty six percent of men and 85% of women agree that "The university should provide quality, low-cost child care for both faculty and students." While the majority of both sexes favor university supported childcare, many more women do than men.

## **How Nationality Affects NJIT Faculty Perceptions of Faculty-Student Relations**

Only NJIT data on nationality is presented here. The ratio of American to international professors at NJIT is more evenly divided than at the other colleges surveyed: 97 American and 73 international faculty respondents at NJIT.

Demographically, about 3/4 (72%) of the NJIT faculty respondents are white. However, only 52% of them are born in the USA; 16% are European, 20% born in Asia, and 6% in the Middle East. No African-American professors completed a questionnaire at NJIT. Less than a handful of Black Caribbeans (2%) and Hispanic (1%) professors did. The vast majority of people of color are Asian (21%), predominantly Indian and Chinese, and 4% Middle Eastern (e.g., Iranian, Turkish, Egyptian). The rest did not state their nationality. Faculty responses to these questions differ by nationality:

### **1. whether student sex ratios affect classroom dynamics.**

Notably higher percentages of American faculty (48%) agree that sex ratios affect classroom dynamics compared to (33%) of international faculty.

### **2. whether women in their field need to "fit in" with men.**

More Americans (48%) than internationals (26%) disagree that "women students won't have any problems in my field as long as they blend in with the men."

### **3. whether the curriculum is gender-biased.**

The majority of all nationalities at NJIT disagree that the curriculum is gender biased, but many more internationals (79%) than Americans (58%) disagree.

### **4. whether families suffer when mothers work full-time.**

More internationals (42%) agree that children will suffer in families where the mother works full-time than Americans (20%). In fact, 56% of Americans disagree that children suffer when mothers work full time.

**5. whether they sacrifice family needs to job needs.**

Far more internationals (46%) than Americans (29%) state that they often sacrifice the needs of their family to the needs of their career. In fact, about 2/5 of Americans say they do not sacrifice their families to the job.

**6. whether social interactions with colleagues affect career advancement.**

More internationals (41%) than Americans (23%) agree that social interactions have been important to their career advancement. In fact, 47% of Americans disagree. This question also provoked a similar response from women and racial minorities who believe that socializing with colleagues is valuable to career advancement, while white men generally do not.

**7. whether men would be uncomfortable working for women bosses.**

Most Americans (52%) disagree that "most men would be comfortable working for a woman boss" while 58% of internationals say they have no opinion. These responses could mean that more Americans are willing to talk about the discomfort of having a female superior, while internationals would rather avoid the issue. Or does it mean that more internationals would feel more comfortable working for a female boss? More research is needed to answer these questions.

**How Departmental Division Affects Faculty Perceptions of Faculty-Student Relations at 5 N.J. Colleges**

When respondents are broken down by division (engineering/ technology, science/math, social science, and humanities) at all five colleges, their responses differ in the following ways:

**1. Whether gender affects pedagogy.**

Notably higher percentages of engineering/tech (51%) and science/math (44%) faculty disagree that "the gender of the professor makes a difference in how a subject is taught" than social science (23%) and humanities (34%) faculty .

**2. impact of male/female ratio on classroom dynamics.**

Many more engineering/tech (46%) faculty disagree that sex ratios affect classroom dynamic than faculty in any other division. However, 43% of the science/math faculty agree, along with 52% of social science, and 55% of humanities faculty agree that sex ratios affect classroom dynamics. Interestingly enough, faculty in the "soft sciences" where sex ratios are generally nearer equal believe that sex ratios make the most difference. Faculty in the "hard sciences" where there are higher male-lower female sex ratios, see sex ratios as less important to classroom dynamics.

**3. whether women rarely appear in textbooks.**

The majority of engineering/tech faculty respondents (55%) agree that "women rarely appear in the textbooks I use," while 40% in science/math, 42% in social science, and 60% in humanities disagree. Clearly women appear much less in engineering/tech textbooks than in textbooks in any other division .

**4. importance of considering racial bias in textbooks.**

The majority of engineering/tech faculty *disagree* (52%) that "I consider possible racial bias in a text as one of the factors in selecting a text," while the majority of social science (51%) and humanities (55%) *agree*. Science/math faculty were more split between 34% disagreeing and 25% agreeing .

**5. do departments try to hire female faculty?**

More than any other division, the majority of engineering/tech faculty (56%) agree that their department makes a concerted effort to increase the number of women faculty, but that there

are not enough qualified applicants. Only 23% of science/math faculty agree. On the other hand, 39% of both social science and humanities faculty disagree that their departments make a good faith effort to hire women.

#### **6. Whether they sacrifice family needs to job needs.**

Most professors in the science/math (50%), social science (53%), and humanities (53%) divisions disagree that they often sacrifice family needs for career," whereas only one-third of engineering-tech respondents disagree. This may be because there is a higher number of women in the non-engineering disciplines.

## **Discussion**

### **Departmental Division**

The majority of engineering/technology respondents do not see racial bias as an important factor in text selection. This could be interpreted two ways: either they believe there is no racial bias in their textbooks or they may not feel it important to eliminate racial bias from their texts. Humanities and social science respondents clearly believe that there may be some racial bias in their texts, and that it is important for them to take this into account. This divisional difference is striking.

Engineering/Technology faculty say they are more likely to sacrifice family needs to the demands of their jobs. But is that because they are predominantly males in the engineering division? Specifically, is this more a phenomenon of gender than of departmental division?

In summary, departmental division makes a notable difference in faculty responses to certain gender and race related questions. More than any other discipline, Engineering/Technology faculty are more likely to dismiss questions about whether gender affects classroom dynamics, the hiring of female faculty, and whether their textbooks are racially-biased.

### **Nationality**

In sum, international faculty differ from American faculty regarding: the impact of sex ratios on classroom dynamics, the need for professional women to "fit in" with men, the existence of gender bias in their curricula, the impact of working mothers on families, the acceptability of sacrificing family needs to job needs, the importance of social interaction with colleagues to career advancement, and the issue of male discomfort with female superiors. It appears that American faculty at NJIT place greater importance on gender issues. More internationals believe that mothers who work full-time will harm their children. Internationals seem more reluctant to discuss their feelings about working for a female superior on this questionnaire.

### **Gender**

Sex ratios are an interesting variable throughout this study. We found that sex ratio questions, more than any other, polarized people by gender, race, nationality, and ethnicity. Male professors do not think the high male: low female student sex ratios of engineering classrooms matter much. Women professors do. More research is needed on the effect of sex ratios on classroom dynamics.

The P.O.W.E.R. data also suggests that male professors do not notice the often cited observation in the women's literature on classroom climate (Sandler, 1982; Rosser, 1990) that male students talk more in class.

This suggests the possibility that there may be certain behaviors/subjects where one is gender blind: e.g., men may not notice that other men are doing all or most of the talking. However, they may notice when women are doing all the talking. Perhaps male professors, blinded by their gender, really cannot see that other men, in this case students, are dominating classroom talk. Black studies literature has long pointed out that members of dominant groups, i.e., whites, are often unaware that they dominate discussions when minority group members are present (Rothenberg, 1988). Minority groups are painfully aware of the dominant group; the reverse is not true.

These findings, along with the fascinating differentials on how male and female professors view male student's challenge to their classroom authority, suggest that the engineering/science classroom is still indeed a gendered space. We conclude with a Campus Gender Climate Table:

**Table 1. Campus Gender Climate**  
Reported by Faculty at 5 N.J. Colleges (n=644)

Faculty Overheard/Saw Faculty/Staff/Adm. Engage in:	College				
	Urban NJIT	HCC	BCC	Suburban MCC	OCC
Sexist Jokes	45%	43%	61%	65%	63%
Sexist Language	42%	42%	62%	65%	62%
Racist Jokes	42%	27%	51%	53%	59%
Gender Discrimination	28%	30%	37%	34%	45%
Sexual Harassment	25%	26%	27%	28%	44%
Rape	1%	4%	5%	2%	4%
Anti-Semitic Remarks	22%	22%	35%	33%	40%
Anti-Gay Remarks	30%	32%	46%	47%	53%



## WOMEN IN PHYSICS: MEASURING A CHILLY CLIMATE

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### INTRODUCTION

In 1994, women earned more than 50% of all bachelors' degrees and 40% of the PhDs awarded in the U.S. (Department of Education). In physics, however, the picture was very different: less than a fifth of the bachelor's and PhD degrees awarded that year went to women. As Figure 1 shows, the number of female students taking introductory high school physics courses was nearly on par with the number of male students. A gender gap becomes evident beyond this point. In second-year and advanced placement high school physics courses only about 30% of the students are female (Neuschatz & Alpert, 1994).

Participation of Women at Different Points in the Physics Education Pipeline.

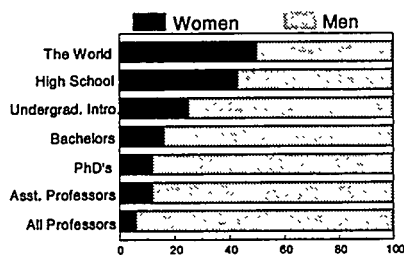


Figure 1

pace with the PhD production rate at 12%. But women comprise only 6% of the physics faculty as a whole (Blake, 1994). Even with these low percentages, improvement from a decade ago is evident.

Although the representation of women in physics has made some gains over the past decade, it is clear that gender equity remains a distant goal at all stages in the pipeline beyond introductory high school physics. Before they enter college and throughout their college careers, an increasing proportion of women become "turned off" to physics, and opt out of further study. In recognition of this fact, the women's committees of the American Physical Society and the American Association of Physics Teachers undertook a joint study

The gap widens at the college level. About a quarter of the students in introductory undergraduate physics courses were women, and women earned only 16% of the physics bachelor's degrees which were awarded in 1994. The proportion of women earning PhDs in physics that year was slightly lower, 12%. While this proportion is very low, it nevertheless represents a gradual increase over the past decade. In 1985, women earned just 7% of the PhDs in physics.

The proportion of assistant professorships that are held by women appears to be keeping

to examine the conditions present in physics departments that influence a woman's decision about completing a degree in physics. The Committees devised a two-part plan to identify the problems women are experiencing in physics departments. The first part consisted of a series of site visits. The second part consisted of a national survey of men and women undergraduate and graduate students.

## **THE SITE VISITS**

### **Methods**

A team of women physicists visited 17 graduate and undergraduate physics departments to assess the university climate for women physics students. The visiting team met with physics department chairs, university administrators, physics faculty members, student advisors and women and men graduate and undergraduate students. The major purpose of the site visits was to gather general and specific information about the climate for women in physics departments and make suggestions outlining how each department can assess its own climate and then act to improve it.

### **Results**

The climates the teams encountered ranged from welcoming to hostile, but most were described as chilly for women (Dresselhaus, Franz, & Clark, 1995). During the site visits, female graduate students identified many factors that they believed contributed to this chilly climate in their physics departments. Many of the issues they raised were of concern to men as well. The overriding concern for women was the lack of women faculty. The site visit team reported that there was a direct relationship between the quality of the climate and the proportion of women faculty and students (Dresselhaus, Franz, & Clark, 1995).

In addition to few female faculty, other concerns discussed by women graduate students during the site visits included: a) the absence of a support net; b) the absence of a networking group; c) the absence of department advocates for women's special concerns; d) poor communication with the Department Chair; e) the absence of welcoming signals, such as visibility of women in the physics brochure, and welcoming receptions or parties for incoming students; f) unsupportive attitudes of some faculty toward women in the department; g) the lack of female role models who have successfully combined a physics career and family; h) the lack of personal safety during late hours; and i) the lack of established policies and procedures for responding to practices that exclude, threaten, or demean women (Dresselhaus, Franz & Clark, 1995).

## **THE DEPARTMENT CLIMATE SURVEY**

### **Methods**

In addition to the site visits, information about the climate in physics departments was obtained by distributing questionnaires to a nationwide sample of graduate and undergraduate physics students. The American Institute of Physics Education and Employment Statistics Division collaborated with the women's committees of the AAPT and the APS in developing questionnaires to assess the university climate for women physics students.

The graduate student questionnaires were sent to a sample drawn from respondents to AIP's 1992 annual Graduate Student Survey. All the female graduate students (approximately 1000), both U.S. and non-U.S. and a similar number of male graduate students, both U.S. and non-U.S., received questionnaires. There was approximately equal representation of U.S. women, U.S. men, non-U.S. women and non-U.S. men in the sample. The overall response rate was 60%.

Undergraduate physics students were also surveyed. There were virtually no gender differences in the responses from undergraduates about the climate in their physics departments. Possible explanations for the similarity in responses include: a) undergraduates may not be as integrated into the fabric of the department, due to outside activities; b) undergraduates usually do not have any other college experience to compare against; c) the sample was drawn on the only available list of names and addresses of undergraduate physics majors, SPS members, who may have the benefit of belonging to a group; or d) the questionnaire may not have been adequately designed to identify differences. Due to the similarity in responses from female and male undergraduates, results from these groups will not be discussed.

The questionnaires used in the study were deliberately silent on issues relating to gender. That is, they omitted explicit questions about sexual harassment and other experiences related to gender. Opportunities for comments and open-ended responses were placed at strategic places throughout the questionnaires.

## **Graduate Student Survey Results**

### Reasons for Discouragement

A major goal of the questionnaire component of the Department Climate Study was to identify the special problems and concerns of female students, and to contrast them with those of male students. To address some of these problems, graduate physics students were questioned "The last time you felt discouraged in physics, what were the two major reasons for feeling that way?" The major source of discouragement for both men and women was uncertainty about long term career opportunities. U.S. women chose long term career opportunities less often than other students did. They were much more likely to identify the department climate as a source of discouragement than other students were.

### Interactions with Advisors and Other Faculty

Most U.S. graduate students enjoyed collegial relationships with their advisors, but women significantly less than men. Most non-U.S. women (about 60%) lacked this relationship with their advisors (see Table 1).

In general, students found that faculty who were not their advisors were accessible and encouraging about academic and career goals, but did not believe that they treated them as colleagues. Significantly fewer U.S. women found it easy to discuss ideas with faculty members than did U.S. men.

Table 1: Interactions with Advisors and Other Faculty

	U.S.		Non-U.S.	
	Women	Men	Women	Men
	(%)	(%)	(%)	(%)
Advisor treats me as a colleague	54	62	39	52
Faculty treat me as a colleague	28	34	27	31
Faculty are easy to discuss ideas with	38	52	46	49

### Interactions with Other Students

Students were positive overall about their interactions with other graduate students, but U.S. women differed significantly from U.S. men on nearly every item that dealt with relationships with other students. U.S. women were less likely than men to agree that other graduate students readily discussed ideas with them, respected their opinions, or valued them as individuals. They were slightly less likely to agree that other graduate students treated them as colleagues. In addition, more women than men felt that other students were too competitive.

### Environment in the Department

The majority of graduate students characterized the physics departments as friendly places, but not places that encourage self-confidence. Only about a quarter of U.S. women agreed that their physics departments encouraged their self confidence, compared to about 40% of all other physics students who felt this way.

### Student Self-Rankings

Despite sources of discouragement and the effect that being in graduate school have on one's self-confidence, students had positive feelings about their abilities, especially in comparison to other students in their physics departments. As shown in Table 2, about half of the U.S. students, both men and women, believed they were in the top 25% of the students in their physics departments academically.

Table 2: Students' Academic Self-Rankings, Compared to Other Graduate Students in Their Departments

	U.S.		Non-U.S.	
	Women	Men	Women	Men
	(%)	(%)	(%)	(%)
Top 10%	20	20	32	44
Top 25%	26	31	36	31

### Professional Expectations

Overall, 85% of the graduate students expect to become professional physicists, and the majority plan to be involved in both teaching and research, suggesting that they picture traditional academic careers for themselves.

The majority of physics graduate students (80% of U.S. students and 65% of non-U.S. students), would study physics if they had it to do over again. Among those who would not, the number one reason for not pursuing physics is the lack of jobs. Some of the other reasons which women frequently cited include: a) it takes too long to get a degree and the return is minimal; b) personal preference for more applied, cross-disciplinary work; c) physics is too narrow a field, detached from the real world, not relevant; d) the environment is too competitive; e) everything has been done already; f) it is difficult to have both a physics career and a family; and g) would choose a field with more women.

## **DISCUSSION**

### Recommendations for Improving the Climate

Based on these two sources of information, the site visits and the survey, some recommendations for change were made. The first set of recommendations was summarized by the site visit team. They include: a) hire more women faculty; b) recruit more women graduate students; c) establish a supportive environment for women faculty and students; d) accommodate the needs of faculty and students with children; e) provide opportunities to increase interactions; f) invite more women physicists to speak at colloquia; g) insure a safe work environment; and h) place greater importance on the quality of teaching (Dresselhaus, Franz, & Clark, 1995).

The graduate students who responded to the survey were asked to identify one or two changes that could improve the department. This list includes: a) provide sensitivity training for faculty and students; b) make women feel welcome in the department, not because it looks good, but because it is a worthy goal; c) establish a department-wide policy on parental leave; d) make graduate school more accessible to students with family responsibilities (make part-time grad school a realistic option; make child care available; e) retire the most prejudiced of old men; and f) put more women's bathrooms in the building.

Balancing academic research and motherhood was a predominant theme in many of the female graduate student's comments. Recommendations were made to extend the time until a tenure decision is reached so that women with families would not be penalized. It was also suggested that postdoctoral fellowships for part-time work and programs concerning child care, parental leave, recruitment and retention be implemented. Another recommendation is a little more radical: compulsory retirement for faculty who refuse to treat women fairly. At the very least, it has been suggested, these faculty members should not teach courses where they can do a great deal of damage.

### Impact of the Study

The reports returned from the department chairs indicate that the site visit program has made a difference. The 17 departments have implemented or planned several changes, including: a) increased efforts to recruit women faculty members; b) increased efforts to recruit women graduate students; c) opening communications between women students and women faculty, and between women and department chairs; d) efforts to increase faculty awareness of issues that concern both women and men students, and women faculty and staff; e) establishment of advisory committees to address problems identified in the site visit reports; f) increased department activity in career counseling, job fairs, and industry contacts; g) more women speakers invited to speak at colloquia; and h) improvements in safety in the workplace (Dresselhaus, Franz, & Clark, 1995).

Another result of the site visits is that other disciplines are adopting the model to evaluate the climates in their departments. The Association for Women in Science has received funding to develop a similar program in chemistry, biology, and math.

Although there are no plans for APS and AAPT to conduct additional site visits to physics departments, the program described here can be adopted by any department that wishes to evaluate itself. The women's committees of APS and AAPT can provide guidelines for carrying out an evaluation. As Franz (1995) noted, "the climate for all students and faculty, both male and female, improves when steps are taken to improve the climate for women."

### Final Note

Conditions are improving, albeit slowly, for women in physics. The change is evident in the membership of the American Physical Society. The APS is by far the largest organization of physicists in the United States, with more than 40,000 members. Women account for about 8% of the overall membership (Curtin & Chu, 1994). But among young physicists (age 30 or younger), they account for 17%. The age distribution by gender, reveals that the profile for men is relatively flat, but among women the younger members predominate. In fact, the median age for men is 45, while for women it is 33. The future of physics lies with young physicists, and increasingly these physicists are women.

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## CORPORATE FUNDING OPPORTUNITIES

### **Moderator**

Suzanne R. Nagel, Ph.D.  
Director of Manufacturing, Research and Development  
Lucent Technologies

Suzanne R. Nagel is Director of the Manufacturing Research and Development Laboratory Division at the Lucent Technologies Bell Labs Engineering and Environmental Technologies Division, where she leads efforts to deploy competitive, leading edge manufacturing technology. She joined AT&T Bell Laboratories in 1972 as a Member of Technical Staff in the Glass Research and Development Department, where she specialized in R&D on materials and processes for optical fibers used in lightwave communications. In 1980 she became Supervisor, then Department Head, and subsequently Director of efforts in lightguide research and development. In 1992, she was the first woman to be appointed AT&T Bell Laboratories Fellow, the highest level of technical recognition.

She received a B.S. in Ceramic Engineering from Rutgers University and an A.B. in Liberal Arts from Douglass College in 1968, and her M.S. and Ph.D. in Ceramic Engineering from the University of Illinois in 1970 and 1972 respectively. She has published 45 papers in the areas of glass science and fiber optics, given over one hundred technical talks, and holds two lightguide fabrication patents.

### **Recorder**

Karin L. Mack  
Director, Center for Women in Engineering  
University of California, Davis

### **Presenters**

Debra Fowler  
Workforce Planning Manager  
The Dow Chemical Company

George Brewster  
Manager, Recruiting and Temporary Employment  
Corning Incorporated

John Vergelli  
Program Manager, National College Recruiting  
The IBM Corporation





## CORPORATE STRATEGIES FOR INCREASING THE PARTICIPATION OF WOMEN

Karin L. Mack

Director, Center for Women in Engineering

University of California, Davis  
College of Engineering

Presentations at this session focused on the strategies each company has implemented to insure a fully diverse and cultural workforce. Presenters were as follows: George Brewseter, Manager, Recruiting and Temporary Employment, Corning Incorporated; Debra Fowler, Workforce Planner Manager, The Dow Chemical Company; and John Vergelli, Program Manager, College Relations and Recruiting, IBM. Suzanne Nagel, Director, Lucent Technologies Inc. presided as Moderator.

The presenters each discussed recruitment and retention strategies and possible funding sources for women in engineering programs. Key points mentioned by all companies represented on the panel include the following:

- 1) Maintain a recruitment program which creates a solid base of support systems for the people you hire;
- 2) Measure your results and continue to build on the retention (for example, Corning Inc. administers an annual climate survey and IBM surveys a different segment of their population every 12-18 months);
- 3) Make sure you have something unique to offer the individuals you are recruiting (for example, childcare, maternity leave, job-sharing, flex time etc.--the benefits must change to match the target populations needs);
- 4) Keep the strategies simple (For example, IBM helps undergraduate women gain visibility with their corporate recruiters by targeting Society of Women Engineers (SWE) and asking the members to "staff" their control tables at information sessions).

Panelists agreed that recruitment and retention need to be intertwined in order for a message of concern to be conveyed to the underrepresented groups; this concern being that not only are the companies recruiting, but they are also aware of special needs and/or circumstances of the special groups. Corning Inc. has conveyed this message beginning in the late 70s when they first began an aggressive recruiting campaign to address affirmative action concerns, and in 1977 they hired their first female engineer from a student SWE chapter. The next step for Corning was to learn from their female engineer the issues other women in engineering had; thus began their building of a core of female engineers.

Building a strong policy for recruitment and retention must be done in stages. Corning Inc. continues to use their female engineers as sounding boards for building support systems within the company. In 1983, Corning initiated a company policy based on the "quest for equality" which incorporated not only a company gain of financial independence and return value to shareholders, but also to creating and maintaining a diverse workforce. Corning recognizes that an integral part of a diverse workforce is the ability to empower the special groups within the company. For example, the Society of Black Professionals was started as well as a Professional Women's Forum, for all women in the company.

Companies, like IBM, Dow and Corning have recognized that the viability of the company depends upon diversifying the workforce, therefore, recruitment begins early, at the college level. As IBM believes, giving undergraduate women exposure to companies early in their student-career is essential. IBM considers it part of their college relations to provide speakers and or monetary gifts to student clubs, even during their "dry years" of recruitment. Most companies select target schools for recruitment purposes. Dow recruits from some 60 key schools and IBM 58, with plans to increase to 82 schools in 1997.

Recruiters from each of three companies represented in this panel have access to discretionary funds to assist student clubs, like SWE. For example, Dow sees themselves as a "university partner" and builds into their recruiting policy interaction with the students, either in the form of classroom presentations and/or funding. Team captains from Dow are assigned to various regions. These are the individuals that should be contacted in regard to receiving monetary gifts from Dow for any special programs, such as women in engineering programs. These team captains can make recommendations to Dow for larger grants. Corning, on the other hand, will consider grant requests from two areas 1) the medical field and 2) engineering programs where Corning plants are located or to schools on their target list. IBM will only consider grant funding for K-12 programs.

In summary, those of us responsible for the implementation of women in engineering programs need to form a collaborative working relationship with corporate recruiters who visit our institutions. These relationships serve two purposes: 1) promoting our female undergraduates as viable candidates for engineering positions within the companies and 2) creating new sources of funding for women in engineering programs. Sometimes you can generate these relationships by way of your campus career center or contact your alumni currently working at the corporation you're interested in pursuing. The panelists all agreed that if your school is not on a particular company target list, then you need to have someone inside that company to champion your cause.

## Maximizing Your Resources: Working Effectively With Student Employees

Kathleen A. Bott  
Associate Director  
Office of Women's Programs  
Stevens Institute of Technology  
Hoboken, N.J.

### 1. Introduction

In a time of downsizing, many of us are faced with the challenge of doing more with less. Women in Engineering Programs know this challenge all too well. Most of us operate with bare bones budgets and very small staffs. In order to maximize our resources, the Office of Women's Programs (OWP) at Stevens Institute of Technology has designed and implemented a student employee program. Before I describe this program in further detail, I'd like to provide you with some information about Stevens and OWP.

#### *About Stevens*

Stevens is a small, private, competitive, urban, technical college located in Hoboken, N.J. Our undergraduate enrollment is about 1,400 undergraduates (20% female) and 2,000 graduate students. Stevens offers bachelor's master's and doctoral degrees in engineering, science, computer science and management and a bachelor's degree in the humanities and liberal arts. Stevens has many college work study positions for our undergraduates funded by our Financial Aid Office. Some departments opt to pay students through their grants or other budgets.

#### *About the Office of Women's Programs*

The OWP was established in 1978 to increase the number of women in engineering and science. Most of our programs are targeted to pre-college students. Each year we offer four one day engineering and science career seminars, conduct high school visits and a national summer program.

We also offer programs for our undergraduate and graduate students. These programs include a Freshmen Women's Luncheon, academic and personal counseling and referrals, an electronic scholarship database, a career literature library and a Women's Seminar Series. OWP also serves as advisor to Stevens student chapter of the Society of Women Engineers.

OWP is the Eastern Regional Center for WEPAN. As such, we conduct an annual regional training seminar and develop and publish several publications each year to assist other institutions expand or initiate their own women in engineering program.

### *OWP Staff*

Our office consists of two full-time professionals and one full-time administrative assistant.

As Associate Director, part of my responsibilities include supervising our college work study students or as we refer to them, program assistants. We usually employ anywhere from four to five students per semester. About six students work with us over the summer to assist with the coordination of our national summer program. In the past, we have also hired a part-time graduate assistant who was paid through grant moneys or funded in part by Stevens graduate office.

## **II. OWP's Student Employee Program**

Because our staff is small, we have made an effort to utilize our student staff members as much as possible. With the help of our students, we have been able to expand our programs due to the extra support they provide us with. This partnership is not only beneficial to us, but also to our students. By providing them with a meaningful work experience, we extend their education to outside the classroom. Later on, I will discuss the benefits to you and the students in greater detail.

### *Student Orientation Program*

When a student is hired to work with OWP, she participates in a brief orientation seminar which is conducted by myself and lasts for approximately thirty minutes. This orientation is described in the *Student Program Guide*. I'll highlight some basic components of the guide.

Before her orientation, each student is given the *Student Program Guide* and some literature about our programs. She is asked to read over this material on her own, before the actual orientation. During the orientation, I highlight some of OWP's major activities, goals, mission, etc.. After this, I discuss our department's expectations of our student employees. We have found it very helpful to be direct and tell students up front what we expect of them. Our students are requested to be on time to work, to phone ahead when they will be more than ten minutes late, to adhere to their work schedule, etc. We believe that this training is an important part of their professional development and helps our students develop good time management skills.

### ***Projects Assigned To Student Employees***

Our program assistants are involved in a number of diversified activities. Usually, new student employees will start off performing general office duties. As students progress and become more familiar with our department, they become more involved with helping us design and coordinate our programs. Some of the projects students engage in include:

- \* *For our on-campus pre-college programs: speakers, instructors, lab assistants, tour guides and resident assistants*
- \* *Newsletter writers*
- \* *Assist with coordination of all of our programs (e.g. for conferences- registering participants)*
- \* *Designing brochures*
- \* *Computer work (e.g. databases, letters, etc.)*
- \* *Exposure to national conferences: work at conference, give papers*

Each student employee has a "work bin". Their projects and assignments are placed in this bin so that they always have something to do, even if myself or our director is not in. This has worked really well for us and students appreciate the fact that we take them seriously and plan ahead of time, so they almost always have something to do.

### ***Student Employee Rewards & Incentives***

We reward students for their efforts by offering them flexibility in where they work (e.g. some students work at home or in their dorm room during the evening and weekends). Because we have limited office space, having students work from their home or dorm room has really helped alleviate overcrowding in our department.

Students may choose flexible work hours, especially during mid-terms and final exams. Some students work fewer hours and others opt not to work at all during mid-term and finals. Students who have worked with us for a fairly lengthy period of time, are invited to participate in the WEPAN Women in Engineering National Conference. We cover the costs associated with the conference. Occasionally, students present papers at the conference and they work at the conference and help the conference committee with registration, etc.

## **III. The Benefits of Utilizing Student Employees to You and Your Office.**

Next, I'd like to discuss the benefits to your office of using student employees:

***Supplements your staff***

Implementing a student employee program really makes sense in a time when academia, like industry is downsizing. Student employees are a valuable addition to a women in engineering program, since most are understaffed.

***Provides staff with assistance in performing repetitive tasks***

For example, students perform repetitive tasks such as inputting information on databases, typing, filing, telephone answering, etc.

***Increases Your Department's Productivity***

Because your student staff can focus on repetitive tasks, your professional staff are free to focus on additional projects.

***Opportunity to Obtain Student Input***

Your student employees can give you input that will help you tailor your programs so that they are truly geared to your undergraduate and/or graduate women.

***Increases Student Attendance and Participation in Your Programs***

If you conduct programs for undergraduate and/or graduate women, and you solicit their help in designing and coordinating the program, this will definitely help boost their attendance and participation in your programs (e.g. they tell their friends and encourage them to participate). Remember, people support that which they help create!

***Keeps You Informed***

Your student employees will help keep you informed about current student concerns and issues on your campus.

**IV. Benefits to Student Employees Who Work With Women In Engineering Programs**

In addition to the monetary compensation students will receive, they will also reap several benefits by working in your office.

***Provides them with a meaningful work experience***

When students engage in general office duties, they will become familiar with how an office should run. Their work experience will also teach them about event planning and programming.

*Enhances their professional development and helps them develop the following skills:*

- Time management
- How to work effectively with others - teamwork
- Leadership skills
- Effective communication skills
- Public speaking skills

### ***Retention Tool***

Studies indicate that students who work on campus are better retained than those who do not. Interacting with different offices on campus, helps students establish relationships with other staff and faculty. It also gives them a better idea of how the university runs and who are the appropriate people to contact to get their questions answered and problems resolved.

Students will appreciate the personal support you and your staff members can offer them, especially when it comes to stressful times for them, like getting through their freshmen year and midterms and finals.

### ***Establish industry contacts and develop networking skills***

If students work on projects that require them to interact with industry, this enables them to network with professionals in the field. Such contacts can lead to mentoring relationships, additional sources of encouragement and support as well as potential jobs.

## **V. How to Develop Your Own Student Employee Program**

### ***How can I fund or pay student employees?***

Investigate your options!:

- Financial aid office (college work study)
- Grants, other budgets
- Share a student with another office (e.g. Student Affairs or Student Development Office)
- Graduate school

### **Recruiting & hiring student employees**

Advertise in high profile areas:

- Student newspaper

- Internet

- Posters/flyers

Conduct interviews

Conduct an orientation

Provide them with a "work bin" and a comfortable area to work in

Help them prioritize

Perform follow-up on a regular basis

Provide ongoing feedback and evaluation

Give incentives and rewards

Take the time to find out what type of work your student employees enjoy doing and what they are best at and try to tailor their assignments to these interests if possible. For example, some students like number crunching so they may enjoy tallying evaluations and summarizing data. Other students enjoy writing, so they may want to be writers for newsletters. Students interested in developing their management skills can be offered the opportunity to manage other program assistants. Some students like to utilize their creative abilities by helping you market programs and designing brochures.

### **VI. What type of projects are best suited for students?**

Clerical tasks

Newsletters--conduct interviews, write articles

Data reports--summarize program evaluations

Speakers

Tour guides

Lab instructors/assistants

Design brochures

Gather research materials

Help organize conferences, seminars, etc.....

Resident Assistants for summer programs



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## **VII. Helpful Hints For Working With Your Own Student Employees:**

Remember to give praise on a regular basis.

Don't assign projects that you have not fully developed or those without clear goals

Always provide clear instructions.

Take them and their work seriously.

Don't expect too much or give them too much work. This will give them additional undue pressure which could interfere with their academics.

Avoid scheduling major projects or programs which require alot of student assistance near midterms or finals--chances are, students will not be able to work as much or at all during these high stress times.



## RETENTION EFFORTS: PROGRAMS THAT WORK

### Moderator

Jane Z. Daniels, Ph.D.  
Director, Women in Engineering Programs  
Purdue University

Jane Daniels is the Director of Women in Engineering Programs at Purdue University- a position she has held for the last 15 years. Dr. Daniels received her Bachelor's degree from Washington University in St. Louis, Missouri, and both her Master's and Ph.D. from Purdue University.

Dr. Daniels was the founding President of WEPAN. She continues to be active in the organization serving on the Board of Directors and as Executive Director of the WEPAN Midwest Regional Center. She is a consultant to engineering schools and engineering employers throughout the United States, as well as a number of foreign countries. In 1993 Dr. Daniels was on leave from Purdue to serve as Senior Program Officer for the newly created Programs for Women and Girls at the National Science Foundation in Arlington, Virginia. There she was responsible for setting policy, managing programs, and providing information on gender equity in the sciences and engineering to both internal and external constituencies.

### Presenters

Marsha LoFaro  
Research Associate for the Committee on  
Women in Math, Science, and Engineering  
Washington University

Cinda-Sue Davis, Ph.D.  
Director, Women in Engineering and Science  
University of Michigan

Jennifer L. Vest  
Evaluator/Research Assistant, Women in Engineering  
University of Maryland at College Park

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## **FACT FINDING: WHAT ARE THE NEEDS AND WHAT IS WORKING?**

**Marsha LoFaro and Sandra C. Cooper**

**Washington State University, Pullman, Washington**

The Washington State University (WSU) Committee on Women in Math, Science and Engineering was founded in 1989 as an ad hoc committee of faculty and graduate students concerned about the under representation of women in the sciences, engineering and mathematics (SEM). The primary focus of the committee has been freshmen women expressing an interest in SEM, but efforts have been made to serve all undergraduate women, graduate students, and faculty in SEM. Most of the programs are inclusive and benefit men as well as women. The Committee has student, faculty and staff representation from the College of Sciences, the College of Engineering and Architecture, the Women in Engineering Program, Residence Life (the campus unit responsible for staffing and programming within the residence halls), the Student Advising and Learning Center, and the Women's Resource Center. Financial support for the Committee comes from the Dean of the College of Engineering and Architecture, the Dean of the College of Sciences, and the Coalition for Women Students.

WSU is the land-grant university of Washington State and is one of the largest residential campuses west of the Mississippi River. Current enrollment stands at 16,737 students, 2024 of which are graduate students. The ratio of men to women students in SEM at WSU is approximately 2:1 as compared to the national ratio of 3:1.

### **MISSION**

The mission of the Committee on Women in Math, Science and Engineering is to understand the issues of recruitment and retention of women in academic disciplines falling under the broad umbrella of science, engineering and mathematics and to use that information to initiate, develop, and coordinate programs that support the success of women students at WSU in these areas. This Committee seeks to accomplish its mission by following the pertinent literature, conducting research at WSU and developing and/or collaborating on programs and services that support a comfortable, academically supportive and encouraging atmosphere leading to the success of women in SEM. Most of the services developed and implemented benefit all students regardless of gender.

### **NEEDS**

The studies at WSU have produced results that are either consistent with what is found in the literature or expand upon those findings. The importance of the research lies in understanding the problems and needs of the students being supported. Below is a summary of the needs that have been identified here at WSU.

- Cooperative rather than competitive atmosphere
- Clustering women in classes to avoid isolation

- Realistic expectations of grades in entry-level courses
- Regular interactions with faculty members and fellow students
- Better or different instructional styles in entry-level classes
- The time and place to study without distractions
- Thorough advising and readily available assistance for academic problems
- Study skills suitable for success at the university

### PROGRAMS AND SERVICES

The following are some of the programs and services in place at WSU that were designed to meet the needs outlined above.

#### Math, Science and Engineering (MS&E) Residence Hall Project

The MS&E Residence Hall was initiated by the Committee in an effort to promote an academic/social network that supports the goals of women in SEM. The model for the hall was the Douglass Project at Rutgers and as such the original concept was to have a program focused entirely on women, but through student input it evolved into the co-educational project of today. Benefits for the students in the project include the following.

- The support of living with others who share common interests and ambitions
- Being surrounded by potential study partners and role models who are further along academically
- In-hall programs and resources designed specifically for students interested in math, science and engineering
- A state-of-the-art computer lab located in the hall and equipped with the software widely used in science, engineering and math classes
- Tutor-assisted study hall located in the hall
- Access to drafting tables
- Study/meeting rooms on each floor
- Resident advisors, most of whom are science, engineering or math majors


A brief history of the project illustrating the rapid growth is summarized in the table below.

Academic Year	Residence Hall	# female residents	# male residents
1991-1992	Stephenson North	25	25
1992-1993	Orton	90	170
1993-1994	Goldsworthy	80	200
1994-1995	Gannon/Goldsworthy	128	284
1995-1996	Gannon/Goldsworthy	142	326

#### Science, Engineering and Math Advising Fair

The Fair was a new initiative in Spring 1995 and will continue to be held each spring two weeks prior to pre-registration. It is an opportunity for SEM students to get information that is not readily available from their advisors. This includes, but is not limited to the following.

- Details about courses outside the advisor's department
- Majors or minors in other departments

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- Student clubs/scholarships/career opportunities
- Research and work opportunities within departments
- Information on the Honors Program, International Studies, Career Services and Service Learning

### **Study Hall**

The Committee coordinates a study hall located in the MS&E Residence Hall lobby. Tutors are available Sunday-Thursday evenings from 6:30 p.m.-9:30 p.m. to help with entry level mathematics, physics and biology courses that are mainly populated by SEM majors.

### **Other**

The Committee maintains a resource collection of books, bulletins, magazines and articles on issues related to women in SEM. It produces a directory of women mathematicians, scientists and engineers in Washington State that is designed to enhance the connections between women in these fields. Students use it to contact women for information about internships, careers and employers; organizations use it to identify speakers for programs designed to support and encourage women; and professional women use it to find and maintain connections with other women in their fields. The Committee also works with the undergraduate group *Women in Technology and Science* and the Palouse Chapter of the *Association of Women in Science* to bring women to campus for public lectures and the opportunity to meet informally with women students and faculty in SEM.

The Committee monitors retention rates, graduation rates and general satisfaction of students in SEM at WSU. It also conducts research aimed at understanding the factors contributing to persistence and attrition in these fields.

## **WHAT WORKS**

From different forms of assessment that have been done to date, the following programs or approaches seem to have a positive effect.

### **MS&E Residence Hall**

Several pieces of data point to the success of the MS&E Hall; the participation has grown every year, in-hall surveys and interviews indicate a general satisfaction with the hall and the support programs, and the number of students electing to return to the hall increases each year.

### **Academic Support within the Hall (study hall, computer lab, freshman seminar)**

The in-hall surveys and interviews highlighted the fact that students appreciated and valued this support. Approximately 150-200 students took advantage of the study hall each week and the computer lab was often full, especially during the evening hours. The freshman seminar was a new offering this past fall and students requested that the weekly study group associated with the seminar continue into the spring semester.

### **Mentors in Student's Fields (upper class residents, resident advisors, peer tutors, Sisters in Science)**

Surveys and interviews indicate that mentors are an influential factor in students lives. Also, programs such as the Sisters in Science Program which links freshmen and sophomore women with juniors and seniors in a closely related discipline have good participation.

### **General Advising before Official Advising**

The two Advising Fairs have had good attendance in spite of conflicts with other popular events such as the NCAA finals. The evaluations from the Fairs have been overwhelmingly positive.

### **Student Input to Planning and Programs**

Experience has shown that much better success is achieved when students are actively involved in the planning and production of programs. Some programs which have been planned and produced by the Committee have been monumental failures. Student involvement guarantees that the program will be of interest to students and, furthermore, the student volunteers are very effective at recruiting friends and neighbors.

### **Personal Invitations to Events**

Students respond well to a personal invitation to a program from a friend, professor or mentor. Personal invitations are particularly effective as a supplement to posted flyers and written invitations.

### **Interviews with Students in Addition to Written Surveys**

The same general questions can be asked on written surveys and in interviews, however, the information gleaned from an interview is often richer in detail and identifies specifics that would have been missed by the written survey. The time required for a few interviews as a complement to a detailed written survey can be very beneficial.

## **WHAT DOES NOT WORK**

### **Gender Exclusive Programs**

In the co-educational environment here at WSU, women students have resisted certain gender exclusive programs. For example, they were adamant about maintaining the MS&E Hall as a co-educational hall using the argument that any familiar face in class is welcome regardless of gender. However, smaller gender exclusive initiatives such as the Sisters in Science mentoring program have had success.

### **Locating Non-SEM Students in the MS&E Hall**

During the rapid growth period for the MS&E Hall, extra space was filled by non-SEM students which had a disruptive influence on the morale and community environment. The non-SEM students felt slighted since most of the in-hall programming was designed for SEM students and conduct problems increased as a result.

### **Doing Too Many Surveys at One Time**

The students have certain periods of time when they are bombarded by questionnaires and surveys. The results are poor response rates and incomplete surveys which have to be omitted.

### **Not Planning Assessments Ahead of Time**

Assessment needs to be part of the initial planning of a program because some forms of data are lost forever when not collected in advance. Also data collected in an ad hoc manner tends to be incomplete and can be inaccurate and confusing to obtain and sort out.



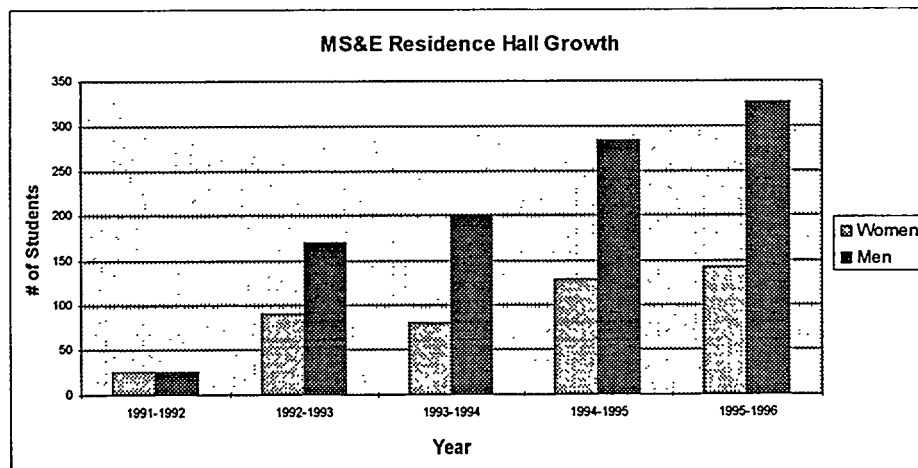
## ASSESSMENT

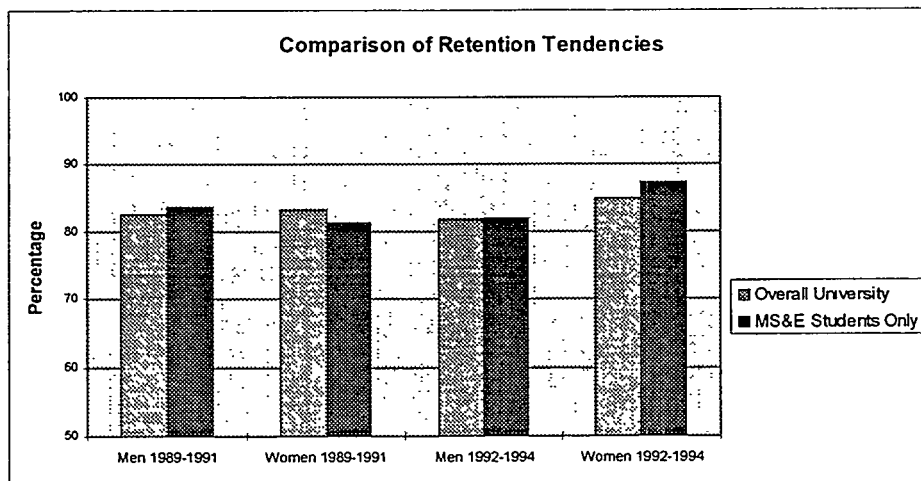
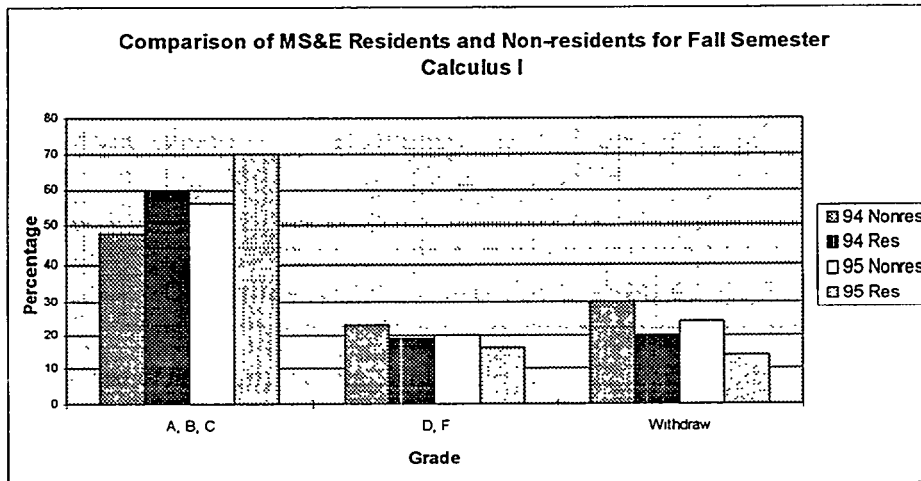
A critical component of any good program is careful assessment. When planned in advance, assessments can be easy to obtain and of fundamental importance to funding decisions. Assessment measures can promote the program virtues through a balance of both quantitative and qualitative outcomes. Qualitative data collected in a small random sample of the individuals who take the quantitative surveys can clarify responses. Often the small sample interviews will have common themes which identify consistencies overall. Quantitative data collection should be larger than needed as there will be attrition in the number of final outcomes. In addition to surveys, results on retention, graduation, and grade point averages can be gathered through university systems.

A program with long term benefits should have a long term assessment tool. One such plan could be a longitudinal study including, where appropriate, beginning and ending attitude responses. These could be supplemented by qualitative and quantitative data collected throughout the study period. Also significant to the validity of the assessment would be the parallel study of another group which has not participated in the program. Evidence of the benefits of the program can be obtained through matching similar groups, such as the SEM students of the residence hall and the SEM students not living in the residence hall.

## POSITIVE INDICATORS

The Committee was very naive in the beginning and neglected to build careful assessment into the programs. Hence current attempts to measure success are incomplete and subject to error yet there are several positive indicators that will be given below. The first graph is rather obvious and shows the growth in the MS&E Residence Hall over its first five years of existence. The second graph shows a grade comparison between MS&E Hall residents and non-residents in first semester calculus for Fall 94 and Fall 95. The third graph gives a comparison of retention data between all WSU students and WSU SEM students. Retention data is based on a student's first year at WSU and measures whether or not the student enrolls the subsequent year.





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## **The Women in Science and Engineering Residence Program: A Model Living-Learning Program at the University of Michigan.**

**Cinda-Sue Davis, Ph.D. and Mary Hummel, Ph.D.**

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### **INTRODUCTION AND GOALS**

The underrepresentation of women in the sciences and engineering is a serious national problem. Nationally, the percentage of students majoring in fields of science, mathematics, and engineering declines from 28.7 to 17.4 between the freshman and senior years.<sup>1</sup> Women receive only 30% of the science and engineering bachelor's degrees, although they earn more than 50% of the total baccalaureate degrees awarded.<sup>2</sup> Studies indicate that a student-centered pedagogy and peer groups with high intellectual self-esteem are two important factors related to the retention of students in science and engineering.<sup>1,3</sup>

In order to address the problem on the institutional level, the Women in Science and Engineering Program (WISE) and University Housing at the University of Michigan developed the Women in Science and Engineering Residence Program (the WISE-RP). WISE-RP is a living-learning program for undergraduate women who are interested in academic majors and careers in the sciences, mathematics, and engineering.

The major goal of the WISE-RP is the retention of women in the sciences and engineering. A supportive peer groups plays an integral role in the retention of students in the sciences. The WISE-RP aims at creating a supportive academic environment for women outside of the classroom by housing students with similar academic interests together in the same residence hall. Participants can share their academic experiences and career goals on a daily basis, thus reducing the sense of isolation many women feel in male-denominated science and engineering classes. The peer groups have a common understanding of the academic and time demands involved and the barriers women may face as they pursue majors and careers in the sciences and engineering.

All WISE-RP participants live contiguously on a floor of Couzens Residence Hall, a moderately sized (600 residents) coed facility. The pilot program in 1993-94 consisted of 57 first-year students. In 1994-95 the program expanded to include 86 students, 21 of whom were returning sophomores. In 1995-96, the program expanded once again to a total of 110 participants, 8 of whom were returning sophomores and juniors. These groups represented a roughly equal distribution of science/mathematics (College of Literature, Science and the Arts) and engineering (College of Engineering) majors.

The goals of the WISE-Residence Program are the following:

- To increase the retention of women at the undergraduate level in mathematics, science and engineering.
- To provide opportunities for women to meet others with similar academic interests.
- To create a smaller, supportive living/learning environment for university students in engineering and the sciences.
- To provide resources and linkages to enhance the undergraduate experience.

The WISE-Residence Program is funded by the University of Michigan and a grant from the Fund to Improve Post-secondary Education (FIPSE) from the Department of Education.

## PROGRAMMATIC COMPONENTS

The following paragraphs provide more detailed information about the various WISE-RP components:

**Contiguous Living Arrangement:** In order to create a small, close-knit living environment, WISE participants are housed together on a floor of Couzens Hall. A residential community of students with similar academic interests together facilitates the formation of supportive peer groups, both academic and social. WISE students experience an intellectually stimulating environment outside the classroom because their roommates and hallmates share many of the same classes, academic interests, and career goals.

**Formal and Informal Study Groups:** The WISE-RP offers formal study groups for mathematics and chemistry. In addition, WISE-RP encourages students to form informal study groups on their own by providing them with a list of other WISE students enrolled in the same classes, in areas such as foreign languages, history, etc.

**Academic and Career Workshops:** In order to provide role models for its participants, the WISE-RP invites women faculty, professionals, and graduate students in the sciences and engineering to share their experiences. Panels such as "A Day in the Life of a Physicist, a Biologist, and a Physician" help students learn more about career possibilities in the science and engineering. "Combining Career and Family" addresses students' concerns about managing both a successful career and a meaningful personal life.

**Academic Advising:** A special academic advisor with a background in science works with WISE students in the residence hall.

**Course Sections:** Special sections of science and mathematics courses are designated for WISE-RP students, allowing participants to take classes with other women in the program. The purpose is to reduce the sense of isolation many women feel when they are one of only a few women in a science or engineering class. Also, taking classes with their hallmates facilitates collaborative learning and the formation of informal study groups among WISE-RP students.

**Research Opportunities:** WISE-RP has created linkages with the Undergraduate Research Opportunity Program which provides first and second-year students with the chance to participate in research activities with faculty in their areas of academic interest.

**Mentoring Program:** The WISE-RP Mentor Program pairs first-year students with second-year participants. As science and engineering majors, mentors understand the demands of pursuing a career in these field. Mentors help new students adjust to university life by providing valuable information about the resources at the University as well as the surrounding community.

**Laboratory Tours:** Special tours of campus laboratories and facilities in science and engineering are arranged for students. Tours of the Human Genome Laboratory and the Atmospheric, Oceanic, and Space Science Laboratory, for example, give students a taste of the exciting research projects and quality facilities at the University.

**Social Activities:** In addition to academic and career-related programming, WISE-RP sponsors a variety of social events each year in order to foster a sense of support and community among its members. Social activities have included study breaks, games nights, a Halloween party, pizza parties, and shopping trips. An outdoor challenge ropes course in the fall and a winter retreat focus on team-building and the development of leadership and communication skills.

**Residence-Life Staff:** Three resident assistants live on the WISE-RP hall. As science and engineering majors, the RAs can assist new students with the transition to university life and understand the demands of pursuing a career in the sciences or engineering.

## EVALUATION DESIGN

The WISE-Residence Program is currently being evaluated using a variety of quantitative and qualitative measures. There are currently three cohorts: the 1993-94 WISE participants and control group; the 1994-95 WISE participants and control groups, and the 1995-96 WISE participants and control group. Each cohort is being tracked longitudinally throughout their undergraduate years at Michigan.

A survey is filled out at the beginning of the academic year by WISE participants and by a control group of other first-year students, both male and female, interested in mathematics, science or engineering, living in other U-M residence halls. Similar surveys are filled out by former participants and the corresponding control groups at the beginning of their sophomore, junior and senior years.

A survey is also administered only to WISE-RP women at the end of each year, asking participants to evaluate the various individual components of the program.

Focus groups are conducted with the various cohorts and their corresponding control groups in order to gather qualitative data on students' experiences.

**Academic Measures:** The various academic parameters measured in the students evaluation include the following:

- Retention rate.
- Grade point average
  - overall and in subject areas
- Course load
  - cumulative credit hours
  - lower and upper division credits
- Course selection patterns
  - related to academic interest  
(i.e., science, engineering, pre-med, nursing)
- Choice of career and further schooling

**Psycho-Social Measure:** The various psycho-social parameters measured in the student evaluation include the following:

- Perceptions of campus climate
  - perceptions of barriers
- Academic cognition/self-concept
  - Confidence in skills and abilities, both intellectual and scientific
  - Values and expectancies about grades
  - Future schooling
- Academic stressors and coping strategies
  - Anticipated and experienced difficulties at college
  - Help-seeking behaviors
  - Academic support network
- Social networks
  - Peer group influences
  - Teacher and family influences
- Personal well-being
  - Self-esteem
  - Depression and other psychosomatic complaints

## **PRELIMINARY RESEARCH FINDINGS**

The data from the first three cohort studies is currently being analyzed. However, preliminary research findings from the fall 1993 survey results include the following:

- 1) WISE-RP and control women are more likely than men to say they prefer to work with a study group and to talk with members of that group if they experience academic difficulty.
- 2) Women are more confident than men that they will pursue a successful career in their chosen field.
- 3) Men and WISE-RP women are more confident in their math ability than control women.
- 4) Control women and WISE-RP women are more likely to say that discrimination is a problem that could discourage them from pursuing science and engineering interests.
- 5) Having friends in their field of choice, supportive study groups, tutoring, smaller classes, and avoiding anonymity in a large student body are benefits of a residential science program that are more important for WISE-RP women than for control women and men.
- 6) Men express more confidence in their intellectual ability and are more likely than WISE women and control women to expect to do very well at the University of Michigan.
- 7) Control women appear to be more concerned about the aggressive atmosphere in science and engineering classes than are WISE-RP women.

Over the 1993-94 academic year, this first-year cohort had the following changes:

- 1) WISE-RP women, compared to control women, were more likely to deal with a difficult class by changing how they prepared for tests, discussing their difficulties with tutors or study groups, making sure they attended class more regularly, and seeking a professor's help.
- 2) WISE-RP women gained more confidence in their ability to do science.
- 3) From fall to spring, WISE-RP women saw an increase in how much their friends encouraged them to study science and engineering.
- 4) WISE-RP women became more aware of two possible barriers to their attendance in graduate school: the aggressive nature of engineers and scientists, and the discrimination against women.

## QUALITATIVE DATA

The focus groups, as well as open-ended questions on the surveys, offered interesting insights into the day-to-day experiences of University of Michigan students, from both the WISE-RP and the control groups.

## WISE-RP Participants

*"I feel that this atmosphere has greatly helped me adjust to the University and has helped me academically. It's nice having people around you who study about the same amount and take similar classes. ...you know you're not the only one who studies in the wee hours; that others have the same interests, and that they're feeling the same way you are."*

*"There's always someone who has been through the class you're taking. It keeps my spirits up to see other women in science and engineering having the same problems and being able to talk. We're always studying so the distractions are minimal."*

*"Since we're all science and engineering, I don't think we party as much (substance-free hall), so the dorm's pretty quiet. It's also socially acceptable to stay in on a Friday night and study."*

*"My friends motivate me to study harder because they set good examples. I see how hard my hallmates study every day. Also it's very convenient to be able to go next door or down the hall and talk to someone who has all my classes."*

## Control Students

*"My hall is quiet, therefore I can get a lot of work done. The problem is that no one else on my hall is an engineer, so they always get mad at me for studying and not doing things with them. They think I over-exaggerate the amount of work I have."*

*"If study groups were formed for each class (with students in the same hall) I'd be more motivated to do my work."*

*"I feel part of my hall's uncertainty and apathy about their academic future has hindered my ability to share my academic goals with them."*

## CONCLUSION

The WISE-Residence Program has been an exciting and rewarding intervention effort, both for participants and program directors. It is still too early, however, to determine the overall effectiveness of this effort, both in terms of retention and psycho-social measures. The additional issues of cost-effectiveness must also be considered. Nonetheless, qualitative measures indicate that this particular program is popular and meaningful to the students. The increasing numbers of participants applying for the freshman year and reapplying for the sophomore year is also impressive.

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<sup>1</sup> Astin, A.W., and Astin, H.S. (1991). Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences. Los Angeles: Higher Education Research Institute, Graduate School of Education, University of California.

<sup>2</sup> Alper, J. (1993). *The pipeline is leaking women all the way along*. *Science* 260: 409-411.

<sup>3</sup> Manis, J.D., Thomas, N.G., Sloat, B.F., and Davis, C.S. (1989). Factors affecting choices of majors in science, mathematics and engineering at the University of Michigan. Report #23, Center for the Education of Women, University of Michigan.



## **INVOLVING STUDENTS THROUGH BUILDING COMMUNITY: CHALLENGES FOR WOMEN IN ENGINEERING PROGRAMS**

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### **Rationale**

The critical mass of female students in engineering decreases as women proceed through their undergraduate and graduate education. In addition, the "chilly climate" embedded in the culture and environment of engineering often leaves women students at-risk for feeling isolated and disconnected from the institution. Thus, establishing and maintaining a sense of community for female students in engineering is a major challenge facing women in engineering programs today. Within the context of student development theory, including student involvement (Astin, 1984) and marginality versus mattering (Schlossberg, 1989), this paper will examine barriers to building community and fostering involvement among female undergraduate and graduate students. Based on the SPAR Model (Jacoby & Girrell, 1981) of program implementation, a set of strategic initiatives that can be taken by women in engineering programs to build a sense of community and mutual support among women students will also be explored.

### **Introducing Theoretical Models**

According to Alexander Astin's (1984) theory of student involvement, colleges and universities that involve their students in their educational experiences not only enhance student learning outcomes, but also increase student retention. Astin (1984) explains that student involvement refers to the "amount of physical and psychological energy that the student devotes to the academic experience" (p. 297). Based on a longitudinal study involving college students who left their institutions before attaining a degree, Astin (1984) found evidence for the existence of certain factors in college environments that tend to impact student persistence. According to Astin (1984), factors associated with increased levels of involvement include: residing on campus, holding a campus job, participating in intercollegiate sports, being involved in an honors program, engaging in research with faculty, and establishing a high level of identification and affiliation with the institution. It is also interesting to note that "frequent interaction with faculty is more strongly related to satisfaction with college than any other type of involvement or, indeed, any other student or institutional characteristic" (Astin, 1984, p. 304).

Schlossberg (1989) concurs with Astin's theory of student involvement through her theory of "marginality and mattering." Schlossberg (1989) explains:

Involvement creates connections between students, faculty, and staff that allow individuals to believe in their own personal worth. This involvement also creates an awareness of our mutual relatedness and the fact that the condition of community is not only desirable but essential to human survival. Therefore, the concern over involving students, although expediently related to satisfaction and retention, is the very process that creates community (p. 6).

In essence, Schlossberg acknowledges that students will ask themselves, "Do I belong here?" A student, for example, who feels that she matters to the institution and to others has internalized the notion that others depend on her and are concerned with her fate. In contrast, a student who thinks that she does not matter will feel marginalized. As a result, she may be at-risk for isolation from her peers and a sense of disconnection from the institution, both of which could serve as barriers for her educational persistence. Thus, a female engineering student's level of mattering will ultimately shape her experiences and level of motivation to further pursue engineering. Within this context, students who feel a sense of identification with others and the institution -- a sense of community -- are more likely to become involved and persist. Therefore, the framework of community is perhaps one of the most powerful mediums through which to involve women engineering students, enhance their educational experiences, and increase their likelihood of completing an engineering degree.

Although theories of student development and involvement are integral in giving voice to the experiences of college students and assisting educators in fostering their development, a major limitation of many theories is that they were developed and based on the experiences of traditional-aged students, many of whom were white, middle-class males at four-year residential institutions (Jacoby, 1991). This brings to question the appropriateness of applying such theories for work with diverse student populations on college and university campuses today, including women engineering students. In exploring the degree of applicability of these theories to women students through the contexts of involvement, retention, and community, how can women in engineering programs ensure that female undergraduate and graduate students have the opportunity to become involved in their institutions and feel that they matter to others?

In attempting to answer this question, one conceptual model in the literature that can serve as a framework for structuring and implementing women in engineering programs that are sensitive to the diverse needs of students is the SPAR Model (Jacoby and Girrell, 1981). Within this conceptual framework, functions that enhance the educational and co-curricular experiences of students can be organized along the following four interrelated dimensions: (1) Services (functions that are performed for students), (2) Programs (functions that are performed with students), (3) Advocacy (functions that are performed on behalf of students), and (4) Research (the vital ingredient that determines the types of

services, programs, and advocacy best suited to meet the diverse needs of students). Including these four components in a women in engineering program can increase student involvement, intentionally foster a sense of community, and increase the overall quality of women's experiences at the institution.

### **Examining Barriers to Involvement and Mattering**

Both individual and institutional factors serve as barriers to fostering involvement and a feeling of mattering among female undergraduate and graduate students in engineering. First, in examining individual barriers, women experience multiple roles -- as learners, mothers, daughters, partners, and professionals -- that may serve as challenges to their involvement in their educational experience. Related to this, a phenomenon commonly cited in the research literature is that of "role conflict," which Stoltz-Loike (1993) explains "results when individuals must function simultaneously within multiple roles and the demands for optimal performance in each role cannot be simultaneously achieved. Role conflict can lead to stress, anxiety, or decreased levels of performance at work or at home" (p. 116).

Directly related to role conflict is the issue of lacking available resources, including time and finances. For example, a female student who is attempting to balance multiple caretaking responsibilities along with holding a job and the rigorous demands of the engineering curriculum will have less time to become involved -- such as living on campus, making friends in classes, participating in academic study groups, or taking part in engineering societies. In contrast, students who do not have these other roles and responsibilities have many more opportunities to become involved. In this respect, involvement in one's academic and co-curricular experience is a privilege that is not easily achievable for all women students.

On the institutional level, the "chilly climate" of the engineering discipline may serve as a hindrance to female students' involvement and feelings that they belong and matter. The emerging literature on engineering education suggests a link between the impersonal and competitive norms imbedded in the culture of engineering and the underrepresentation of women in engineering (Barber, 1995; Brush, 1991; Ginorio, 1995). Examining this phenomenon in the context of student development theory, it is clear that the engineering curriculum does not always foster a feeling of belonging for women students. Instead, students enter the discipline with the unspoken understanding that most introductory engineering courses are meant to "weed out" students (Ginorio, 1995; Tobias, 1990). Thus, students must earn the privilege to belong to the engineering community by successfully completing these tasks. For female students, however, this is even more complex since many of the factors that help to sustain students are not available, such as a critical mass of like-minded peers and female role models.

Relationships and connection are central components in women's psychological development (Gilligan, 1982; Jordan, Kaplan, Miller, Stiver, & Surrey, 1991). Jordan

and associates (1991) state that "for women at all life stages, relational needs are primary and healthy. dynamic relationships are the motivating force that propels psychological growth" (p. 37). They further explain that a woman's self-esteem and sense of self worth are directly related to the extent that mutuality is developed within her relationships. However, the devaluation of women's relational orientation is pervasive throughout society (Gilligan, 1982). This is particularly true within the culture of engineering, which is often characterized by a highly impersonal and competitive training process. Barber (1995) illuminates that boys are socialized to develop qualities (i.e., assertiveness, competitiveness, linear thinking) that are most often rewarded in the culture of science and engineering. In contrast, for girls becoming a scientist or engineer challenges the core of self, which is relational. This can communicate to female students that their way of relating to the world is not valued within the engineering community and therefore, they do not belong or must suppress a part of themselves in order to feel that they belong.

The devaluation of women's relational orientation is particularly prevalent in the engineering classroom, where often only a few learning styles are highly valued and rewarded. Research examining women's cognitive development has shown that while male students prefer to argue and debate in class, women students are often reluctant to share their views, express their opinions, or provide answers for fear of alienating others (Belenky, Clinchy, Goldberger, & Tarule, 1986). In an environment perceived as competitive and hostile, women may become even less inclined to speak out. In addition, the lack of examples that include women clearly communicates to female students that their presence in the classroom is insignificant. Furthermore, marginalization impacts women outside the classroom, where opportunities to establish mentoring relationships with faculty, receive research funding, and other educational experiences are rewarded to students who fit the non-relational cultural norms and criteria for success.

### **Building Community Among Women Engineering Students**

In linking the barriers associated with involvement and mattering to building community among women engineering students, it is first important to provide an operational definition of community. According to Hillery (1955) as cited in Johnson (1991), a community is "a group of individuals engaged in social interaction, possessing common interests and goals, who show concern for and are sensitive to the needs of other members, and are primarily interested in furthering the group goals over all others" (p. 3). In a similar vein, Schlossberg (1989) highlights that "those working to build a sense of community through activities are challenged not only to understand why certain individuals get involved, thereby creating community among themselves, but also why others seem unable to establish connections or meaningful level of involvement." The aforementioned barriers to involvement and mattering for female engineering students can make community-building among women a particularly difficult challenge.

In exploring the interrelated concepts of involvement, mattering, and community, it is apparent that one of the strategic goals of women in engineering initiatives should be to

dismantle barriers that hinder women students. In reintroducing the SPAR (Services, Programs, Advocacy, Research) Model (Jacoby & Girrell, 1981) for program implementation, women in engineering programs can organize their initiatives and refine their focus in dismantling such barriers as a primary tenet of their structure, functioning, and mission. As cited in the 1995 WEPAN Data Book, there exist numerous initiatives on college and university campuses that actively foster community among women students in engineering. In conclusion, the following four facets of the SPAR Model provide a holistic approach to implementing community-enhancing initiatives for women engineering students.

**Services:** Services are functions that are performed for students, and it is integral that they are both appropriate for and accessible to students (Jacoby, 1991). Within the context of women in engineering programs, services provided may include job and scholarship listings; workshops on career development and graduate school; personal, academic, and career counseling; and opportunities for student employment. In this respect, fostering collaboration with campus resources such as the counseling center, career center, and the financial aid office is extremely important. At the same time, one of the most important yet often overlooked facets of providing services is disseminating information about them, as students are often unaware of the institutional resources available. Distributing newsletters, compiling e-mail aliases of women students in various engineering departments, informing faculty of services, and collaborating with engineering student societies can be effective measures to achieve this end. Thus, women students see that the institution is responsive to their needs and that they actually “matter” to others.

**Programs:** Programs are functions that are performed with students (Jacoby, 1991). Programs responding to the needs and interests of women engineering students may include: mentoring with professional engineers; teaching and research fellowship opportunities; collaboration with community colleges; tutoring programs; and engineering outreach programs with high school, middle school, and elementary school students. Through their participation, women become actively involved with other students, faculty, and staff, and have the opportunity to develop connections and significant relationships that are central to their psychosocial and cognitive development. These programs not only provide women engineering students with valuable personal and professional experiences, but they also enhance their sense of self-efficacy, help them gain valuable interpersonal skills in working with others, and foster their leadership potential.

**Advocacy:** Advocacy occurs on behalf of students to ensure that their needs and interests are being recognized and incorporated into the policies, practices, and culture of the institution (Jacoby, 1991). In terms of advocacy, women in engineering programs play a vital role on campus in raising awareness surrounding women’s issues, particularly with respect to male-dominated academic disciplines and professions. Women in engineering programs can sponsor curriculum transformation initiatives, facilitate workshops on

sexual harassment, and conduct research about women in the sciences and the barriers they often face. In this capacity, they ultimately serve as advocates not only for women in engineering, but also for creating a gender-equitable climate for all students on campus.

**Research:** Finally, research serves as the vital link between the key components of services, programs, and advocacy (Jacoby, 1991). Through research, women in engineering advocates can assess the needs of women students, design programs and services accordingly, and evaluate their initiatives in terms of their quality and effectiveness. Research, evaluation, and assessment ultimately inform and justify the existence of programs and services as well as determine priorities, directions, and future initiatives. Research can take on both quantitative and qualitative forms, including surveys, focus groups, and informal discussions that bring together diverse groups of undergraduate and graduate women. The focus group model, in particular, extends beyond the goals of research and evaluation by fostering community among female engineering students and creating a forum through which they can share their experiences with each other.

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## K-12 OUTREACH PROGRAMS

### Moderator

Lisa J. Oliveira  
Director of Admissions  
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Lisa Oliveira graduated from MIT in 1990 with a Bachelor's degree from the Sloan School of Management. She started as an Admissions Counselor at MIT after graduation, and was promoted to Assistant Director one year later. Her responsibilities included the recruitment of women students, the transfer admissions process, and the creation and maintenance of the Admissions Office WWW pages. She recently moved to Riverdale, NY and is currently the Director of Admissions at the Horace Mann School. She has been a member of WEPAN since 1991 and coordinated the creation of the WEPAN web pages. She is also the Chairperson of the Admissions Action Group.

### Presenters

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## THE GOES PROJECT: A SUCCESSFUL OUTREACH PROGRAM THAT INTRODUCES MIDDLE SCHOOL GIRLS TO ENGINEERING

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### INTRODUCTION

At Drexel University the Women in Engineering (WIE) Program members are keenly aware of the reality that many young girls do not choose engineering as a career path because they are either turned off science and math or are dissuaded from its pursuit at a very early age<sup>1-3</sup>. The causes are many, including peer pressure, ignorance on the part of teachers and councilors, an inability to impart information about what engineers do, and what is needed to become an engineer, and a general lack of reinforcement and encouragement<sup>4-11</sup>. As a result, Drexel WIE sought NSF funding and Drexel University support to initiate GOES (Girls' Opportunities in Engineering and Science), an outreach effort which seeks to remedy detrimental effects of women's under-representation in engineering by creating an engineering workshop that literally GOES to middle and junior high schools located outside a one-hour radius of Drexel University. The format builds upon the successful experience of the Drexel WIE Program in reaching out to local young women through on-campus engineering career days. The GOES program targets pre-High School students, specifically those in grades 6 to 9, because during this critical stage students finalize their decisions about pursuing high school courses in mathematics and science. The goal of the project is to raise the awareness of these students as well as their teachers, counselors, and parents about the opportunities offered by the engineering profession. The specific aim is to facilitate their interest and motivate the students to pursue science and mathematics subjects which constitute the building blocks of an engineering education<sup>12</sup>.

### FACILITATION OF THE GOALS OF THE PROJECT

To achieve these goals, hands-on experiments were designed by female Drexel faculty in the college of Engineering, specifically to convey the fun and excitement of applied sciences and engineering. The discovery and exploration element is emphasized to give participants a taste of engineering practice. To ensure that these events have lasting effects on the students, teacher and parental involvement is encouraged, in line with studies that have shown their primary influence on girls' career decisions<sup>13,14</sup>. Another benefit of educator and parent participation is to also introduce them to the practice of modern engineering and the role that women engineers are playing in affecting a fundamental culture change.

## A TYPICAL TRIP

### Pre-visit Organization

#### School Selection, Contact, and School Responsibility

Initially school selection was based on previous contacts made by the WIE Program with individual teachers at schools. However, the word has spread fast, both by word of mouth and by various favorable articles in the Philadelphia press, and we now get frequent requests from schools, several each month.

The selected school receives the NSF proposal project summary, which is usually required by the contact personnel to obtain the necessary administrative approval. A letter is sent indicating there is no cost to the school and outlining their responsibilities. Schools are asked to provide a large multi-purpose room (usually the gym) with tables, chairs, a VCR and an overhead projector. They are also asked to notify parents and teachers and to select the 50 students who will be attending the program.

#### Selection of Students

After the first three visits, it became clear that the original concept of "self-selection" did not meet our goals. Given the opportunity to attend an all day program on engineering, girls responded at a rate of about 10%. To counter this lack of enthusiasm, we developed a flyer for distribution, to describe the program, and spark enthusiasm. When school-selected girls were required to attend, there was as much enthusiasm during the event (if not more). This method was more in keeping with our goal of introducing engineering to all girls just-in-time for the right high school course selections. When girls self-selected, they were in general "good in math and science" and probably would continue with math and science. The objective of the program is to present engineering in time for when girls consider various career options.

#### Material Preparation, Storage and Delivery to the School

All of the labs were designed to be portable, and are stored in a secure room provided by Drexel. Equipment is stored in the original boxes, and other lab materials such as polymer solutions, k'nex pieces etc. are stored in large, labeled Rubbermaid® containers. Good organization is essential to ensure the smooth running of multiple trips per term. The lab developers have trained undergraduate and graduate students who can set up and also conduct labs when faculty are not available. These students are responsible, under the direction of the project coordinator, to load the van early (earliest was 6:30 am, not a popular time for students!) in the morning of the visit and to unload/load and set up/dismantle the labs at the school. In addition to the labs, ancillary material such as the movies that will be shown, and laminated display posters highlighting famous women in Science are also packed. Folders are prepared for each girl. Each hand-out is copied on a different color paper so as to be easily identified. Together with the day's schedule, each folder contains (1) "Engineering and You" brochure<sup>15</sup>, (2) a listing of the Engineering Professional Society and their addresses, (3) "Is Engineering for Me?" -- considerations when choosing careers, which provides a summary of the topics we wish to cover through the day's activities, (4) Movie "do" sheet, (5) Descriptions of the four basic fields of engineering, (6) the difference between engineering and science, and (7) Do I have the Aptitude for Engineering - a list of some of the aptitudes needed for



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES

1996 WEPAN National Conference

engineering. Since equal numbers of four different color folders are used, they also serve as a simple mechanism to divide the girls up into four groups for the labs.

#### **A typical schedule for the day**

8:30-9:30	Drexel team sets up laboratory and displays
9:30-10:00	<i>Welcome:</i> Distribution of name tags, and "Science is Women's work " badges. <i>Warm-up exercise:</i> Girls are asked to identify the process of waking up and coming to school and then identify how an engineer may have been involved at each step. <i>Startling facts and figures:</i> Girls are asked to guess the % of women in different careers. Salaries are given. <i>Introduction to engineers:</i> All the Drexel women in the room are introduced, with their discipline, "This is Mary Smith and she is a Chemical Engineer".. <i>Movie:</i> (8:40 minutes) Bikes! Art, Elegance and Engineering <sup>16</sup> The girl are asked to use the movie "do sheet"
10:00-11:30	Two 45 minute lab. sessions Girls are organized into 4 groups of 10-15 and will rotate through the labs. (2 in the morning and 2 in the afternoon)
11:30-12:30	Lunch
12:30-2:00	Two 45 minute lab. sessions
2:00-2:10	Group photograph with all the k'nex designs and judging of the tallest k'nex structure. Photographs are later mailed to each girl
2:10-2:25	Free time. Second visit to lab activity of their choice
2:25-2:45	Wrap-up Revisit "what engineers do" (hopefully more input now) Movie (12 minutes)"Who are Engineers? You?" <sup>17</sup> Filling out and collection of evaluation form

#### **DESCRIPTIONS OF SOME OF THE EXPERIMENTS**

We have prepared six labs, four of which are taken on a visit. In each case the emphasis has been on fun and hands-on-learning. The labs are constantly evolving, each trip gives us ideas for improvements and additional material. In most cases the material that was initially conceived has been simplified, reducing the amount of information imparted, but increasing the time for the girls to experiment for themselves. We have also noticed that when the girls can take something home, a paper cup "overflowing" with solid foam, a scanned picture of themselves, a bottle of microcapsules containing brightly colored sand, the level of enthusiasm is heightened. We also feel that this will encourage

discussion with classmates, parents and siblings, and extending the positive aspects of the labs beyond the day of the visit.

Extensive lab details may be found by visiting our Drexel University Women in Engineering WWW site at <http://berl3.ece.drexel.edu/wie/>. Following is a distillation of the labs to give a flavor of the activities. The labs start with information about the particular engineering discipline which would best encompass the activity, and follow with constant interaction between the presenter(s) of the labs and the girls, with carefully directed questioning and encouragement, all the while weaving in information about what engineers do, and need to know. Safety glasses are supplied for all girls.

### **Engineering Design Lab**

This lab was developed by civil and architectural engineers to teach the concepts of engineering design, and teamwork. The girls form four groups and are given a design handout delineating the steps in design, from problem statement through strategy development and prototype construction. They are instructed to build the tallest free standing structure that they can in a given time period using a box of k'nex connectors and rods. At the end of the allotted time, all the structures are compared, and the tallest is kept for entry into the overall contest.

### **Exploring Multimedia and Computer Networking**

With the electrical and computer engineers, the girls are introduced to bits and bytes and writing their names in ASCII. Then they sing, clap giggle and talk into PowerMacs and watch the generation of the waveform, and see how the sound changes with different recording and processing parameters. Discussion can range from medical imaging to compact discs and sound editing to voice recognition.

In the image processing section they can capture images of themselves, or scan them into the computer. They can record a short video of themselves and their friends and watch it appear on the screen. Together with discussions again of medical imaging and image reconstruction they learn about pixels, and how much larger the memory has to be to store a picture.

### **Chemical and Biomedical Engineering applications of Polymers**

With the Chemical Engineers, the girls learn about polymers and cross linking agents on a molecular level. They are directed in an exercise where they themselves are monomer units which join up to be a viscous solution of polymer strands and then set hard when some of the girls are "bonded" between the "polymerized" chains made up of their classmates. They are then introduced to the world of polymeric microcapsules (carbonless paper, [they love to be asked how many of them have a credit card to sign off on], scratch and sniff, perfume samples, pharmaceuticals) and a lab in which clear polymer solutions containing four different brightly colored sands are formed into capsules by dropping them from a plastic syringe into a hardening solution. The girls are encouraged to experiment and make encapsulated strands etc. The capsules are made in small screw cap vials, which can be taken home.

## **Materials Engineering: Processing and Properties of Materials**

This lab is run on alternate trips with the Chemical Engineering lab, and starts with the same exercise of "polymerizing" the group. There then follow two very popular labs in which the girls make foam in a paper cup and slime<sup>18</sup>. The slime can be made to bounce or flow. Then they turn to metals, and play with shape memory wires (Ni-Ti alloy) that they form into any shape, and then place in hot water and see it straighten out.

## **Ground Water Flow and Pollutant Transport**

Many young people are very concerned about protecting the environment, and girls are particularly interested in activities which can be seen as increasing the common good. With the Civil Engineers, they participate in a demonstration of how substances (in this case solutions of food color) travel from the source, through different deposits, and into the ground water. Also they are encouraged to discuss ground water and water quality, properties of aquifers and wells, and the general causes and sources of pollution.

## **Drills: Design and Manufacture**

With the Mechanical Engineers, the groups are again introduced to design. After using cordless drills to put screws in chunks of 2 x 4, and in some cases, when the other groups do not complain too much about the noise (!) compare this with hammering in a nail, they are encouraged to draw a picture of what they think is inside the drill<sup>19</sup>. Next they are instructed on how to open up the drill and look inside. They are asked to place the case on a paper and trace the outline, then to draw the inside of the drill that they see. In this way they are introduced to design and manufacturing and encouraged to discuss economics, and design improvements.

## **CONCLUSIONS**

Without exception, Drexel faculty and students who participate in this program are heartened and greatly rewarded by the intelligence, exuberance and enthusiasm of the girls who take part in this outreach program. Invariably, the schools which we have attended are eager that we return in subsequent years. No schools have expressed concern about presenting the program to girls only, since most educators are very aware of the need to stimulate and inform young females about engineering. With the freedom to be themselves in a friendly supportive atmosphere, the girls display great aptitude and engineering ability. They take enormous pride in their tallest k'nex structure, or rush up to the microcapsule table to make another vial of capsules in the free time. They also give us very useful (usually positive) feedback from the questionnaire which they fill out at the wrap-up session, and many students come up to the instructors at the end of the day to personally thank them for a great time.

In the future we intend to seek funding to enlarge this effort and involve many of the excellent science-based institutions in the greater Philadelphia and New Jersey area, such as the Zoo, Academy of Natural Sciences and the Franklin institute. This will give the

opportunity for extensive follow up. We also would like to develop a mechanism for tracking the girls through high school to see if any of them do chose engineering as a career. In the future, if research reveals that by 6th grade girls are already turned off science, we may have to target even younger students and develop labs for 1-5 graders.

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**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

## COMBINING MENTORING AND SERVICE LEARNING - A NEW APPROACH

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### INTRODUCTION

At the University of Iowa, teams of female students in the engineering, sciences, and mathematics fields are taking their learning beyond the classroom and teaching their disciplines with new techniques to elementary and secondary school children in extracurricular settings. These college students are participating in *Service Learning Projects*, developed by the University of Iowa's Women in Science and Engineering (WISE) Program and sponsored by a grant from the Iowa Science Foundation.

#### What Is Service Learning?

Service learning refers to a form of experiential education that emphasizes for students the importance of accomplishing tasks that meet the needs of others. The National and Community Service Act of 1990 defines service learning with four criteria:

- (a) students learn and develop through active participation in thoughtfully organized service opportunities that meet actual community needs;
- (b) the service is related to the student's academic curriculum, and students have time to think, talk, or write about the service activity;
- (c) students acquire and use new skills and knowledge in real-life situations;
- (d) the service activity extends student learning beyond the classroom and helps foster a sense of caring for others.<sup>1</sup>

In our *Service Learning Projects*, the community need is for extracurricular science education for elementary and secondary school children. Extracurricular settings may include science clubs, other youth clubs, after-school programs, and Girl Scout groups. As for the students, college undergraduates and graduates are organized by similar academic interests in teams of four to six members. Each team is advised by a staff or faculty member from the University, or by an off-campus professional. These mentors and their teams of college students develop hands-on science activities related to their

own academic curriculum. Activities are chosen that use gender-free language, require hands-on experience, relate the exercise to daily life, are non-competitive, and support more than one correct outcome. By working in teams, students think, talk, and document their projects in the form of curriculum packets, consequently improving their verbal and written communication skills as well as their knowledge in the academic area. Their presentation skills are also enhanced as they deliver their projects to children in various extracurricular settings.

### **Who are the Mentors and Mentees?**

*Service Learning Projects* benefit two groups of mentors and mentees. The first group of mentors and mentees are the college students and the elementary/secondary school children, respectively. The college students serve as role models to the elementary and secondary school children as they deliver fun, hands-on science activities. The second group of mentors and mentees are the team advisors and the college students, respectively. The team advisors serve as mentors to the college students as they develop and deliver hands-on science activities together. These mentoring relationships are likely to continue long after the teams have completed their *Service Learning Projects*.

## **OBJECTIVES OF SERVICE LEARNING PROJECTS**

The purpose of *Service Learning Projects* is to design, implement, evaluate, and disseminate a model program for helping educators in extracurricular settings present science activities that will interest and challenge elementary and secondary school girls while helping female undergraduate and graduate students improve their scientific expertise and develop professional communication and presentation skills. *Service Learning Projects* address three main objectives:

- 1) To develop a university-based service learning program for female undergraduate and graduate students in science, engineering, and mathematics disciplines;
- 2) To design three gender-equitable science curriculum packets for use with elementary school girls (and boys) in extracurricular settings (Rocks and Fossils for grades K-1, Structures/Engineering for grades 2-3, and Genetics for grades 4-6);
- 3) To deliver and evaluate all components of each curriculum packet in extracurricular settings in Iowa City and surrounding school districts.



### **Whom do Service Learning Projects Benefit?**

On an individual basis, *Service Learning Projects* will benefit elementary school children, female college students selected for the program, and the female team advisors. On a public basis, *Service Learning Projects* will increase the awareness of gender issues in science, engineering, and mathematics; promote gender-equitable teaching in science at all levels; place science education in the context of the community; extend the scientific and technical resources of the university into the community; and increase the visibility of female scientists and engineers. Dissemination of this model program to other sites will further increase its public impact.

In addition, science and engineering groups from other institutions may benefit from *Service Learning Projects* by incorporating this model into their own outreach programs. By using *Service Learning Projects* as a model, existing outreach programs may be strengthened by adding a gender-equitable training element and by establishing strong relationships with extracurricular groups such as science clubs and other youth programs. Institutions will also be more likely to acknowledge science and engineering groups who implement outreach programs that benefit both the college students and the school children they influence. Combining service learning and mentoring accomplishes just that.

### **TEAM ROCKS AND FOSSILS!**

Four students, one teaching associate, and one faculty advisor comprised the first Team Rocks and Fossils! and were successful in developing hands-on science activities and a curriculum packet about rocks and fossils for children in grades K-1. Highlights include a homemade fossil hunt sandbox, a list of the better fossil and geode collecting areas in Iowa, a recommended book list for children, and several coloring activities.

### **TEAM STRUCTURES!**

Two students and one doctoral candidate advisor comprised the first Team Structures! and were also successful in developing hands-on science activities about structures and engineering for children in grades 2-3. Highlights include a story about an artist who made a mosaic picture out of tiles for a king. Today's version of the artist's creation uses seven geometric shapes that can be arranged in endless combinations to make different animal, boat, and other shapes. Team Structures! uses this activity to discuss how engineers use simple structures to build bridges, homes, and other buildings.

## TEAM GENETICS!

Three students and one scientist advisor comprised the first Team Genetics! and were also successful in developing hands-on science activities and a curriculum packet about genetics for children in grades 4-6. Highlights include making fingerprints, understanding the transfer of genes down generations using jelly beans, understanding what happens when genes “jump” between chromosomes using water color paints, and creating a “monster creature” using pictures of different body parts and the concepts of dominant and recessive genes.

## IMPROVEMENTS IN RECRUITMENT AND RETENTION OF WOMEN

By combining service learning and mentoring in a new approach to K-12 outreach programs, *Service Learning Projects* expect to positively influence the recruitment and retention of women in engineering, science, and mathematics fields, both at the pre-college and college levels. Although the program is currently in its first year of implementation at the University of Iowa, two out of the three teams have already delivered their projects to local after-school science programs with grand success. The Women in Science and Engineering Program is currently committed to organizing additional sites for each of the teams to visit, as well as to disseminating the completed curriculum packets to other institutions.

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## THE ACCESS PROGRAM FOR WOMEN IN SCIENCE AND ENGINEERING (ACCESS WISE)

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### Access WISE: The Beginning

The Access Program for Women in Science and Engineering (Access WISE) is a community outreach program for students in kindergarten to grade 12, and adults. The primary objective of the program is to encourage women to consider engineering and the physical sciences as viable future careers. As the Access program is by far the most active university outreach program at the University of Manitoba, a secondary goal is to foster an overall community understanding of science, engineering, and the university in general.

Access WISE began on May 1st 1990 as a pilot program jointly operated by the Faculties of Science and Engineering in response to a common problem: a lack of women pursuing areas that required physics and mathematics. Women were dropping high school mathematics and physics courses at a disproportional higher level than their male counterparts, and by in large not choosing to pursue engineering and the physical sciences even if they had completed the requisite high school math and physics. To reverse this disturbing trend and to encourage girls to see engineering and the physical sciences as accessible, Access WISE began its program of school visits. Two women students, one from science and one from engineering, were hired as presenters (Access co-ordinators).

Initially, these presentations were strongly targeted to students in grades nine to eleven. This is the time when students make crucial decisions about which courses to take in high school and what areas they will apply to at university. The purpose of these talks was to get the girls "excited and enthused" about engineering and science, to show them how important it is to keep their options open by taking high school physics and math, and to show them how these apparently dry and academic disciplines relate to "real life" concerns like job satisfaction, travel, salary, and job security.

During the program's first weeks of existence, it became obvious that attitudes about science are formed much earlier than grade nine and that no presentation, no matter

how engaging, will reverse these attitudes. The Access presentations were expanded to include grades 4 to 12 and demonstrations and experiments were added to enliven the talks to younger audiences.

The results from the first year of the program were so encouraging that what was intended as a one time only summer project was continued on into the fall term on a part time basis. Access WISE was expanded as requests from the schools for talks soon outstripped the availability of the Access Co-ordinators. In the spring of 1991, a year after the start of the program, additional co-ordinators were hired to meet the increased demand from the schools. The variety of presentations offered by Access WISE was increased to be more sensitive to the wide range of audiences, and the program began to grow into the shape that it now has.

Since its inception, Access WISE has continued to grow in its popularity, not only with the schools throughout Manitoba, but with other community groups such as Brownies and Girl Guides, 4 H Clubs, Science and Mathematics clubs, parent-teacher associations, women's groups and a host of others - both urban and rural. To date, co-ordinators have given over 3000 presentations to well over 120,000 students throughout Manitoba.

#### **Community Specific Outreach Success**

It is impossible to talk about outreach without placing it in its proper context. A large part of the success of the Access Program has been that it endeavours to appeal specifically to distinct communities within the ethnically and geographically diverse province of Manitoba. From small farming communities on the flat expanse of the prairies in the south, to isolated mining communities on the Canadian Shield in the north, Manitoba is an amalgamation of many cultures and communities.

With over half of the population of the province living outside of the capital city of Winnipeg, the Access Program has placed a very special emphasis on its non-urban outreach. For many of the small communities, the contact with Access WISE is their first - and often only - exposure to university culture. To be effective at encouraging girls to consider science and engineering, Access presentations must address also their concern about relocating to an urban environment and study at an institution which is often perceived as being large and impersonal. To convey this information properly, the co-ordinators must speak to each community in its own language - in both a literal and a figurative sense. Whenever possible, Access presentations are given by co-ordinators with a background similar to their audiences. For instance, Franco-Manitoban co-ordinators are hired to speak to the French and French immersion schools, women who grew up in rural Manitoba speak to the rural farming communities, etc. This helps assure that the information provided by Access WISE is given in terms that the girls and women will understand and appreciate.

## **The Presenters**

All Access presentations are given by the Access Co-ordinators, who are women students of engineering or science. They are an interesting and well-informed group of women who are excellent communicators and motivational speakers. The rationale for sending out university students is twofold. First, as presenters, they provide positive role models that break the stereotypical image of male engineers and scientists. Second, as university students, the presenters are more apt to be perceived as peers by student audiences. The similar concerns and perceptions of audience and speakers add to the overall effectiveness of the presentation.

To provide outreach to the diverse Manitoban community, Access WISE strives to maintain a representative diversity in its staff. This co-ordinator diversity is not only based on ethnicity. For the presentations to older than average students, Access WISE employs co-ordinators who are themselves women who have returned to school after raising a family or working in industry, and therefore have first-hand experience of the specific demands that are placed on this group of students.

Access WISE provides in-depth training that addresses ways in which presentations can be made more involving for girls and women. This training is regularly reinforced and augmented with training sessions and in-house seminars.

The employment of students as co-ordinators helps fund and support women already pursuing careers in science and engineering. The Access Program operates in a very lively and supportive atmosphere. Many former co-ordinators have cited this environment as one of the factors that helped them "get through" their university education.

## **Access WISE Presentations**

Within the wide array of presentations given by Access WISE, a majority of presentations are directed to school children in grades 3 to 12 , and amongst these, most are given to school children in grades 3 to 8.

### **Presentations to Students : Grades 3 to 12**

For students in grades three to seven, most presentations revolve around the "Science Roadshow", a collection of very dramatic visual demonstrations and experiments (examples include: a Tesla Coil, LASER, and liquid nitrogen) whose fascinating visual effects illustrate basic science and engineering principles. Roadshow demonstrations are interspersed into a general discussion about science and engineering where co-ordinators try to dispel the negative "nerdy" image of scientists and explain what engineers actually do. The focus of this presentation is how much fun science and engineering really are, and to show students that they are not fields reserved for the associated stereotype of white male geniuses with socialisation problems.

For the older students (grades 9 to 12), the presentations are designed to provide information about the wide range of career options that are available in both science and engineering. Career counseling is the primary focus of these talks, with the central theme being the importance of not limiting future choices through course decisions made while in high school. In rural and remote areas these talks are expanded to talk about university in general.

At the request of administrators and teachers, Access WISE has also designed other - more specialised - presentations on topics that directly relate to the Manitoba Department of Education science curriculum. Essentially for students in grades 3 to 8, these include:

- 1) States of Matter,
- 2) How to Prepare a Science Fair Project,
- 3) Geology: Identifying Rocks and Minerals,
- 4) Basic Chemistry,

These newer topics allow the Access Program to return to schools and address the same students each year without repeating information from a previous year.

A recent addition to Access WISE presentations is the "Water Resources Module" of lectures for grades five to eight. The senior co-ordinator, Laura Binkley, in conjunction with Brock Corydon School, and Dr. Barbara J. Lence, Department of Civil Engineering, has developed a module to teach children about water resources engineering. This educates students about the basic scientific concepts required to study water quality, while at the same time, it gives them an in-depth understanding of a specific field of engineering. The module is comprised of a computer program to model the in stream amount of dissolved oxygen, a series of nine lecture topics, transparencies for overhead projection, handouts, experiments, assignments and tests. The module will be available world-wide through the Canadian SchoolNet computer network.

Experience has taught us that, in many cases - especially at a younger age - it is better to give presentations to mixed groups of both girls and boys, but we will leave the final decision to the discretion of the teachers involved. Although not a hard rule, we have found that girls only groups work better in grades nine and ten, when girls, if alone, are far more likely to respond to a presentation or ask questions.

#### Other Groups

An important component of Access WISE is the PRIME (Progressively Returning from Industry, Motherhood, Etc.) Access program. The PRIME program targets presentations to women's groups to encourage older than average students to examine these fields when returning to school. The co-ordinators that give the PRIME presentations are themselves women who have returned to school after raising a family or being in the work force.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

In response to requests from a variety of different sources, Access WISE also gives presentations to a number of groups outside the classroom. Parents, administrators, counselors, etc., also are concerned about the factors that influence girls away from the sciences. As the media reinforces the importance of math and science for future careers, these concerned individuals have turned to Access WISE as a resource for finding ways in which they can increase the participation of girls in those areas. At venues such as teachers' and administrators' conferences, parent-teacher group meetings, and university sponsored "information days", the senior co-ordinator of Access WISE gives presentations to such groups.

### **Access WISE: Program Structure**

The policies and objectives of Access WISE are established by a six member Access Advisory Committee, with representation from science, engineering and central university. The daily operation of the program is managed by the senior co-ordinator, Laura Binkley, the one full-time employee of the program. Ms. Binkley is herself a part-time engineering student. The supervision of the program is provided by the chair of the Access Advisory committee, a rotating position which is currently held by Ms. Irene Mikawoz, P. Eng. Director of Students Affairs for the Faculty of Engineering. Six to eight part-time co-ordinators - full-time women students of science or engineering - are employed to give presentations.

The program operates full-time during the months of May and June, and part time during the academic year from September to April. During the months of July and August, only the senior co-ordinator remains on staff. During these months, new presentations are developed for the following year, and a limited number of presentations are given to camps and day camps within Manitoba.

### **Accolades**

The success of the Access program has generated interest from a variety of sources. Co-ordinators have been invited to give presentations on local children's television programs, at the Winnipeg Children's Hospital, and to various groups at the Manitoba Museum of Man and Nature. In February of 1995, the Women's Television Network (WTN) taped a presentation given by the Access Program. Segments of this presentation, along with interviews with the co-ordinators and the children who watched the presentation, were aired on "Call Us" a program dealing with non-traditional careers for women.

The Access Program was chosen as the 1994 recipient of the Students Project Award. This is an annual prize given by the 1989 Canadian Engineering Memorial Foundation to a student, or group of students, actively encouraging the engineering profession through outreach. This award was presented at the Association of Professional Engineers of the province of Manitoba's (APEM) "Recognition Nite" on March 7, 1995.

The continued support of the Faculties of Science and Engineering and the central administration of the University of Manitoba - especially at a time when budget cutbacks have resulted in the loss many viable programs - is a further indication of the success of the Access program.

### **The Future**

In the future, the Access Program hopes to expand its presentations to better serve its constituency. To achieve this, finding a more permanent source of funding is of paramount importance. One way in which this goal is being accomplished is through the establishment of an endowment fund with support coming from private and industry sources.



## **AFFIRMATIVE ACTION: PROMISE OR PROGRESS? WHAT LIES AHEAD?**

### **Keynote**

**Yvonne Blanchard Freeman, Ph.D.**

**Provost and Vice President**

**Clark Atlanta University**

In January, 1996, Dr. Yvonne Blanchard Freeman assumed the position of Provost and Vice President for Academic Affairs at Clark Atlanta University. Prior to this appointment she served as Associate Administrator for Equal Opportunity Programs at NASA. While at CAU Dr. Freeman continues to work with NASA as a consultant on equal opportunity and education issues and serves as advisor to the NASA administrator.

At NASA, she led the development of minority education programs, managed funding for research centers in (HBCUs) and institutions with a predominance of minority enrollment, provided policy direction on the development of equal opportunity programs, and directed the development of pre-college programs on campuses of HBCUs, Hispanic Serving Institutions, Tribal Colleges, Local Education Agencies, and Non-Profit Organizations.

Her accomplishments at NASA include establishing minority training projects in four universities, increasing funding for research centers in 14 HBCUs, establishing NASA programs to support more than 650 undergraduates, 170 graduate level, and 12,000 pre-college students in S.E.M, implementing an agency-wide multicultural education program, and creating and implementing the Minority Internships and Summer Employment Program at JPL and North Carolina A&T State University.

Prior to joining NASA, Dr. Freeman worked in a variety of senior level positions in the US Department of Agriculture, the US Agency for International Development, and the US Department of Education.

Dr. Freeman is a graduate of Fisk University, holds a Master's degree from Loyola University at Los Angeles, and received her Doctorate in Education from the University of Massachusetts. She is a recipient of numerous awards and recognitions including the National Association for Equal Opportunity in Higher Education Leadership Award, the Presidential Award of Distinction from Moorehouse College, and the NASA Medal for Outstanding Leadership.



**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES**

**1996 WEPAN National Conference**



# AFFIRMATIVE ACTION: PREFERENCE, PROGRESS OR PROMISE, WHAT LIES AHEAD?

1996 Women & Engineering WEPAN Conference

by Dr. Yvonne Blanchard Freeman

Provost/Vice President for Academic Affairs

Clark Atlanta University

June 26, 1996

Thank you for affording me this opportunity to share a few thoughts and observations with you on the subject of affirmative action. I recall vividly the visit of Dr. Suzanne Brainard and Dr. Susan McIntyre to my office at NASA last year. Their visit was the outcome of an inquiry on how the Office of Equal Opportunity Programs at NASA might work with WEPAN. I recognized the important contribution of WEPAN to the advancement of women in engineering and I wanted to ensure that its contribution was assured through a broader network of diverse membership.

Since that visit, I have moved to academia where the issue of affirmative action continues to rage ferociously and insanely. In an arena where rationality and civility are purported to be the dominant values, U.S. academia is at risk of becoming the forum of insanity and duplicity. I am in the eye of the storm and I accept the challenge with the clear understanding and conviction that I can make a difference in the university community. Thank you for the opportunity to discuss a subject most people are afraid to discuss even in polite audiences. That subject is affirmative action or affirmative inaction. On the eve of the 21st Century, most organizations, institutions and sectors of society are undergoing a major transformation: education is reforming, with new partnerships among leaders in education, business, service, and government; corporate America is restructuring in an effort to be globally competitive; authority in every sector is becoming more distributed; and entire nations, such as the former Soviet Union, are restructuring along these lines. I believe that Affirmative action is key to America's success in the global marketplace. However, if you had not noticed, my opinion isn't shared by everyone. Maybe we can find answers if we address the following: Is it possible for a person living in this country to attend kindergarten, elementary school, college, do post-doctoral work and never hear of our national anthem, the Statute of Liberty, or NASA? Is it possible for Majority (white) Institutions to enjoy accreditation without a visit? Is it possible for a white manager, administrator, engineer, scientist, accountant, or professor to believe that they've achieved stature and position in corporate America, academia, or government only because of their hard work and talent or brilliance? Most whites are not consciously aware of the ways in which they have benefitted from a preferential system, (a system that prefers them to the exclusion of others) that works, and has worked historically, to benefit them. If you have not surmised, we are not talking about affirmative action. We are talking about a preferential system that is built into the core and fabric of society, fueled by racism, sexism, ageism, and other forms of discrimination and "social astigmatism". All that one needs to do is look at the disproportionate number of women and people of color clustered on lower back shelves. We know that their absence from top shelf or upper shelves is not coincidental. Until this situation radically changes, lawyers will continue making millions of dollars on employment decisions from managers on issues ranging from affirmative action to managing diversity; to re-engineering for equity.

I recall the comments of a young pilot who flew across the Atlantic Ocean at the age of 12. At one point of the flight,

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

ice formed on the wings of the aircraft. She descended to a lower altitude, flying only 500 feet above the sea. The ice melted and she continued her history making flight. "Were you afraid?" The pilot was asked. "No, I knew what I was doing. I have confidence in what I can do," was her reply. The pilot is a wonderful junior high student, whom I meet last year named Vicki Van Meter.

Her confidence came from her 'years' of preparation and the caring network of family and friends. All of us in the business of creating a better future for the next generations have our years of preparation and our networks of caring friends, colleagues, and family members. WEPAN is such a network. We can make a difference. We all can make a positive contribution to the future. The challenge is, Are we the preferred? Have we made progress? Does the future promise equity with every change? Are we focused on our goals? What are women doing in the quest for equity, especially in the field of engineering? What is our progress? Is our eye on the prize or are we blinded by preferential behavior and isms or social astigmatism?

To answer the question of progress, we may want to turn to a paper presented to the American Society for Engineering Education in 1993 by William K. LeBold and Donna J. Lebold of Perdue University. Their paper, "An historical perspective on women engineers and a futuristic outlook" discussed the role of women in engineering for the 100-year period between 1893, when the Society for the Promotion of Engineering Education was founded, and in 1993, when the paper was presented to the SEE Annual Conference. One of the anecdotes the authors cited is worthy of repetition at this assembly even though many of you may be familiar with it. The LeBolds wrote:

The Brooklyn Bridge might not exist had it not been for Emily Warren Roebling. For eleven years she assisted with the construction after her father-in-law, a master bridge builder, became incapacitated when his leg was crushed by the bridge's timbers. Additional responsibility was given to her when her husband contracted a dread disease leaving him paralyzed... The bridge had taken thirteen years to build and twenty men had lost their lives.

The bridge was completed in May 1883, and indeed a woman was among the master builders.

The LeBolds (who were among the presenters of the WEPAN Conference in 1994 ) noted that during the first half of the 100-period, women's roles in engineering were "fraught with discrimination, rejection and inequity". However, the second half of the 100-year period brought "almost exponential changes in engineering education for women". They credited "the women's movement, civil rights, affirmative action, and greater acceptance in the technological workplace" for improving opportunities for women in engineering.

According to a recent note on the INTERNET, "the engineering student population of women in the United States has reached a plateau at around 16 percent. Less than 10 percent of the working engineering population are women." To amplify an outdated popular expression, we might say, "While we have come a long way," we have promises to keep, and miles to go before {we} sleep!" Women have achieved significant progress in engineering even though true equity-- is yet to be realized. I dare say women are uniquely qualified to redefine the equity agenda.

In a slightly different vein, Dr. Anne Petersen, National Science Foundation's Deputy Director, in an address to the NSF Conference on Women and Science last December, also spoke of the many signs of progress." There are more women in policy meetings, more women at the mastheads of corporations. The former chief scientist of NASA, France Cordova, is a woman. The former head of the Office of Management and Budget Alice Rivlin is a woman. A number of astronauts are women, in fact of significant note we celebrate 3 new African American Women in the 1996 Astronaut class at NASA. Increasingly, university presidents are women. I invite your attention to the leadership of Dr. Johnetta Cole, President of Spelman College who inspite of the rocks on the playing field she continues to "raise

the bar". We need to recognize and celebrate progress of women , for they offer a glimpse of what is possible and a marker of our progress through the unending journey to equity.

All of you know of the increasing and unending assault on affirmative action which is being touted in the public media as a wedge issue for this year's election. When I was at NASA, I directed the Equal Opportunity staff to develop an affirmative action survival kit consisting of significant articles and papers on affirmative action. For a brief three-month period last year, the staff had collected more than 80 significant articles. Recently, I asked a colleague to do a literature search on the same subject, and he reported that the task was "mission impossible." The floodgate has opened and there are literally hundreds of articles on the subject and dozens of national organizations working to support affirmative action.

In the Chronicle of Higher Education, the "trade paper" for university professionals, there are more than 100 items on "affirmative action and women" in the last 10 months, since September 1995. A sampling of the headlines for May 1996 might provide a snapshot of affirmative action as the media reports it:

Georgia may face suit over affirmative action, May 31

College leaders plan strategy to defend affirmative action, May 31

Penn State University settles lawsuit over firing of gay administrator, May 24

Black students week to enter court case on affirmative action, May 24

University of California Regents to discuss ending minority scholarships, May 17

Texas asks high court to uphold legality of affirmative action, May 10

California Bill would criminalize preferences in education, May 3

Appeals Court suspends order barring use of race in admission, May 3

Most of the articles in the May issues of the Chronicle deal with the race issue. In fact, most of the articles on affirmative action since the beginning of the debate deal with the race issue. If the primary foci of these articles are indicative of the nature of race discrimination in this Nation, we in this audience might celebrate that gender or sex discrimination has been reduced to a negligible level, no longer worthy of public attention. However, we know, mostly from our personal experiences, that sexism and sex discrimination is alive and well in this Nation. The distorted focus on the racial dimension of affirmative action is nothing more than a political ploy to distract and discount, and perhaps discredit.

Stated differently, we might ask, since women are the primary beneficiaries of affirmative action and more white women have been advanced through the implementation of affirmative action, why is the attack on affirmative action focused on its racial aspect and not its gender aspect? The answer is simple: There are more women voters than minority or minority male voters.

There is a continuing attack on affirmative action based on the theme of "preferential treatment" that minority people are given special privileges. The truth is, opponents of affirmative action are the products of preferential treatment. They were privileged from the moment they were born. What they are objecting to is that the same privileges they enjoy have to be shared with other people, people of a different colors, pigment imperatives, ethnic and religious persuasions.

Affirmative action is an outcome-based initiative and some people have argued that America should not focus

on the equality of outcome. They suggest that we should not pay attention to whether women and minority people are found in the work force or in colleges and universities, or whether they have a fair share of the public money for research and contracts. The critics of affirmative action want us to focus on the equality of input, that is bring everybody to the starting gate and let them compete on their own merits, with or without track shoes as usually required for optimal performance or just shoes. Unfortunately for many the input process also has precedent preferential treatment as some were born with seats at the table while others were born without seats or tables. More recently, in California and Texas, they have changed their minds. They don't want people different from themselves or their children to be at the starting gate. They want to TALK - I put the emphasis on the work "talk" -- they want to talk about equality of opportunity not "equalizing opportunities".

In all spheres of business, we are to focus on outcome, but in the use of human resources, we are told not to pay attention to outcome. Isn't that interesting? Interesting double talk, it certainly is!

Willie Brown, former Speaker of the California Assembly, now mayor of San Francisco, has an interesting answer to the notice of equality of opportunity. He said, "Let me tell you what you're really saying when you talk about taking away affirmative action. You have, in America, a country which for years, if they were playing poker, has been cheating in the game. They've been cheating on every card, they've been cheating on every bet, and suddenly you discover that they're cheating and you say, "Hold it." Now they have accumulated about 98 percent of all of the chips, and when you catch them cheating, what do you do? Do you say, "Okay, now you don't cheat anymore. You keep all you've acquired through cheating, but now you don't cheat anymore. You just don't cheat anymore. From now on, we're all equal. Does that make sense? Willie Brown provided an answer. He pointed out that in that lopsided situation, "all you've got to do is just keep upping the bet from the accumulation of chips you already have and I won't be equal because I can't compete with that because I don't have the same resources."

Affirmative action gives white women and minority people a chance to excel on a level playing field. I have no doubt that I could and would reach the top of civil service in my life time as I demonstrated in 1993. I am not sure I would have reached the top as fast as I have without the push of affirmative action. You see, affirmative action raises the consciousness of the work place. It makes the practice of "like hiring like" less acceptable. It makes the employer more aware of the availability of exemplar yet melanin defined talents in the global community. It is through programs such as affirmative action that more women and minority people are able to "break the glass ceiling," and to achieve economic equality, to be engaged in non-traditional occupations and to be considered for graduate and post-graduate study, and for faculty and presidential appointments.

The current debate on affirmative action offers an excellent case study on the crucial importance of being able to define the terms of the debate. Despite clear and unequivocal emphasis on targets or goals for accomplishing a more diverse work force, reflective of the diversity in America, critics of affirmative action insist on labeling targets and goals as "quota." The Republican National Chairman Haley Barbour has said, "The American People abhor discrimination. They are sick of special preferences. They are sick of quotas, giving preferential treatment because some people are part of some class." But, as Speaker Brown said, white people are where they are as a result of special preferences in the past! Preference is for some a birthright, for others a passport and for others still non existent.

We must choose our terms for the debate and we must be on the offense. What the critics of affirmative action refuse to recognize is the privileges enjoyed by the dominant group since the founding of America. They clamor for color-blind decisions, and they cry "foul" when the outcome is of a color different than what they want. They claim to want to treat all people alike, but they favor the old boy network! They favor gender, "male" and race "white"! We need to expose this secret, while not so secret a secret it is that the attack on affirmative action is really an attack on women! We must define the terms of the debate.

In the January 24, 1995 issue of Los Angeles Times, professor Norman Matloff of UC Davis presents an interesting argument for using a lottery for selecting applicants for admission to University of California schools. He points out that "neither SAT scores nor any other numeric measure will be a very accurate predictor of future grades. It thus makes no sense to admit one applicant over another simply because the first applicant had slightly higher test

scores.” He points out, however, that numeric measures do have some power in predicting success at a school,” And he recommends that “some threshold values should be established for numerics such as SAT scores... After having set such threshold values, there is... no defensible reason for further comparison of these scores among applicants. Once the applicant pool has been narrowed in this manner, a sensible policy would be that school admissions officers use a lottery for selecting applicants.”

In addition to college admissions, some critics argued that lottery should be used for employment decisions. Many of you are probably familiar with a case known as *Taxman v. Piscataway*. Sharon Taxman, a white teacher, and Debra Williams, a Black teacher, were hired on the same day to teach business skills at Piscataway High School in New Jersey. “In 1989, the school board faced a budget deficit and decided one of them would have to go. Historically, in cases where both employees were “equally senior,” the school board flipped a coin. Not in this one. The board decided that because Williams was the only Black teacher in the business education department, she would stay and Taxman would be separated from the employ of the School district.” Taxman sued the board and the case is headed to the U.S. Supreme Court. I am not getting into a discussion of the merits of the case; I am simply pointing out that, like the critics of affirmative action, we must be free to define our terms of the debate and we might think of an alternate way to the present system of implementing affirmative action. If drawing lots or flipping a coin would give minority people and women a better chance in career advancement or college admission than the current subjective selection process, let’s give the alternate way a trial!

I have already stated that the attack on affirmative action is really a political ploy, a socio-political distraction. In the higher education arena, you are undoubtedly familiar with the negative action of the Board of Regents of University of California voting to eliminate affirmative action. Last week, a panel of the American Association of University Professors issued a report to condemn that decision stating that “the regents were motivated by partisan politics, rather than educational concerns.” Politics of race and gender again raises its ugly head. The panel noted that the regents violated the principle of shared governance which requires that the university’s administration and faculty be deeply involved in major decisions of this sort. A majority of Regents disregarded the factor that the chancellors and faculty senates at each of the university’s nine campuses had expressed support for affirmative action. Partisan politics and political ploy! An equation for the destruction of social justice and shared equity. Politicians are using affirmative action programs as another code word for minority bashing. We know many white men are hurting, afraid, and angry. Instead of leveling with the people, especially white males, about the challenge of the global economy and the high cost of change; instead of calming their fears and soothing their angers, politicians continue to mislead their constituents by scapegoating minority people. Who made the decision to send our country’s economic resolve to other countries? Minorities? Women? I don’t think so. Worse yet, while they are more subtle in not naming the minority group for scapegoating, it is made abundantly clear that Black people are who Politicians have in mind. Thus, they exploit the fear and anger of white males; they fan up inter-racial hostility, all in the hope of winning the White House or retaining control of the Senate or the House. And, of course, these are our national leaders! People we empower to lead this Nation out of chaos and into reason and tolerance. The road to progress must always be under construction.

The fact is, even if all the jobs held by minority people are given over to the white males, they will still be discontent. The world they once knew is no more and will never be again. They must wake up and realize they cannot go home again. Yet, the desire for the mythical golden past or the “gilded age” is so powerful that they would listen to the nonsense of aspiring presidential candidates who talk of bringing us back to the America we once knew. Listen to the pious rhetoric. Are these politicians for real? And yet they have their following! As a Black woman, I certainly do not want to be brought back to the America we once knew. The pain is debilitating, overwhelming, and toxic. I have no desire to be spat upon again as I was spat on in Nashville in 1965, merely 30 years ago! I have no desire to sit at the back of a bus or to drink from a “Colored Only” fountain!

Instead of gathering and channeling the resources of the Nation, through proper taxation, America under Ronald Reagan had become a debtor nation. Interestingly, Reagan was a popular president, certainly more so than Jimmy Carter.

I wonder what it is in the American psyche that allows us to be so easily deceived. What is it in our

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

socialization process that we confuse form with substance, we want greatness without pain and discipleship and discernment. If a candidate can promise what we want, we elect him our president! Promise is not enough. We honor the entertainers and the jokes while our national house goes up in flame. Under Reagan, we gave tax cuts to the middle class, and the very rich, wrecked the national economy, and dismantled programs credited for sustaining life and dignity. And we said ignore the historically underrepresented, the undereducated, the underpaid and their children. Under the Republican majority, we shut down the government to score a political point. History does have a way of repeating itself, doesn't it? Instead of promoting and investing in the American people, politicians preach strangling the poor and they are re-elected time and time again! Instead of using diversity as our competitive edge in the global market, we want to compete without regard to the external reality. And we ask why we are losing ground! We ask why our fingers are slipping from the edge of the ledge of dignity and self respect.

During the presidency of Ronald Reagan, America began running up its national deficit and now his spiritual descendants are talking of a "Balanced Budget Amendment!" The trouble is, even with a so called balanced budget, America will not regain its competitive edge without a mobilized population. If "life, liberty, and the pursuit of happiness" is not equally available to all Americans, we will be so preoccupied with internal conflicts and strife that we have no energy left for global engagement. We will be no better than a Third World nation in the 21st Century. In fact we may be closing the gap on a Nation within a Nation or a two tiered society, of haves and have nots. We need to have a new Covenant with ourselves as Americans, to make sure that decency, civility, and dignity for all people is kept alive in this Nation, that "life, liberty, and the pursuit of happiness" is real and not an illusion, and available to all people. Only then can we turn this Nation around.

It is time that we inform White males in America that they lose ground not because they are displaced by minority people or women. They lose ground precisely because the world they knew-- we once knew-- has been replaced by a new world. The ground in fact isn't theirs, it's ours all of ours. Much through some of their decision making and because many more responsible politicians would desire it, America does not live in isolation, it lives in a world or global community. The political upheavals in Tokyo, Beijing, Moscow or Islamabad have as much impact on us as those in London, Paris, or Berlin. We are engaged in global competition and some of the jobs white males used to have in the manufacturing sector are no longer here. The white owners and managers have exported their jobs overseas, to the cheaper labor markets abroad. It is not minority people or women who say to the white men that they have lost the competitive edge; their white owners and managers say so by their actions! Blaming it on affirmative action is merely a convenient excuse, tantamount to a scuba diving exercise, submerged in fluid argument and experiences, free flowing and uncontained.

White males are losing ground because the skills they have are being replaced by machines. Automation has matured. Cars can be assembled by robots. Cash can be dispensed by an ATM. We are increasingly a wireless, paperless society. It has been estimated that 500,000 clerical and technical jobs had disappeared since 1992! It is projected that many more white collar workers -- most of whom are white men -- will become redundant by the early decades of the next century.

As the Nobel Laureate economist Wassily Leontief said, "the role of humans as the most important factor of production is bound to diminish in the same way that the role of horses in agricultural production was first diminished and then eliminated by the introduction of tractors."

The white men lose ground ironically as a result of the gains they made in the Reagan years when taxes were cut and defense spending was increased. The policies of the Reagan era were to enrich the top 20 percent at the expense of everybody else. And the top 20 percent are predominantly white men! The less fortunate white men had the illusion they were getting ahead with the tax break; they discovered lately that the quality of their life had deteriorated. Due to drastic under funding, education, public health, transportation, housing, and public safety have sunk to a lower level. They expect better. Should it surprise you that they are angry? Unfortunately, they continue to allow themselves to be misled and they direct their anger on the wrong objects! Minority people, women and mostly immigrants



Prejudice is a strange thing. You might remember the saying "My mind is made up; don't bother me with facts." Regardless of the heap of facts you can pour on a bigot, he or she is unlikely to be moved by them. Consider the following facts as compiled by the National Rainbow Coalition:

White males are 33% of the U.S. population, but they account for:  
80% of tenured professors  
80% of the U.S. House of Representatives  
90% of the U.S. Senate  
92% of the Forbes 400  
97% of school superintendents  
99.9% of professional athletic team owners

Given these data, can you tell me how white men have been disadvantaged by affirmative action? This disadvantage is numerically non-existent.

The crux of our problem is not whether white men as a group have lost ground. It is that some individual white men are not getting what they are brought up to expect to get. They have what psychologists call a "dissonance" in their life experience. They are uncomfortable. And they complain. While they argue that using race as a criterion for selection is unfair, they rely on race as the primary factor for their argument. As there are more white men as a group than the various minority groups, the crescendo of their complaint has drowned out the voices of justice and equity. We need to find a way to reach these angry and afraid white men and let them know that we are on this planet together. We are in the same boat, and bail water as we must, together to stay afloat.

Exactly a hundred years ago, in 1896, almost to the date, the U.S. Supreme Court ruled in favor of the infamous doctrine of "separate but equal" in the case of *Plessy v. Ferguson*, barely 31 years after the end of the Civil War in 1865.

You might recall that in 1865 and 1868, the United States ratified the 13th and the 14th Amendments establishing the rights of citizenship of former slaves. In 1870, the 15th Amendment was ratified, prohibiting race, color, or previous condition of servitude as grounds for denying or abridging the rights of citizens to vote. These amendments were ratified during Reconstruction. However, even as Blacks were empowered, Black Codes were introduced in the Southern States. The Black Codes, you might remember from U.S. history, were the laws that restricted Black economic options and thus forced them to continue working as plantation laborers. Did we need, do we need Affirmative action? Of course we do, yet we push Human rights abroad.

The Compromise of 1877 allowed Rutherford Hayes to assume the presidency. In return, the Republicans agreed not to challenge Democrats' control of South Carolina, Florida, and Louisiana. The Compromise of 1877 ended the Reconstruction. Federal troops were withdrawn from the South. In the last two decades of the 19th Century, Blacks were disenfranchised and stripped of other rights through the enactment of Jim Crow laws in the South. The infamous "*Plessy v. Ferguson*" decision in 1896 was merely a reflection of the tenor of the time. The gains of Black people in the Reconstruction period were wiped out 31 years after the end of the Civil War. California and Congress are about set to abolish affirmative action barely 30 years after the beginning of that program! History does have a tendency to repeat itself! Or, perhaps I should say, we have a tendency to repeat history.

What can we do about this? What should we do about this? For a start, we must repudiate efforts that exploit the fear and anxiety of people. We need moral leadership. We cannot count on Congress or the Supreme Court to provide it. We have to define this moral compass for ourselves. We must speak up when our so-called leaders are disseminating misinformation, marketing malice and social disgust.

I think it is absolutely essential that we maintain the vitality of our network of associations, the civil rights groups that serve as the conscience of this Nation and help won the hard fought battles, the professional groups such as WEPAN that ensure the inclusion of the hitherto excluded, the community groups that monitor and support the well being of all people. I know all of us are busy. All of us have more than we can do within our allotted time. I also know

**WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES**  
1996 WEPAN National Conference

that I find time to do that which I feel is important. If we do not find time to speak up when vital issues are being discussed, we have ourselves to blame for the vanishing opportunities. You need to write to your local papers, express your opinions. Weigh in!


I contend that what lies ahead is a rough and rocky road. I share Lani Guinier's viewpoint, a professor at the University of Pennsylvania School of Law, whose nomination to head the civil rights division of the Justice Department in June 1993, was withdrawn after she came under fire from conservatives. "The leadership vacuum from both the Supreme Court and the Political institutions is creating a void --- Nature abhors a vacuum, and into that vacuum may move the most extreme voices on each side." This leads me to believe that greater conflict and confusion over affirmative action is inevitable. Rest assured the history of exclusion, isolation, disdain, disenfranchisement of some minority people guarantees that we commit our individual attention to equity in a real sense as the retreats from the journey to equity and fairness will be few. Just like Dr. Suess in Bartholomew and the 500 Hats, some people history requires that they "keep coming". Uncompromised Pride and one peoples history will usually sustain you.

I also think that it is essential for you to contact your representative and senator, both at the national and state levels, and share your concerns with them. They may not recognize your name, but they are still your representatives. Make them responsible, make them accountable. Tell them about the importance of diversity in global competition. Get in touch with the committees that have oversight of science and technology and issues of importance to women and professionals. Urge them to provide adequate investment for the future. Urge them to pay more attention to waste management instead of wasting resources. As an aside, I would offer a challenge to you as engineers. You need to use your cerebral power to develop the tools and the systems to manage organic and inorganic wastes. Environmental pollution, social pollution and environmental racism are alarming problems, symbols of waste confronting the world. As scientists, you have an obligation to find a solution to waste elimination.

Indeed the most potent argument for affirmative action is that people of a different background can bring to the table a different perspective which can generate new vitality and resiliency. In the natural world, we know that biodiversity is critical to the survival of a species. It is equally true in our social world. The challenge confronting us is what kind of contribution we make after we have arrived. As women engineers, how have you contributed to the development of your profession? What business are you engaged in? To what extent have you made a difference and what kind of difference do you make? What are your unique contributions in terms of perspective and methodology? In the course of reaching where we are, have we been masculinized or become androgynous (neither male or female)? Can we think like a male and still maintain or femininity? These are questions you need to ask and your answers might well define the future of affirmative action.

Stripped of all data and rationale, affirmative action is ultimately a moral issue. It is the attempt of a society to cure itself of a virulent disease known as the R-S complex of racism and sexism and to restore a fuller measure of health to the body politic. Racism and sexism are fundamentally issues of power and control. As women and as professionals, we can bring to the diagnosis and treatment of the disease with our unique antidote, antigen, and antibody. We must demonstrate how we share power, share control share vision and share leadership. Collectively, we are the demonstration that we can be whole. We do not need to be sickened with racism and sexism. And as we live and grow through the swarm and yet not be contaminated, we show the world the basic truth of diversity. We are different yet we are the same and we can cure our society from its penchant for self-destruction.

Therefore, affirmative action is far from being dead. Globalization is forcing us to learn, to innovate, and to operate with far greater quality and excellence in order to compete successfully in the world global marketplace. To achieve world-class performance standards, we will have to better respect and honor the diversity of individuals, and empower them in their quest to maximize their talent, creativity, and whole potential. The 21st Century will need to develop whole new percepts about the value of every human being. While affirmative action alone is not enough to meet this challenge, it does serve a vital role in helping our generation establish new role models for our children, who will then live in a society which appreciates both genders and the broad spectrum of all people.

 OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

We have promises to keep and miles to go before we sleep. The drum beats we hear from the distant; they are not the noisy gongs or the sounding cymbals of the new Congress nor the babbles of the misled multitude. The drum beats we hear are the steady beats of human dignity, justice, and equality. Let us march together, and steadily, to the distant drum beats! If we are going to live together in this world we must have a passion for equity and fairness.

Let us understand the broad implications of preference, understand and define well our progress and heed our promise not to fail as a Nation, at fairness. With our collective compass we will move in the right direction, with the right people for the right reasons Diversity is the application of democracy and I believe therefore life's greatest opportunity for equity and peace. Perhaps diverse people represent life's greatest symphony. With a moral compass, hope lies ahead.

While our talent bank is exponentially fuller than it was 20 or 30 years ago. It is encouraging to note that there is a pool of African American and other minority college graduates and it has increased in the last decade. Women have made impressive gains in entering the labor force, especially white females. These gains can be traced to affirmative action.

I must also caution you to continue to revisit the Glass Ceiling issues. According to the Glass Ceiling Report, a larger proportion of women and minorities continue to be locked into low wage, low prestige, and dead-end jobs that are not connected to any career ladder. Equally discouraging is the finding that equal educational attainment does not guarantee that Black men and women in particular are getting through the glass ceiling or they are fairly compensated. We have long been aware that equal educational attainment does not level the playing field for Black men and women. Although Black female occupational mobility shows an increase since 1964, Black women are still the most under represented group in executive, administrative, and managerial occupations on any educational level, when compared to Black men and white non-Hispanic men and women. While Black men and women with college degrees are more likely to be in executive, managerial, and administrative positions than Black men and women without degrees, the pattern for white women indicates a nearly equal proportion of white women with only high school education in the same top positions.

In 1995, minority and women correspondents were less visible on the network news program than in 1994, according to a new study by the center for Media and Public Affairs. This is the first time the percentage has dropped since the Center began assembling annual data in 1988. Last year, minority correspondents reported 12.5 percent of all news items on ABC, CBS, and NBC news shows, compared with 14 percent in 1994. Women reported 21 percent, down from 25 percent. (News and Notes, "Less diversity on camera," The Bergen Record, Thursday, February 15, 1996).

We also know that women-- especially white women-- are bridging the salary gap with men, but black and Hispanic women lag behind. Over the past 15 years, the gap in men's and women's pay has narrowed. Today, women earn 76.4 cents for every dollar earned by men, vs. 62.5 cents in 1979. But Black women earn only 66 cents of every dollar men earn, and Hispanic women earn 58 cents. (Gary and Susan Berger, "Women could be big losers if affirmative action falls,"

As I close I share a much loved quote.

"The real voyage of discovery consists not in seeking new landscapes but in having "new eyes." - Marcel Post with these "New Eyes".

We must ask America, "Oh say can you see real equity". Let's stay the course and make the moral difference.

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## AN INTERACTIVE DISCUSSION ON AFFIRMATIVE ACTION

### **Moderator**

Kristy Schloss

President

Schloss Engineered Equipment, Inc.

An engineer and environmental, small business, and women's advocate, Kristy Schloss is President of Schloss Engineered Equipment, Inc., a 98-year-old Colorado-based environmental equipment design and manufacturing firm. The company has a national and international reputation for quality water, wastewater, hazardous waste, and bulk-materials handling equipment. It is the only woman owned manufacturing firm in its industry in the USA.

Kristy has a B.S. in Civil Engineering from the University of Colorado-Boulder, and serves on the University's Engineering Advisory Council and numerous boards including the EPA Small Business Environmental Action Committee, Girl Scouts Mile High Council Board, the Colorado Women's Chamber of Commerce Foundation Board, and is Legislative Co-Chair of the Colorado Women's Leadership Coalition.

She is listed in *Who's Who Worldwide* and *Who's Who in Science & Engineering*, is the recipient of the National Society of Women Engineers Distinguished Engineer Award, the Coalition's Woman Leader of Excellence Award, and the Colorado Engineering Council Honor Award. Kristy is currently Region VII White House Conference Implementation Co-Chair, was appointed by Governor Romer to the Colorado State Board for Community Colleges and Occupational Education, and was recently appointed by the U.S. Department of Commerce to the District Export Council.

### **Recorder**

Jill S. Tietjen, P.E.

Assistant Vice President

Stone & Webster Management Consultants, Inc.

### **Presenters**

Steven T. Halverson

Regional Vice President

M.A. Mortenson Company

James Mejía

Executive Director

Human Rights and Community Relations

City and County of Denver



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## **Facilitated Discussion: An Interactive Discussion on Affirmative Action**

Jill S. Tietjen, P.E.

Assistant Vice President

Stone & Webster Management Consultants

Englewood, Colorado

Kristy A. Schloss

President

Schloss Engineered Equipment, Inc.

Aurora, Colorado

### **Panelists:**

Steven T. Halverson, Regional Vice President, M.A. Mortenson Company, Denver, Colorado

James Mejía, Executive Director, Agency for Human Rights and Community Relations, Denver, Colorado

Kristy Schloss, President, Schloss Engineered Equipment, Inc., Aurora, Colorado

joined by:

Dr. Yvonne Freeman, Provost and Vice President, Clark Atlanta University, Atlanta, Georgia

### **What is affirmative action?**

Affirmative action is about goals, good faith efforts, and opportunities. It is not quotas nor a welfare program. It is not unqualified individuals and it is not handing opportunities to anyone on a silver platter. It is providing opportunities for all qualified individuals and allowing all people to compete equally. It is also an extremely political and emotional issue in the country today.

### **Myths about affirmative action**

Five myths have been spread about affirmative action in the media. With thanks to *Working Woman* and other sources:

Myth 1: Women no longer need affirmative action.

Reality: Women now earn approximately 76% as much as men compared to about 60% in the mid 1970s. According to a study conducted by the Glass Ceiling Commission, working women are clustered in only a handful of industries. Nearly 75% of employed women work in business services (such as education, health care and nonprofit organizations), finance, real estate, insurance, and retailing. Although women make up 35% of the federal professional work force, according to the White House review of federal affirmative action programs, they hold 86% of the clerical jobs. Furthermore, women own 40% of the businesses in this country, yet receive less than 2% of all federal contracts.

Myth 2: Affirmative action rewards gender and race at the expense of merit.

Reality: In real life, the playing field is not level and the most deserving candidates don't always get the jobs. Standing in the way of the proverbial level playing field are nepotism,

brown-nosing, club ties, alumni considerations, corporate politics, and discrimination. The Glass Ceiling Commission found that white men with four or more years of college were 40% more likely to hold administrative, managerial, and executive positions than should be expected given their numbers in the work force. Similarly educated black women were underrepresented by 12% and white women were underrepresented by 33%. When matched pairs of candidates were sent on interviews for the same job, white men consistently received more jobs offers or advanced further in the hiring process than equally qualified women or minority men.

**Myth 3: Quotas are the backbone of affirmative action programs.**

**Reality:** Most Americans support the goals of affirmative action and equal opportunity, according to public opinion polls. When the words quota or preference are used, however, the support drops off. The only circumstance in which quotas are used is as a last resort, court-ordered tool to redress rampant discrimination uncovered as a result of a successful lawsuit. Under the Civil Rights Acts of 1964, vacant jobs must go to the most qualified candidates, no position can be held open until a suitable minority or female candidate is found, and qualified white men cannot be passed over in hiring or for promotions because of their color.

**Myth 4: Affirmative action has caused a backlash among white men.**

**Reality:** Affirmative action may be blamed for troubles in employment among white men, but the real issue appears to be limited opportunities. What with corporate downsizing, or rightsizing, or whatever the euphemism, there is an underlying insecurity among workers in America today. The economy is shifting as we become part of the global economy and the shifting sands make many nervous.

**Myth 5: If affirmative action is dismantled, diversity in the workplace will die too.**

**Reality:** In a survey of 140 CEOs of major companies, almost 75% said they would continue their own affirmative action programs even if federal or state laws were weakened or repealed. One reason is that the new entrants to the work force by 2000 are expected to be approximately 15% white male, 55% women (42% white, 13% minority), 7% minority men, and the rest immigrants. Another is that diversity improves business results. A more diverse work force also gives companies an edge in selling to a more diverse customer base, and as companies branch out globally, diversity becomes even more important. However, diversity in terms of top management may lag, as companies shove affirmative action to the back burner because it is difficult and draining.

### **Why should companies support affirmative action or diversity?**

Three drivers for affirmative action exist wholly apart from governmental and other political pressures, at least for the design and construction industry, in particular.

First, the design and construction industry needs a stable, long-term, fair environment for its business. The environment cannot be unfair, with social unrest. The environment must have social justice and stability in order for communities and businesses to wish to construct new facilities. All members of the community must have a fair shot at participation in order for the community to experience economic growth and prosperity. States that tend to be inclusive and fair tend to prosper; the design and construction business within those states will also tend to prosper.

Second, the changes in the workforce that are occurring are profound. The design and construction industry must be able to find trained and competent white and blue collar workers. The environment has to be a hospitable place for women and minorities to work



in order for the industry to be able to attract the talent that it needs. Individuals do not want to work in an environment that isn't comfortable. Industry leaders generally feel a need to provide a hospitable environment. Those enlightened ones understand that an hospitable environment is key to recruiting and retaining all qualified individuals.

Third, affirmative action is the right thing to do. People intuitively know the difference between what is right and what is wrong. Industry and organizations cannot rely on political pressure or promote divisiveness between groups. We are all trustees for the future. We need communities that work; that have a sense of social justice and fairness.

Industry has a financial stake in redefining or restructuring society for the benefit of the community. These skills are transferable to government and communities.

### **How should universities view affirmative action?**

The audience appeared to believe that universities were not as far along in implementing affirmative action as corporations.

The point was made that universities need to understand the demands of one of its customers - the organizations that hire its graduates. These organizations need to have a diverse work force in terms of women and minorities. The "product" the universities are producing (its graduates), therefore, needs to be diverse in nature. The product comes from many sources: there are about 16,000 school districts whose graduates attend approximately 3500 universities including 117 historically black colleges.

Education is needed for all groups in order to have an opportunity to start leveling the playing field. However, the point was made, that even with many well-educated women and minorities, top levels of management were still being filled almost exclusively with white males.

It may not be adequate or effective just to have an open door or level playing field for admissions of candidates to engineering schools. And GPA and test scores may not be the best indicators of educational success in college. Even with current admittance standards, attrition rates can be as high as 25% per year, so maybe GPA and test scores are not the best criteria for predicting success in an engineering curriculum.

In some cases, remedial math and science education may be appropriate to prepare students for the rigors of an engineering education, particularly if their preparation was not complete in these areas. Otherwise, the math and science requirements might be so overwhelming that engineering no longer is a viable career option. Some institutions offer special programs for academically at risk kids, such as summer programs to get them ready for college. These programs are not a panacea, kids still drop out, but some make it into engineering that wouldn't have otherwise.

There are proposal opportunities for enrichment programs for minorities, women, and the disabled through federal government agencies. The Jet Propulsion Laboratory has a model program for summer internships. There is a Geospace Academy for at risk youngsters. The new interface and equalizer is computer technology.

More women and minority faculty members will help make women and minority engineering students more comfortable. Most engineering colleges around the country are quite homogeneous. Role models and mentors have proven to be very effective in retaining women and minorities in the engineering profession.

**How can colleges work with corporations to place students, particularly colleges not generally found In the Top 20?**

Corporations need to realize that in order to get a diverse workforce, it may not be enough to recruit from the colleges they have always recruited from in the past. Mortenson has expanded its recruitment effort to include eleven new colleges with a special emphasis on diversity. They are also moving into "partnering" with colleges to support research, teach classes, and generally get to know students better to be able to identify unpolished gems, instead of just stars. Networking with high schools is also an area that Mortenson is investigating. A program being considered is sponsoring kids from when they are juniors or seniors in high school through college. Then when they graduate, they come to work for Mortenson.

**What can/should be done about the current political climate and governmental policies at all levels (local, state, and Federal) regarding affirmative action?**

In Colorado, there appears to be mixed support for affirmative action. On one hand, the Mayor of Denver established an affirmative action task force that developed policies regarding contracting and subcontracting. In addition, a joint budget committee in the Colorado legislature has appropriated money for a disparity study. Such a study is required to determine through rigorous scrutiny if there is proof of previous discrimination. If there is proof of discrimination, then appropriate affirmative action programs can be implemented.

However, statewide, two procedures with regard to employment and hiring have been withdrawn after challenges by the Attorney General. The citizens of Colorado may have an opportunity to vote on a ballot initiative in November 1996 that would repeal affirmative action in employment, hiring and contracting. The wording for the initiative has been cleared; signatures are currently being gathered and will need to be verified.

Affirmative action is not gone but groups across the country are trying to repeal it. One of the key roles of affirmative action was to provide opportunities - those opportunities didn't exist because of barriers in place. The pipeline of "qualified" women, minorities, and people with disabilities does exist, but social barriers preclude many of them from achieving.

**If affirmative action policies to date have not resulted in improved outcomes, are there alternative approaches that should be tried?**

Women are only 3.5% of mechanics and repairers, and only 1.9% of construction workers. Women are only 6.2% of boards of directors at Fortune 500 and Service 500 companies. Women are only 8.6% of engineers.

It was suggested that education is one of the most critical steps in removing impediments to women and minorities. Root causes should be addressed, "not the symptoms but the actual disease." Education from the pre-kindergarten level through college should be a possibility for all interested parties. And the group facing the largest challenge is women of color. Some reeducation of guidance counselors is probably in order.

Industry, state and federal agencies could benefit the educational system and youngsters at risk. Three ways to do this include community outreach, mentor-protégé relationships, and focus on people by providing job opportunities. Particularly key are summer jobs for

youths at risk. Many of these youngsters at risk have never had role models to show them how to get a job; how to be prepared to go to work. Many have never had someone take an interest in them; to give them the "Dare to be great" speeches. Support groups and support for individuals are needed.

More women and minority-owned businesses are needed, to build capacity in the industry. As such organizations are strengthened, there should be more business opportunities. Structural barriers industry by industry need to be recognized and worked through. For example, the design and construction industry has strong associational ties and requires high levels of capitalization. And there needs to be significant attention paid to utilization of the entire workforce.

#### **How can negative attitudes from affirmative action be combated?**

Women and minorities are often uncomfortable with the notion of affirmative action as their accomplishments may be minimized - they may feel that they were hired to fill a quota or selected for a job as the "token" but not qualified. Thus affirmative action may mean that some women and minorities are not viewed as competent or capable, and this may cause the women and minorities to believe that they are thus not competent or capable.

#### **Discussion conclusions**

It appears that affirmative action is being attacked from many sides. One reason could be the perception that after many years of affirmative action being in place, not much progress has been made when numbers of women and minorities in top management positions are examined. However, it also appears that many organizations believe that in order to be competitive in a global economy, diversity of the work force will be necessary. Universities need to turn out a diverse group of students; this objective would be aided by more diverse faculty. The engineering community has a lot of work to do to ensure that women and minorities are aware of the profession, are interested in pursuing an engineering education, and are welcome in the profession during their careers.

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## PROGRAMS AT TWO-YEAR AND COMMUNITY COLLEGES

### Moderator

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Mr. Vergelli has more than 31 years employment experience with IBM as a computer programmer, site manager of programmers and engineers, and human resources specialist. For the last 13 years, Mr. Vergelli has been with the IBM Corporate Office with responsibilities for national college relations and recruitment.

### Presenters

Judy P. Remsberg

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## COMMUNITY COLLEGE SUCCESSFUL INTERVENTION PROGRAMS: ATOMS, RSI, AND VOCATIONAL GENDER EQUITY

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### INTRODUCTION

The Mission Statement of Thomas Nelson Community College contains the statement, "As a community-based institution, TNCC strives to be responsive to the educational and skill needs of area businesses, industries, and government agencies." The following narrative describes three programs initiated to support this aspect of the college mission.

#### ATOMS and RSI

*Adventures in Technology = Options in Math and Science (ATOMS) and The Regional Summer Math and Science Institute (RSI)* are unique, successful programs that promote science, math, engineering, and technology interest at the middle school level. They are unique because they target the backbone of the future's workforce, the *average achievers*, who frequently opt out of the higher levels of high school math and science courses. In addition, these programs address a persistent lack of progress in mathematics and science by female and minority students. The documented increase in the students' interest in science and math after the series of ATOMS/RSI activities show that the programs are successful. More important, these students *enroll at a higher rate* in math and science courses than students who have not participated in ATOMS. *And, ATOMS students score higher on achievement tests* after the interventions than do their counterparts.

The ATOMS and RSI Pipeline Pre-college programs were initiated on the Virginia Peninsula in 1990 in response to a predicted shortage of workers with the skills and training necessary to meet the demands of the increasingly technical workplace of the next century. A unique collaboration of business, higher education and the public school systems on the Peninsula met to develop a program geared to the middle achiever, or "forgotten population." These high tech industries know that the future technicians are drawn from the middle third of the senior classes—not from the gifted or at-risk students. With appropriate education, these students are not only better citizens but are more employable.

The Pipeline Programs enjoy broad community support and exposure. Through the initiative of Thomas Nelson Community College and NASA, a loyal constituency has

been created that is strengthened each year. The premier high-technology employers on the Peninsula are active partners, making available talented, young, enthusiastic employees to serve in the programs. Approximately 150 technicians, scientists, and engineers from NASA Langley Research Center, the Continuous Electron Beam Accelerator Facility (CEBAF), Siemens Automotive, Canon Virginia, Inc., Newport News Shipbuilding, and Anheuser-Busch, Inc. eagerly re-enlist each year. All five Peninsula public school systems--Newport News Public Schools, Hampton City Schools, Poquoson City Public Schools, Williamsburg-James City County Public Schools, and York County Schools--participate. New Horizons Regional Education Center, a multi-school system career and technical training center serving secondary students, joined the partnership in 1993. Teachers, guidance counselors, and administrators in 19 middle schools and six high schools support the programs at their schools. Each partner industry sends one representative to sit on the Pipeline Advisory Committee. The combined talent and commitment of these individuals and organizations create the synergy that sustains the programs.

To date over 18,000 students have participated in the Pipeline Programs. Over 150 teachers, guidance counselors, and administrators help coordinate the programs, and over 150 technicians, engineers, and scientists volunteer their time annually.

#### PROGRAM DETAIL

The Pipeline Pre-college programs prepare middle school students with the information they need to construct a secondary school curriculum that will better equip them for post secondary education or the workforce. The major goal of the programs is to promote a positive attitude to mathematics and science. The more positive attitudes will result in increased enrollment in math and science at the high school level. Preparedness ensures that students have opportunities to pursue high-quality technological careers.

#### ATOMS/RSI Program Activities

Time Frame	Activity
7th Grade, Fall ATOMS	<i>Interactive career awareness presentation</i> - students listen to stories, brainstorm in small groups specific career responsibilities, and begin to formulate their vision for their personal goals.
7th Grade, Spring ATOMS	<i>Industry team presentation</i> - students participate in hands-on activities that demonstrate real-life applications of science and technology. Students may see a laser beam at work or measure an angle for piping used in submarine construction. Team members talk about their academic preparation and encourage students to take as much math and science as possible in high school.



8th Grade, Fall  ATOMS	<i>Site visits</i> - students tour the industry of the team that visited them in the preceding spring; Students may see robots moving parts to an assembly line or examine non-destructive metal testing. They meet women and men working with high-technology equipment in challenging and well-paid careers. This activity stresses the importance of teamwork, communication, and proper training.
8th Grade, Spring  ATOMS	<i>Campus visits</i> - students visit facilities that offer technical training such as Thomas Nelson Community College or New Horizons Regional Education Center. While on campus they participate in several activities, such as science and technology lab presentations, math or CAD lab demonstration, and a career center presentation. The campus visit also includes a panel presentation by students in technical programs. Students receive curriculum information at each area, participate in hands-on activities, and ask questions of TNCC student guides and instructors.
Rising 9th, Summer  RSI	<i>Summer Institute</i> - students participate in four weeks of intensive hands on activities designed to show applications of technology in the workplace. Students learn computer aided design, surf the internet, take part in a long distance video conference, learn about polymer chemistry by making silly putty, study fresh, marsh, and salt water ecology, apply teamwork and competition to design motorized vehicles, study the physics of motion, and investigate biological systems.

## EVALUATION and RESULTS

### Demographics

Demographic data for 1990 of the Virginia Peninsula show that 23.8% of the population is minority and 48.8% are female (10-14 years old). Demographic data on ATOMS students show that 50% were minority and 49% were female. Clearly the ATOMS program is successful in soliciting minorities and females.

### Iowa Test

ATOMS students' math and science achievement scores from the fifth grade were near the district average. After participating in ATOMS, a t-test analysis showed that students scored significantly higher than their peers. (.95 confidence interval)

#### *Comparison of ATOMS and General School District Scores Before and After ATOMS*

ITBS scores/Grade level	ATOMS		School District	
	Math	Science	Math	Science
5th grade	134	146	132	140
10th grade	177	191	171	183

Student surveys are used to evaluate the existing ATOMS program. These are distributed immediately after each intervention. The students respond to a statement of interest in the activity using a likert-like scale ("very interesting" to "not interesting at all"). Questions on this survey include those that check on the students' increased understanding of the world of work, importance of math and science, and the need for high technology education. Teachers and counselors also complete a survey that requests their opinion of how they feel the students receive the interventions.

#### Representative evaluation statistics for ATOMS 7th and 8th grade components:

- ☛ Over half (62%) indicated that they had a better understanding of what is involved in high-tech careers.
- ☛ Well over one-half (66%) said that they have a better understanding of why math and science are important school subjects.
- ☛ Over one-third (37%) said that they think a high-tech career is what they want.
- ☛ Almost one-half (49%) indicated they were more likely to take higher-level math courses in high school.

#### Class Enrollment

Minimum science credits are usually earth science in the 9th grade followed by biology in the 10th. Students may elect not to enroll in any science course beyond this point. In the 11th grade, students who are advancing through the ATOMS/RSI Pipeline Programs should be enrolled in chemistry and either geometry, algebra II or trigonometry. When compared to all 11th graders, RSI students are significantly more likely to enroll in these courses as shown in below.

*Comparison of RSI and Non-RSI 11th & 12th Grade Students Enrolled in Geometry, Algebra II, Chemistry or Higher Academic Year 1993-94*

RSI Class	Geometry/Algebra II or Higher		Chemistry or Higher	
	RSI	Non-RSI	RSI	Non-RSI
11th - (1991)	87.0%	67.7%	87.0%	47.6%
12th - (1990)	78.3%	56.2%	34.8%	32.1%

#### Test of Science Related Attitudes (TOSRA)

The Regional Summer Institute utilizes the *Test of Science Related Attitudes* (TOSRA) that is statistically reliable and valid. Students take this test on the first and last days of the summer institute for comparison purposes. The results show a pattern of attitude change in relation to "Science career," "Scientific inquiry," and "Adoption of

scientific attitudes." The survey consists of seven sets of 10 questions each relating to seven areas of science interest. The students responded to each statement using a Likert-like scale of five choices ranging from "strongly agree" to "strongly disagree."

In all gender and race categories, the attitudes were more positive after participation in the RSI program than before. There was a significant increase in the Career Interest in Science for female RSI students (+7.8%) and white RSI students (+10.1%). The minority student raw score average (38.5) on Adoption of Scientific Attitudes shows a more positive attitude than all other categories of RSI students.

### Tracking

The tracking system presently on a data base at the Department of Energy agency, CEBAF, (an ATOMS partner) will be an invaluable source of evaluation.

Enrollments in math and science and grade achievement will be the measures for student success. Tracking also includes standardized scores, extracurricular activities and post graduation plans.

### FUNDING

A grant from NASA provided startup funds for these programs. The partner industries also have contributed to an endowment to fund the programs in the future. TNCC currently funds 50% of salaries and supply expenses. Each school system supports the programs by providing transportation to industry sites and campus visits and for the 4-week summer program. Additional support provided from the school teams consists of math and science teachers, a guidance counselor, and an administrator. These teams attend the fall orientation/training and work with the ATOMS/RSI students through the school year.

### SUMMARY

The ATOMS/RSI Pre-college programs respond to the college mission statement by preparing middle school students with information they need to construct a secondary school curriculum that will better equip them for technological training after high school. More positive attitudes toward math and science are self-affirming for the course choices needed for technological training. Higher scores on achievement tests give ATOMS students the opportunities to pursue the academic technology curricula. The 1995-96 school year will see the first ATOMS students graduate from high school and begin to enter academic training, college, and the workforce.

While acknowledging the effects of multiple intervening variables, it appears that the exposure to technology-based careers and *real-world* applications of math and science through the ATOMS program does indeed motivate students to consider those careers and to enroll in appropriate classes. Longitudinal data on student enrollment in mathematics and science will provide evidence of the long-term effect of the program.

## VOCATIONAL GENDER EQUITY

The Regional Center for Vocational Gender Equity (VGE) is completing its sixth year of service to participants and to the Peninsula community. The Virginia Department of Vocational Gender Equity awarded Thomas Nelson Community College a grant that provided Carl Perkins funds for the creation of a regional vocational sex equity center on campus. The initial goal was to establish and operate a center. The primary mission is to serve the career development, referral, job training and placement needs of the target population.

The primary population served by the center is single parents and displaced homemakers living on the Virginia Peninsula--Hampton, Newport News, York/Poquoson, and Williamsburg. Many of these students live at or below poverty and lack the skills to seek employment at levels that would enhance their quality of life. The program enrolls fifty to sixty people each semester. The philosophy of the program is to promote educational and career opportunities and to inform all students of their rights to choices from the full career spectrum and to the best education possible. Expanded educational opportunities, with a focus on work force preparation contribute to the economic development of the Virginia Commonwealth. Many participants are welfare recipients who exit the welfare system because of their participation in the VGE program. In this regard the program is consistent with and supportive of the Virginia Welfare Reform Initiative.

Another goal is to provide instruction and support services for nontraditional career choices. The program at Thomas Nelson Community College is unique in the Virginia Community College System. Seventy-five percent of the participants are enrolled in nontraditional programs such as women in architecture, mechanical technology, air conditioning/refrigeration, automotive technology, electronic technology, administration of justice, and men in nursing. The remaining 25 percent may be enrolled in traditional majors.

During the six years the program has been in operation, 34 participants have graduated, approximately 15 have upgraded their skills for better employment, and ten have continued their education at a four-year college in a nontraditional career field. There are program participants on the President's Honor Roll, Dean's List, Merit List, and Phi Theta Kappa National Honor Society. This group comes from various backgrounds and a range of ages but has a common cause-- to attain a better future through education.

Through small and large group meetings, VGE offers a variety of programs, workshops, and information to its participants. Programs include career planning, parenting and lifestyle planning, exploration of the gender-role stereotyping (and its negative effects), and vocational gender equity and its advantages for men and women. Each of these components helps make the program successful.

## FEMALES INVOLVED FROM REGIONAL SCHOOLS IN TECHNOLOGY AND ENGINEERING (FIRSTE): OVERCOMING THE CHALLENGE OF RECRUITMENT

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### JUSTIFICATION

Seventy-three percent of the increased college and university enrollment in the last decade is attributable to women, according to the Department of Education's Center for Education Statistics. In 1991, a greater proportion of female high school graduates (67.1) enrolled in college than male (57.6). Although the trend continues with an increased percentage of females (52.0) planning for doctoral or advanced degrees in 1993, a study of the five most often planned fields of study by 1993 seniors indicated "about 81 percent of those who chose engineering were men."<sup>1</sup>

According to the 1994 edition of *Information Plus*, although "women have made important inroads into the life, physical, and computer sciences" they still lag behind men proportionately "in degrees of all levels of physical and computer sciences, and especially in engineering where they earned about 15 percent of the bachelor's and master's degrees and only 9 percent of the Ph.D's."<sup>2</sup>

The FIRSTE program provides a vehicle for Penn State University and the New Kensington Campus to capture the interest of this growing community of college-bound young women, and to introduce them to nontraditional careers in engineering and engineering technology.

### PROBLEM STATEMENT

The Registrar at the New Kensington Campus reports that less than 10 percent of enrolled engineering and engineering technology students are female, and proportionately fewer are of a minority group.

The problem is twofold: 1) young women are seldom encouraged by school teachers or counselors to consider or investigate careers in engineering because engineering continues to be a traditionally male choice, and 2) we are not reaching female and minority candidates early enough to encourage and guide them in preparation for matriculation in engineering or engineering technology.

### PURPOSE

The objectives of the FIRSTE program are to foster involvement of females in engineering and engineering technology careers by reaching them during the career-formative years

and, consequently, increase recruitment efforts and enrollment at Penn State University and the New Kensington Campus. This effort is in direct relation to the New Kensington Campus Recruitment and Retention Plan (Objective 3) which seeks to "integrate women from diverse educational backgrounds into the engineering and engineering technology programs at the [PSNK] Campus to ensure their success and retention."

The New Kensington Campus' size and low student-to-teacher ratio (18:1) serve to "foster students' abilities" (Goal E). In surveys conducted at the New Kensington Campus students consistently indicate that the personal interaction offered by the academic community (i.e., advising and mentoring) has enhanced their academic success. Consequently, our campus serves as an excellent transition for students who must transfer to University Park in order to complete their degree in a four-year engineering program or, for students' direct involvement in the operation of machines and equipment, enrollment in one of our excellent Engineering Technology programs completely housed at the New Kensington Campus.

### APPROACH

Informational brochures and application forms are mailed to 9th through 11th grade students via community high school contacts within an approximate 25-mile radius of the campus, and to 25 minority churches and organizations. Students express an interest in the program by submitting the application form (in 1994, 30 applications were submitted), and 12 are selected. The "undecided" and minority females are given selection preference over those who have already chosen engineering or engineering technology as a career. Once selection is made and acceptance confirmed, the students and their affiliate schools are listed in a news release.

In order to improve upon recruitment strategies, a formal FIRSTE Planning Committee was recently established, consisting of the two program directors and two female engineers from local industries. It was decided that visitations to area high schools, not limited to the 25-mile radius, are necessary and should coincide with National Engineer's Week (February 19-23, 1996). By direct distribution of the program materials, the committee hopes to expand its audience by attracting young females who are rather indifferent toward engineering/ technology/science-related fields as a career.

The brochures will be revised to include quotes from former FIRSTE participants for better appeal. Eventually, successful participants will be asked to return to the program, which they themselves had passed through some years earlier, but in the capacity as mentors. Hopefully, this activity will encourage these same women to become active in the recruitment of young females into engineering.

One member of the planning committee has contacted various professional societies within the area as possible sources of funding as well as to promote the FIRSTE Program. Interested members could be approached to serve as mentors or program volunteers. In any case, they will be asked to market the program should such opportunities arise.

Increased contact with local industries is also essential to the visibility of the program. By the strengthening of such ties, the Penn State New Kensington Campus could potentially recruit the children of these corporations such as suggested by the current corporate sponsors. It is this sort of involvement which could prompt even greater support from the industries within the service area.

## PROGRAM AGENDA

The proposed agenda for the 1996 Summer FIRSTE Program includes "hands-on" workshops, which are held to stimulate an interest in and provide a realistic view of engineering and science-related careers. Under the direction of select faculty and staff, these sessions span the course of two days and generally run for one or two hours. Topics include biomedical, chemical and mechanical engineering, biotechnology. Also computer-aided drawing is introduced, and the participants then apply these drafting skills toward the creation of a design project of their choice. They also receive training on the World Wide Web.

In addition to workshops, a tour is conducted at a local engineering firm or corporation so that these young women can observe the engineering workplace, current methods and techniques, and women in engineering careers at work. This past year, Cheryl Richards, a senior research engineer with PPG Industries, arranged a tour which illustrated the processes required in the manufacture of fiberglass. Previously, Alcoa and Westinghouse arranged similar field trips to their sites.

In order to establish role models, female engineers employed in local industries are invited to participate as mentors. This informal session serves as an opportunity to discuss any concerns or questions that the participants may have regarding engineering and for the mentors to share their personal and professional experiences as well.

The program concludes with the recognition banquet in which parents are invited to share in the achievements of their children. At this time the creative design projects are judged and prizes are awarded to the winning team.

## BUDGET

The total cost of the FIRSTE Program for 1995 was \$3,761.15, thanks to cost containment, volunteer efforts and creative programming.

Equal Opportunity Planning Committee (EOPC) contributed \$780 toward lodging and meals for the participants and their parents along with unit support of \$1,200 by the Penn State New Kensington Campus to cover faculty. Additional funding of \$1,500 was awarded by the Division of Undergraduate Studies through a Diversity Grant to cover mailings, copying, supplies and meals. General support was also provided by PPG Industries in the form of transportation services and a luncheon.

The cost of the FIRSTE Program for Summer 1996 is estimated at \$4,500.

## OUTCOME

This summer, the participants from the first three years were surveyed by phone. Of the 36 contacted, 17 had reached college age. Six have chosen a science-related field. At least 8 have selected engineering as a career choice, most notably architectural, environmental and biomedical, with 7 of these planning to attend Penn State; 4 particularly at New Kensington Campus. In fact, a 1995 FIRSTE participant has committed to engineering at Penn State New Kensington Campus as a direct result of her involvement in the program.

The influence of the FIRSTE Program is further reflected in some of the participants scheduling Applied Chemistry rather than General Chemistry, in order to better prepare

themselves. Another student is taking an additional calculus course even though it is not required for graduation.

The highest GPA among the 21 participants is 4.3; the lowest, 2.7. It appears that the FIRSTE Program has encourages its participants to set high standards for themselves with the realization that their goals can, in fact, be achieved.

No official survey was distributed to the parents because they were directly involved at the recognition dinner. All parents expressed their support for this kind of program and extended sincere appreciation for the committee's efforts.

<sup>1</sup>"Women's Changing Role," *Information Plus*, ed., Alison Landes, Carol D. Foster, and Cornelia B. Cessna, Wylie, Texas, 1994 Edition, pp 142-145.

<sup>2</sup>Ibid.



## NEW WAYS OF LOOKING AT ENGINEERING EDUCATION: TQM

### Moderator

Marjorie A. Leavene

Assistant to the Dean

University of Missouri-Columbia

Prior to her recent appointment as Assistant to the Dean, Ms. Leavene served as Coordinator of Student Services for the Missouri University College of Engineering. Responsibilities included the recruitment and retention of women and minorities in engineering. Though she has had to give up many of her student responsibilities, she is still in charge of a freshman seminar series designed to help freshmen make the adjustments to college life. She is also the academic advisor for the academic housing arrangement for women in engineering, and works closely with the student chapter of the Society of Women Engineers.

Ms. Leavene received her degree from the University of Missouri-Columbia in Business Administration.

### Presenter

Deborah J. Walter

Ph.D. Candidate, Electrical Engineering

Pennsylvania State University



## EVALUATING THE IMPACT OF TWO INITIATIVES

### Moderator

Patricia Berry Glassner  
Director, Women in Engineering Program  
University of Colorado, Boulder

Patricia Berry Glassner received her Bachelor's degree from the College of Humanities and Social Sciences at Carnegie Mellon University. Ms. Glassner spent fourteen years in various staff and management positions at IBM. She became Director of the WIEP at the University of Colorado, Boulder in June 1993. She is involved with many volunteer activities including the Parent Guild, Volunteer Manager for the Boulder Creek Festival, and Committee Chair/Past President of Up With People International Alumni Association.

### Presenters

Caroline Carvill, Ph.D.  
Associate Professor for American Literature  
Rose-Hulman Institute of Technology

Susan L. Smith  
Director, Learning Center and  
Assistant Professor, English  
Rose-Hulman Institute of Technology

Christine M. Cunningham, Ph.D.  
Project Director, Institute of Science and Environment for Teachers  
Cornell University



**THE YEAR OF THE WOMEN: A Report on the First Year of Coeducation at  
Rose-Hulman Institute of Technology**

**Caroline Carvill and Susan L. Smith**

**Rose-Hulman Institute of Technology  
Terre Haute, IN**

In the fall of 1995, Rose-Hulman Institute of Technology admitted undergraduate women for the first time in its 121 years of existence. By June 1996, we will have completed our first full year as a coeducational institution. Drawing on statistical data, observation, and personal interviews with students, faculty, and staff, we will assess the impact of this change on our first female students and our educational environment. In this presentation, we will discuss the three primary stages involved in successfully changing from an all-male environment to a coeducational institution: preparation, implementation, and evaluation.

From the time that the Rose-Hulman Board of Managers voted to change the school's charter in 1991 to the enrollment of the first female undergraduates in 1995, administrators, faculty, staff, and students worked together to change the climate of the Institute, both physical and human. One of the most successful steps was forming a consortium with Indiana State University in 1994 which allowed eleven female students planning to attend Rose-Hulman in 1995 to cross-enroll. These women took introductory calculus and chemistry courses at Rose-Hulman, while taking military history (a freshman requirement at Rose-Hulman), humanities and social science courses at Indiana State University. Through this agreement, all women were housed on the same residence hall floor at Indiana State, and Rose-Hulman provided daily transportation, approximately 8 miles one way, to and from campus. Initially, the women were to have access to computers on both campuses; however, students often found themselves returning to the Rose campus in the evenings for their computer support needs. Eight of the eleven women entered Rose-Hulman as sophomores the following year. These women, four chemical engineering majors, two mechanical engineering majors, one civil engineering major, and one physics major have served the Rose community in a number of capacities ranging from some being summer program counselors to others being sophomore advisors.

To plan programs, provide resources, and better familiarize the Rose-Hulman campus with issues related to gender, the President of Rose-Hulman appointed eight faculty and eight staff members to serve on the Commission for the Implementation of Coeducation. The committee began by viewing such videos as *Tale of 'O'* and *Class Divided*, identifying key areas and topics to be addressed, and reading materials

**WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES**  
**1996 WEPAN National Conference**

related to learning styles and myths such as *Women's Ways of Knowing*.

During the 1992-93 academic year, four female speakers/consultants -- the President of WEPAN, the Director of a Women's Study Program, an Educational Consultant, and a Nuclear Energy Industry Consultant-- visited campus to meet with faculty and students. Rose-Hulman also hosted the Regional Meeting of the American Society of Engineering Education and a panel of female engineers from Alcoa who discussed their experiences in the corporate environment.

During 1993-1994, Rose hosted representatives from industry and education ranging from a Human Resource Consultant from Dupont Corporation on "Diversity- A Corporate Perspective" to representatives from Texas Instruments to the Chair of the Chemistry Department of Eastern Michigan. Rose was especially excited about welcoming Janice Ford, an astronaut from the National Aerospace and Science Administration, to campus.

External speakers presenting workshops in 1994-95 included Anne Fausto-Sterling discussing "Myths of Gender and Biological Theories about Men and Women" and Alisha Waller on "Gender-based Communication Styles."

Sub-committees of the Coeducation Implementation Commission led the internal efforts to educate and inform the campus community about the transition process. One committee developed and published the *Coeducation Update*, a newsletter, highlighting events and articles related to coeducation. Another committee, led by Dr. Caroline Carvill and the Director of the Library developed and presented a Classroom Climate seminar to individual academic departments. Susan Smith developed and coordinated Fast Forward, a summer residential program to interest middle school girls in math, science, and engineering, which became a reality in the summer of 1994. Catapult, an existing three-week summer engineering and science program for high school juniors began admitting females in the summer of 1994. From 1992-1995, Rose regularly sent administrators and faculty to the WEPAN Midwest Regional Training Seminar and the National WEPAN conference. In addition, our library's resources relating to the recruitment and retention of women in science, engineering and mathematics grew significantly. Funding for both external and internal activities was provided by the President of Rose-Hulman, the Rose-Hulman Board of Managers, and the Sloan Foundation.

In addition to changes in the human climate, a number of physical changes occurred on campus. Written documents, such as Admissions materials, were revised to reflect the Institute's transition to coeducation. Gender specific phrases were eliminated to better portray the new learning environment and to offer greater appeal to potential female undergraduate students. Academic buildings were remodeled to provide additional women's restrooms. The Residence Hall Coeducation Committee consisting of Student Affairs staff and students suggested needed changes related to



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

campus housing facilities. Existing residence halls were updated and modified by installing external locks on residence hall stairwell doors and remodeling restrooms. To provide all students with an increased sense of security, emergency call boxes and additional lighting were installed around campus, and two student night host positions were established to monitor residence hall activity and help ensure student safety.

The first freshman women arrived on campus in mid-August to attend Fast Track Calculus, a program for exceptionally strong students which condenses first-year calculus into a few weeks. By the time the fall quarter began, 100 women (almost 25% of the freshman class plus some transfer students) enrolled as full-time undergraduates. Female transfer students, especially those serving as Resident Assistants and Sophomore Advisors, played a vital role in acclimating freshman coeds to all academic and extracurricular aspects of student life.

The week before classes begin, all freshman students participate in our intensive orientation program. As part of that process, students go through extensive testing. Many of these tests showed little difference between the male and female students, but a few did provide varying results. The Predicated Index for grade point average for male students was 2.87; for women 3.02. The math SAT scores were 687 for men, 686 for women; verbal were 563 for men, 596 for women.

Students take a variety of skills and conceptual tests. The Force Concept Inventory, which measures belief systems for Newtonian concepts, and whether those are accurate for motion and force, shows the differences between students' assumptions and the correct answers. On this test, men scored 16.2, and women 11.5. Hestenes' Mechanics Baseline test assesses students' knowledge of basic concepts in mechanics. Men scored 10.2 and women 8.6. The California Critical Thinking Skills Test and Dispositions Inventory assesses five cognitive skills: analysis, interpretation, inference, evaluation, and explanation. Here we saw little difference, with men scoring 118.4 and women 118.2. On the Cognitive Complexity Index, men scored 335 and women 336.

Differences also showed up on responses to the National Institutional Survey. Women students indicated their own level of competitiveness lower than the men (56% to 71%), but their level of stubbornness higher (71% to 47%). In reasons noted as very important in deciding to go to college, to gain a general education and to become a more cultured person ranked higher with women (75% to 52%; 47% to 24%), while making more money ranked lower (68% to 85%). When questioned about objectives considered to be essential or very important in life, women ranked promoting racial understanding, participating in community action, and being involved in environmental clean-up higher than men, while ranking raising a family lower (60% to 79%). More women anticipated graduating with honors (28% to 15%), getting a job to pay expenses (58% to 45%), and participating in volunteer/community service (34% to 12%).

For academic majors, freshman women declared in different patterns than men. Over 25% declared chemical engineering, about 18% for men, 7.5% in chemistry, about 2.5% for men, and 12.5% in mechanical engineering, over 25% for men. More women also declared physics and applied optics than men students.

Women students succeeded at Rose-Hulman by all standards. The grade point averages after the first quarter were 3.00 for men, 2.98 for women. Only two women students left during the first year--one for academic reasons and one for changes in career plans. They participated in student government, student clubs and organizations, tutored in the Learning Center, and many other activities. A chapter of the Society of Women Engineers formed with 23 students.

Rose-Hulman responds to student interests in forming clubs and chapters of national organizations. Two groups of women formed sororities (or women's fraternities). These two groups contacted national organizations, hosted several different ones on campus, set up chapters, went through the process of becoming nationally recognized, and formed the first chapters. Chi Omega and Delta Delta Delta both initiated their first pledge classes in the spring of 1996, after a great deal of hard work by the charter members.

The first women's basketball team, made up of six courageous young women, played a full season, coached by Wanda Schwartz, who began in May of 1995. While not successful in the win/loss column, they generated a great deal of fan support and a quick rivalry with St.-Mary-of-the-Woods College from West Terre Haute. Women athletes also participated in cross-country, indoor and outdoor track and field, and swimming. This fall, Rose-Hulman will also field women's volleyball and tennis teams.

Surveys, focus groups, and informal discussions have all reflected that women students are pleased with their decision to attend Rose-Hulman and feel that the campus has welcomed them. With all the emphasis on the women's satisfaction levels, we cannot overlook the significant impact they have had on Rose-Hulman. Diversifying our student body has resulted in many positive changes, both obvious and subtle, in the academic and co-curricular environment.



## FACTORS INFLUENCING WOMEN'S PURSUIT OF A COLLEGE SCIENCE MAJOR OR SCIENCE CAREER: AN EVALUATION OF THE WOMEN IN SCIENCE PROJECT (WISP)

Christine M. Cunningham, Mary L. Pavone, Carol Muller

Dartmouth College, Hanover, N.H.

This paper reports the results of a formative evaluation of the Women in Science Project (WISP) at Dartmouth College. Through paid research internships for freshmen, peer mentoring, career workshops, industrial site-visits, seminars with women scientists, study rooms, and an electronic newsletter, WISP aims to increase the number of first-year women students enrolling in, majoring in, or pursuing a career in science and engineering fields. Particularly unique to Dartmouth's program is the paid scientific research internship for freshmen. This is a highly unusual approach to undergraduate instruction in scientific research; research experiences are usually reserved for upperclass science majors, most often seniors, and tend to be focused on preparation for graduate study.

### EVALUATION OVERVIEW

The multimethod evaluation of WISP collected quantitative and qualitative data from questionnaires, interviews, focus groups, Dartmouth College Records, and biweekly journals. Data from two freshmen classes, rising juniors, and seniors was used to assess the impact of the WISP program and distill some of the crucial decisions and factors affecting women's choice and pursuit of a science major. This paper focuses on the internship experience of the participants in 1995; more specifically, it reports findings from one data source, an internship journal.<sup>1</sup> As Sheila Tobias' work has demonstrated, student journals can provide in-depth documentation of participants' attitudes and experiences. The journals not only served as an evaluation tool, they also encouraged interns to reflect further upon science and their internship. Biweekly throughout the two terms of the internship in 1995, the evaluator e-mailed the 100 interns nine open-ended reflective journal questions that focused on: 1) Initial impressions 2) Internship responsibilities 3) Communication in the lab 4) Sources of frustration 5) Non-scientific understandings gained from the internship 6) Issue of women in science 7) "Culture" of science 8) Influence on personal views about science and scientific abilities 9) Review of highs and lows of the internship experience. All 900 of the journal entries were read and coded using thematic categories. The entries were analyzed on two levels, by question and by student.

### FINDINGS

Six major themes emerged from the interns' responses—themes that pervaded the questionnaire and interview data as well. The topics address characteristics of science and science teaching that encourage and discourage women's interest in science. Journal responses offer convincing testimony of the role an internship experience can play in helping women more accurately understand what scientific research entails, in increasing women's

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<sup>1</sup> A more extensive report of these findings, and those from the evaluation are available. Requests should be directed to Christine Cunningham, 111 Kennedy Hall, Cornell University, Ithaca, NY 14853 e-mail: cmc3@cornell.edu

confidence in their scientific abilities, and in influencing women's continuation in (or in some cases, departure from) science.

## 1) CONFIDENCE

*WISP does a great job of trying to help alleviate the sexism and the psychological constraints women in science have to confront. So many times, the difference between a woman majoring in science or in a field of the humanities is sheer lack of confidence.*

In their journals, interns vividly described the impact that their research experience had on their confidence in their scientific abilities. Initially many of the interns wrote that they felt overwhelmed by their internship and the background knowledge that they lacked; however, by the end, the experience had "taken away the mystery of the lab" and convinced them that they are capable of doing science and scientific research. For many interns, success in "real science" counterbalanced their doubts about their scientific aptitude that their "low" grades in their science courses raised and encouraged them to continue in science. "The encouragement and experience of my internship made me feel like I can make it {in the scientific world} even though I may not always feel that way as a result of my science classes."

The experience students gained in their internships promoted confidence that affected their coursework. Exposure to science techniques and content made them more comfortable in their classes and helped them perform better. Interns explained how actual hands-on experience helped make classes easier because it made theoretical learning more relevant.

*I am able to see that the stuff we learn in class, which oftentimes seems rather irrelevant to the real world, really is used. My confidence in my scientific abilities has definately {sic} increased since first term.*

The internship also increased their confidence in working, "with other people, and on group projects, as well as communicating with professors about problems."

A first research experience can open the door to future experiences in scientific research. Some women who had laboratory experiences in high school came to Dartmouth seeking more; the internship experience had a similar effect on many of its participants. Students wrote that their internship helped them develop the desire and the confidence in their science abilities to apply for summer jobs and additional lab experiences; about 60% of the interns indicated that they hoped to seek another research position.

The responsibility that the mentors gave interns was one factor that contributed to students' increased confidence in themselves. Interns were surprised by their mentors' trust in their abilities and the freedom that they were allowed to pursue their own ideas and make their own decisions. The confidence that the mentors displayed in the interns often rubbed off on the interns themselves. The fact that sponsors solicited interns' opinions and valued their input boosted students' confidence.

*I'm starting to give more value to my own opinions. No one can tell me exactly what I am supposed to do, so when my prof asks me what I think it is not just an empty gesture, but a genuine request, because I am the one most familiar with the data*

Some of the interns found the unfamiliar lack of guidance and structure stressful. Many women feared "messaging things up" or making mistakes. Women described how answers in science classes and labs are either right or wrong and leave little room for revision or second chances—students strive to attain a known outcome. Interns enjoyed real research because the pressure associated with making a mistake was removed; a "failed" experiment no longer translated into feeling like a failure.

*My internship...has changed my view of myself in relation to science. I was very timid at first in the lab, I felt like I know {sic} nothing and it bothered me a little. But now I realize that it's ok to not know, that the whole thing is about learning, about trying different things to get things to work, about experimenting. And it doesn't always work, but that doesn't mean that you should lose confidence in yourself.*

During their internship, participants came "to understand that there is no failure in science-- maybe things don't work out, but you can just do it again!" and that there are many questions that don't have answers. Hearing graduate students and faculty discuss their own frustrations, failures, and lack of knowledge seemed to reassure freshwomen that their own such feelings did not signal incompetence, but rather were inherent in the practice of science.

## 2) PERSONAL CONTACT AND TEAMWORK

The close, personal contact with people in science that the internship experience fosters is the most valued, important aspect of a WISP internship. Throughout the journals, interns cited their interaction and work with peers and lab members as an influential, necessary, and unique opportunity during their freshman year. Large introductory classes and impersonal departments turn women away from science majors—many miss the close interactions they had with teachers in high school and are intimidated by the aura of professors. In their internship setting, interns came in contact with other members of the lab (graduate students, technicians, upperclassmen); these people offered them support, advice, career counseling, mentorship, and friendship. By exposing the human face of science, the internship contradicted stereotypes about science and made it more appealing:

*WISP has made me realize that science just isn't the impossible, foreign world that it is so often made out to be. I suppose it has humanized the field. The lab I am involved with is full of people truly concerned with scientific problems. They all put so much energy into their research and they care so much about getting helpful results.*

Women frequently mentioned their friendship and conversations with fellow researchers and were struck by their co-workers' willingness to help or answer questions about academics and research as well as career and personal lives. A highly valued aspect of the internship program was the opportunity that it afforded women to glimpse the life a researcher leads both inside and outside the lab. Many freshwomen wondered about balancing a career in science with a family and other personal interests; contact with lab members demonstrated that the two worlds are not incompatible. The internship provided an understanding into "not only the academic part of the 'scientist' lifestyle, but also an insight into what kind of life a scientist leads away from the laboratory."

Interns' informal interactions with faculty fostered different types of relationships and contact outside the classroom helped to make the professors and their departments approachable. Some internships spawned close mentor-mentee relationships and friendships; some of these will continue as interns solicit their sponsor to act as their academic or thesis advisors, continue to work in the labs, or who occasionally touch base.

*I think it was a great opportunity for me to meet professors and other faculty members at the engineering school where I work. I now feel more comfortable asking a faculty member that I know there for help or opinions. It's nice to recognize faces when I go through the building to my classes.*

The interns also had the opportunity to look to the people (especially women) in lab as role models. Interns found their co-workers' work inspirational and their enthusiasm contagious.

*The women in the lab with whom I work all seem to be very intelligent, hard-working, dedicated individuals, and I find it very inspiring to work along side of them. They always offer me advice and try to encourage me when I start to question my abilities in science. I think that this environment has helped me a great deal. I am learning so much about science and research, and it is wonderful to use the women in my lab as models of what I can become with hard work.*

Interns contrasted the support and encouragement of lab members with their experience in college laboratories. The competition that prevails in many science courses is one of the factors that interns cited as a major deterrent to a major in science. Interns imagined labs as intense, competitive workplaces. However, they discovered that this is not so. The relaxed, social atmosphere of the labs in which people "work hard and play hard" was attractive to the women. Many women regarded the internship as a social and support network.

*It was obvious to me that they [lab members] respect each other and will help each other out when they can. The support network was very refreshing. I used to think that like*

*college, the scientific world was dominated by cut throat competition, however, that is not true.*

Part of what made the experience so meaningful to the interns was their inclusion in their lab's research "team." Interns commented on the fact that they were treated as a valued member of their research group instead of an employee that did only grunt work. Having assigned space and materials, attending weekly lab meetings and social events, and working on their own research project that interfaced with other projects in the lab, communicated to students that they were accepted as equals and that their work was important.

Many students who regarded science as an isolated endeavor were pleasantly surprised by the community that existed between members of the lab, between labs at Dartmouth, and between researchers worldwide who investigated similar questions. "I realized science is about team work. I had always had a picture of the lone scientist conducting research in a quiet desolate lab, but it's not at all like this. That's good." Working with people, doing something for people, and doing something useful were considerations that students cited as important ones in choosing a career. Thus, realizing that scientists interact with their colleagues, might influence some students to consider research as a career.

### 3) THE BIGGER PICTURE

One characteristic of science classes that discouraged women was the lack of personal connection with or practical applications of the material they studied. Interns described the important role that the internship played in helping them to situate abstract course content in a larger context. Women contrasted the difference between "just sitting and listening to abstract concepts being explained" in class with doing "actual work to get tangible results" in their lab. But, the uniqueness of an internship experience stemmed from more than just having a hands-on experience; science course labs, too, permit students to work with materials. What set the internship apart was that it entailed doing science that interns perceived as worthwhile—it was not just a verification of an existing fact.

*I feel like I am actually going somewhere with all this, as if I will be doing something hands on, for the first time in my life!... the research is really worth while, and it means a lot to me personally to be part of it. I think that I was expecting something a bit like the class room, where I was never integrated into what was REALLY happening.*

The interns explained that their work was often important for other members of their research team. What they do, and how they do it "counted" not because they were getting a grade, but because their work and results will be used in the future: "It also excites me to know that the work I am doing will have meaning and could be useful to other people." Situating concepts and research in their larger context served to excite students about both lecture and lab science classes. The internship research helped students to see how and why their book knowledge is important and prompted some interns to take science classes to better understand their research project

The "bigger picture" about why they were conducting the research helped students put the details and work (which they realized is often quite tedious) in perspective. The realization that their work could potentially make an impact by generating information that might help solve a problem—intellectual, physical, medical, or social—motivated students to continue their work and their science studies.

*I loved every minute of it, even the times when I thought I would collapse, because I kept thinking to myself that "this is the real world. This makes a difference. What goes on in this lab matters to the whole world."*

### 4) CAREER PLANS

Many students participated in an internship because they felt it would help them make an informed decision about possible future careers. A vast majority of the women were considering medical careers. Their journal responses revealed some of the factors that drive



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

this decision: it is a familiar world, students know what it entails; women perceive it as one of the only fields in science where you come in contact with many people and can help people; and women hold misconceptions and lack of information about other science-based careers. The internship experience broadened their understanding about the range of career options. Not only did internships expose students to new careers, but also to new scientific disciplines. Quite a few students wrote that, as a result of their internship, they plan to take a course in a previously-unconsidered scientific field; others were considering an internship-related field as a possible major. Many mentioned that they were beginning to contemplate a science career outside of medicine based on their experiences.

## 5) UNDERSTANDINGS ABOUT SCIENTIFIC RESEARCH

Regardless of whether or not an intern planned to pursue a career in science, students enthusiastically characterized their internship as a worthwhile experience that taught them much about how science really operates. Interns finished the experience with a much greater appreciation for the difficulties and joys of research.

Interns were surprised by the slow progress of scientific research, and the amount of work it took to understand even one small piece in the puzzle. They enjoyed researching new problems without predetermined answers, however, at the same time they grew frustrated with the unpredictability of science, their inability to get the results they wanted, and the lack of a definite "answer."

*One thing that seems surprising to me about working in a lab is that it really is so much trial and error. I'm so used to having labs for class in which the results are known beforehand. Now, we are trying ideas as they come up. It's interesting to see the results, but there are so many areas that could be causing difficulties in the experiments that it's hard to make any definitive conclusions. I guess what I'm trying to say is that although I always liked science because it seemed to have an answer, I realized that there are so many unknown areas.*

The journals expressed interns' new understandings about the patience, dedication, and perseverance that the researchers in the labs possessed, as interns came to recognize research as hard work. Contrary to the stereotypes in society, interns learned that scientists do not possess inordinate amounts of intelligence, just lots of motivation—an insight that could make a career in research seem much more accessible:

*It has also made me realize what working as a scientist really means. I think before I began the internship, I looked on science as something glamorous, that only really brilliant people could be a part of. Now I know that is not true. Science includes a lot of drudge work that can be done by anyone, but if someone works long enough on one experiment, than {sic} they will be able to form ideas of their own about the subject, no matter how brilliant or not brilliant they are.*

Through their work, interns realized that science is not built on "discoveries" but rather is constructed piecemeal through many unexciting trials. The complexities inherent in designing and conducting experiments; the messiness of data; the stamina needed for tolerating the mundane, tedious details of the work; and the myriad of variables that needed to be taken into account gave them a new understanding of science and respect for its practitioners.

Because they were immersed in a scientific setting, the interns also learned about other important forces that shaped scientific work. Interns had not realized the influence of grants, and the importance and time devoted to procuring funding. The role of publications, communications, and conferences; the organization and hierarchy of a laboratory; and the business and diplomacy that accompany research were described as new understandings about science.

Such glimpses into the innards of science, the lives of scientists, and the culture of science, caused students to reshape their views about science and their own abilities to understand and

conduct scientific research. Students described their new appreciation of not only the products or outcomes of science, but also the process of science:

*I have already learned an incredible amount about the scientific process as it is really used, and it's great to know that there is much more to science than what I'm learning now in my classes.*

The increased awareness, appreciation, and skepticism of scientific facts was an important effect of the internship program. Science is a powerful tool in our society, inspiring fear and awe, often because its findings and mechanisms are misrepresented. By participating in research, interns developed a more complex understanding of the workings of science. Regardless of whether or not they continue in science, interns valued this newly acquired knowledge.

## 6) THE ISSUE OF WOMEN IN SCIENCE

WISP and its existence was a topic of campus controversy at Dartmouth. In their journals some freshmen related that they had never experienced sexism in science. However, as their entries often later revealed, many had faced difficulties or isolation in high school, they just had not classified it as such. Interestingly, interviews with seniors evidenced that over their college career, women in science become much more aware of the issues and challenges that face women in the field. Educating women, especially freshmen, about the issues that women in science often confront and explaining the rationale behind WISP was an important, necessary, and well-received role of the newsletter. Other freshmen talked about the sexism and isolation they had already perceived in science and the important role that WISP could play. Some mentioned the lack of female science and math professors at Dartmouth, the decreasing number of women in their classes, and the differences between male and female questioning and interaction in science, math, and engineering classes. The lack of role models was another issue that women often wrote about when they expressed their appreciation for the support that WISP could provide. For example, one freshman wrote:

*I find gender issues to be very confusing. I still feel that there aren't nearly enough female role models. Growing up, I always felt disadvantaged because I was female and all the heroes, all the doers, and all the role models were male. I thought that I was excluded from all those roles because of my sex. WISP is a step into showing me that the world is not a males only club. I feel like I can put my foot in the door and break into something that interests me.*

## CONCLUSION

The course sequencing and logistics of a science major necessitate that students seriously consider science as a possible major in their first two years of college—without the foundational courses completed it is almost impossible to transfer into a science major in the junior year. However, these same introductory science courses are the reason that many students leave science—the large, impersonal lectures, the competition, the dearth of hands-on experiences and open-ended questions, all drive students away. By allowing students access to scientific research their freshman year, WISP internship experiences expose students to the real face of science at the beginning of their college career. The interns' journals reveal that the confidence that the internship builds, the contact with people in science, and the opportunity to situate their science study in its larger context are very important components that encourage women to continue in science. The interns appreciated learning about the lives and “the mentality of a scientist” (how they approached problems) and were inspired by the mentors with whom they worked. All interns were grateful for the experience, even those who decided that a research career in science was not attractive to them. For other interns, the internship allowed them to realize that they were capable of doing research science and motivated them to continue to pursue science coursework and careers:

*WISP has greatly influenced my view on science. Science is no longer a dream, a far-out-there wish that I think I could participate in. Science is a reality. I actively work in the fields of science and engineering, and my work has given me every confidence that I can go on to get my PhD and really make an impact in science.*

## CURRICULUM REFORM: INNOVATIVE TEACHING METHODS

### **Moderator**

Lisa Frehill, Ph.D.  
Associate Professor  
New Mexico State University

Dr. Frehill received her B.S. in Industrial Engineering from General Motors Institute in 1985 and her M.A. and Ph.D. in Sociology from the University of Arizona in 1993. Her dissertation examined national longitudinal data to understand the sex differences in the decision to major in engineering as well as the factors that account for retention in engineering during college. She conducted a training session in program evaluation during a two hour workshop at the 1995 WEPAN National Conference and then at each of the three WEPAN Regional Training Seminars last autumn.

Since receiving her Ph.D., Dr. Frehill has taught courses on social inequality, gender, race, and research methods at New Mexico State University. Her current research focuses on women's experiences of sexism in various engineering workplaces and on organizational efforts to represent the interests of women in engineering and the sciences. She is also completing a project on the portrayals of women and minorities in introductory engineering textbooks.

### **Presenters**

Linda F. Simmons  
Professor  
Southern University

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## IMPACT OF AN ALTERNATIVE TEACHING METHOD: PERSPECTIVES OF MINORITY FEMALE ENGINEERING STUDENTS

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Southern University

Professor L.F. Simmons  
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### ABSTRACT

Computers have not only revolutionized the way classes can be taught or laboratory experiments run, but computers make it possible to provide increasingly fuller pictures about concepts that can aid the engineers' judgement (2).

As we enter the next millennium, more computer-based teaching methods will be used to enhance the educational process for engineering students. Research indicates that the interactive multimedia instructional method, which is one of the most effective state-of-the-art methods, have the greatest potential to function as a standard for professional learning (1 and 4).

During the 1994-95 academic year, this method, which uses the personal computer along with an assortment of media aids, was introduced to junior and senior level minority female students enrolled in an undergraduate Transportation Engineering course. The performance of these students compared to non-female students was measured and a significant improvement in their visualization of theoretical concepts was realized as well as documented.

Therefore, the purpose of this paper is to discuss a non-traditional teaching method of the future, describe the receptiveness of minority female engineering students toward this new form of instruction, and how this method enhances the transportation subject area.

### INTRODUCTION

Generically speaking, "multimedia" is the presentation of an assortment of concepts converted to graphics, images, and animated video clips through the use of audio, video, and computer technology. As we enter the 21st century, more multimedia instructional presentations are bound to find their way into the classroom of many engineering professors. By doing so, the traditional instructional methods will be complemented with an improved quality of instructional material, provided we don't lose sight of the pedagogical intent of one's instruction.

The objective of this paper is two-fold: (1) incorporate the use of multimedia courseware materials into the CE 382 - Transportation Engineering II class; and (2) evaluate the impact this instructional material had on minority female engineering students enrolled in the class.

## **BACKGROUND OF CUSTOMER AND USER**

### **Customer**

During 1994-95, the Civil Engineering Department at Southern University consisted of 7.5 full-time equivalent faculty members and approximately 120 undergraduate students. All students enter the College of Engineering and the Department after completing 24 semester hours of general requirements in the Junior Division. However, students are allowed to affiliate with a department and take courses in that department prior to their official admittance into a college. All students who meet the Junior Division's requirements for transfer are accepted into the College of Engineering. The University is required to accept all students with high school diplomas into any field of study.

The Department made major revisions to the civil engineering curriculum during 1992-94. These changes were inspired by the desire to reduce the number of credits required for graduation and the lack of flexibility in specialty course offerings. The current program consist of 142 hours. Students are required to take two specified courses in transportation, water resources, and environmental engineering. Five structural engineering courses are required along with single course requirements in geotechnical, statistics, engineering economy and surveying. Students may use three technical elective courses and a senior design course to specialize in transportation, structures, water resources or environmental engineering. Southern has also developed a series of courses leading to a specialization in safety of dams.

### **User**

The course CE 382 - Transportation Engineering II is offered to all seniors, but is required for second semester juniors. The composition of students enrolled during Spring 94' were 100 percent African-Americans, 38 percent females, 62 percent males, 50 percent juniors and 50 percent seniors. All the students enrolled were computer literate and had successfully completed the pre-requisite, CE 381 - Transportation Engineering I, which is offered once a year during the Fall semester. A course syllabus for CE 381 and CE 382 is shown during the oral presentation of this paper. Moreover, the user receptiveness toward this new form of instructional material was very positive in that it improved the user's visualization of theoretical concepts.

## **SUMMARY OF RESEARCH OBJECTIVES AND ACCOMPLISHMENTS**

The implementation of this project was conducted through several objectives. A brief summary of each objective and its respective accomplishment is stated below:

**1) to conduct a background study of the availability of transportation courseware.**

After surveying the Southern University community and other local educational sources, the findings indicate that the availability of produced materials in transportation was not in existence. Therefore, the transportation courseware developed by California Polytechnic State University (Cal Poly) under the auspices of the Synthesis Coalition provided an excellent opportunity for the transferring of technology, thus providing minority students access to state-of-the-art research.

**2) to develop strategies to integrate the courseware material into existing courses.**

The Principal Investigator assisted by a senior undergraduate student, who completed CE 381 and CE 382, identified specific lectures that could be enhanced by the multimedia courseware obtained from Cal Poly. Approximately, 40 percent of the senior level traffic engineering courseware material and 30 percent of the sophomore level introductory transportation courseware complemented CE 382 lectures. Also, there were no additions or modifications made to Cal Poly's courseware material by the customer or users.

**3) to evaluate the integration of courseware material presented in CE 382.**

An evaluation of the implementation of the courseware material was conducted on the context of its use in lectures, exercises and student projects. The traditional university teacher's evaluation was conducted to assess the teaching qualities of the professor. The responses obtained from the students regarding the use of multimedia application in the transportation subject area were extremely favorable. Many students, particularly the females, felt that exposure to this kind of technology enlarged their vision about the opportunities in transportation and provided a better understanding of the concepts presented.

The Synthesis pre- and post-questionnaires were also utilized. The goal here was to assess the impact this instructional material had on the learning process of those students involved in this project. It was determined that there was significant improvement in instructional delivery and student performance (i.e., better retention of information). A general comment made by all students (both male and female) was that they were exceptionally impressed with the "different" instructional delivery because it easily captured their attention and improved their visualization of complex theoretical concepts presented. The results of their questionnaire responses are shown in Table 1.

**Table 1. PRE- AND POST-QUESTIONNAIRE RESPONSES**

Q1: Conceptual problem formulation was integrated with analytic problem solving

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20 %	60%	20%
Post (M)	0	0	0	60%	40%
Post (F)	0	0	0	100%	0

Q2: Interdisciplinary perspectives were integrated in problem formulation and solving

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	60%	20%
Post (M)	0	0	0	60%	40%
Post (F)	0	0	0	100%	0

Q3: The instructor gave attention to the learning process and showed good teaching skills

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	0	40%	60%
Post (M)	0	0	0	20%	80%
Post (F)	0	0	0	0	100%

Q4: Theory and practice were integrated through hands on skill development

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	0	60%	40%
Post (M)	0	0	0	20%	80%
Post (F)	0	0	0	0	100%

Q5: Examples of contemporary industry practice were integrated into class

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	0	60%	40%
Post (M)	0	0	0	60%	40%
Post (F)	0	0	0	80%	20%

Q6: Team participation and management skills included in class

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	80%	0
Post (M)	0	0	0	100%	0
Post (F)	0	0	0	100%	0

Q7: Economic and Social implications of technical issues were integrated into class

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	60%	20%
Post (M)	0	0	0	40%	60%
Post (F)	0	0	0	40%	60%

**Table 1. PRE- AND POST-QUESTIONNAIRE RESPONSES (cont'd)**

Q8: The instruction allowed and encouraged different ways to learn

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	60%	20%
Post (M)	0	0	20%	40%	40%
Post (F)	0	0	0	80%	20%

Q9: Instruction integrated textual, visual, and physical presentations of material

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	40%	40%
Post (M)	0	0	0	40%	60%
Post (F)	0	0	0	0	100%

Q10: ..... has been an attractive model of professional engineering

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	80%	0
Post (M)	0	0	0	80%	20%
Post (F)	0	0	0	0	100%

Q11: ..... has given you a deep commitment to a professional engineering career

	Very Poor	Poorly	Fairly Well	Very Well	Superbly
Pre	0	0	20%	60%	20%
Post (M)	0	0	0	40%	60%
Post (F)	0	0	0	0	100%

Moreover, Table 1 reveals that there was a positive impact on minority female engineering students involved in this project. The improvements are implied by the female students response to questions 1, 4, and 8-9. As it relates to "team participation" and the "integration of economic/social implication of technical issues", questions 6 and 7 respectively, both male and female students had the same post-test response. However, for question #5, 20 percent more female responded "very well" to the use of industry related practices in this class. This difference could be associated with the fact that on average more female Civil Engineering students at Southern gain industrial experience prior to their junior year compared to their male counterparts. Finally, the female students felt "superbly" about this non-traditional teaching method. All of them concluded that they gained a deeper commitment toward a professional civil engineering career and enjoyed being actively involved in the learning process, thus clearing the lines between the lecture and textbook.

## AREAS OF IMPACT STATEMENTS

### **Infrastructure**

This project serves as a demonstration that the transfer of technology (e.g., courseware material) between schools that differ in the types of enrollment (large vs. small), class sizes (larger vs. smaller); student composition (predominate majority with limited mixture of other ethnic groups vs. predominate minority with limited mixture of other ethnic groups); and physical facilities (state-of-the-art vs. limited physical resources) can influence the learning capacity of students regardless of their educational environment.

### **Curricular Reform**

The results obtained from this project indicate an improvement in the quality of instructions which ultimately provides strength to newly reformed curriculums aimed at mainstreaming minority institutions into a posture where they will always have access to advanced technological information.

### **Retention**

The project's major focus was to enhance a junior level transportation course. However, given the existing opportunities, motivation and interest students have toward transportation at Southern University, I foresee this project serving as a vehicle to attract more minority engineering students, particularly females, to pursue a career in transportation.

### **Assessment**

This method, which uses the personal computer along with an assortment of media aids (i.e., graphics, pictures, video clips, sound, animation and text), help foster a development of new teaching material from traditional theoretical concepts. In other words, subject matter that was considered tedious to study is now presented with computer generated images complemented by multimedia techniques. Additionally, students have the opportunity to preview and review the lecture and class exercise materials at their own pace.

## CONCLUSIONS

Through funding received from the National Engineering Education Synthesis Coalition CICEE Metaproject Group, this project on multimedia applications in transportation was the first of its kind to be implemented at Southern University. The performance of the minority female engineering students who participated in this project was measured and a significant improvement was realized as well as documented. On the other hand, because there was only one section of CE 382 offered during the Spring 95' semester at Southern,

there was no comparative analysis done on students not exposed to the material. Therefore, it is recommended that a study of this nature be conducted in the future.

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# INSIDE ENGINEERING FACULTIES: DEVELOPING A NEW LAYER OF ADVOCACY IN AUSTRALIA

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## Background

Recruitment, retention and educational development programs for teaching staff in engineering faculties are currently the three broad layers of 'women in engineering' programs within Australian universities. Many universities have 'women in engineering' (WIE) programs and they are funded and defined in very different ways by different engineering faculties. They are often marginal to central faculty concerns through their location, staff tenure, program decision making and funding levels.

With recruitment or outreach programs, the focus is women in schools and in the community. With retention and support programs the focus is the women within 'non-traditional' courses and training. These approaches have been described as 'women focused' and without them we would not have the increased numbers of women within engineering. Like other WIE programs, the National Centre for Women (see poster) reassessed its programs in the early 1990's and we shifted our emphasis from changing women's career aspirations and support once they had enrolled, to include working toward change at organisational and cultural levels in education and industry. Consequently, a third layer of educational development has been added to recruitment and retention initiatives in engineering faculties.

These educational development programs are challenging and focus on improving the teaching and learning within engineering faculties in response to including more women students. Programs can centre on staff development sessions or can be a longer term model of research and development where staff collaborate to investigate and change their local curriculum and teaching. Both reject the idea that you simply add women to a faculty and stir. Consequently, they represent a shift from changing women to changing engineering.

This paper will briefly outline two case studies of educational development programs within engineering faculties and consequently illustrate the models we are finding useful. I will also discuss the resistance that can be generated from this layer of advocacy. First to the culture of engineering faculties in Australia.

## Gendered engineering faculties

Women comprise only 13.1% of university students in engineering faculties in Australia. The most rapid increase in female students was during the period from 1986 to 1990 where a 1% increase per year occurred<sup>1</sup>. This increase has slowed since then to 0.6% in 1994. Whether this is a plateau in the 'graph' of female participation is yet to be revealed. At the moment however, the rate of increase in women studying engineering is slowing in Australia. These aggregate figures hide the large variations in women's enrolment patterns from campus to campus and from field of engineering to field of engineering. Chemical engineering has shown a 10% increase in female participation over the past six years to almost 32% whereas electrical and mechanical fields have increased more slowly to 9% and 7% respectively<sup>1</sup>. Women academics in engineering faculties comprise only 4%.

Consequently, one of the central issues facing engineering faculties in Australia is the male student environment. Many women students experience a chilly learning environment through how they are treated in the classroom or the laboratory, the relationship with teaching staff, and the informal student exchanges. Not all male dominated engineering faculty environments exhibit characteristics that make them uncomfortable for women, but many do. There is also no predicability about the chilly nature of the learning environment; one year can exhibit a comfortable learning environment for young women and men and the next year can be macho and intolerable for the young women and anyone not part of the dominant male, anglo group<sup>2</sup>.

WIE program managers in universities have been predominantly women without faculty teaching status, and employed to work in educational and promotional programs where their focus is 'safely' outside faculty corridors. Consequently, the teaching staff themselves and the curriculum and teaching practices within these engineering faculties have been largely unaffected and unchallenged by these programs. Many academic staff in engineering do not have educational qualifications.

Perhaps the central obstacles for WIE programs in universities are the pervasiveness of the culture of autonomy, individuality, competition, and the 'old' hierarchical models of management prevalent in engineering faculties. Added to this, research in universities is being maintained as a higher priority than teaching and educational development. The personality characteristics of scientists and engineers also show that males tend to be "emotionally reticent, disliking overt emotional expression in others and themselves....", they also tend to be authoritarian, conservative and controlled in their thinking"<sup>3,4</sup>. The research questions, methods, criteria of success, and styles of teaching are male defined and consequently, the

knowledge itself reflects a bias towards a male cognitive style in its practices, theories, ways of teaching, and ways of managing and organising faculties. Engineers have created a profession where the separation of theory from social and environmental contexts is prevalent.

One of the most illustrative examples of how this culture of autonomy can affect the teaching and learning environment for students came from a project a few years ago where the teaching staff conducted a review of the first year program through surveying all staff and students<sup>5</sup>. They found:

- the curriculum, content sequencing and assessment of most first year subjects were decided independently of other subjects and with little collaboration between first and second years
- staff knew little of what was happening educationally outside their own subject
- the practical component of the subjects had diminished over the past ten years due to diminishing resources and this was having a detrimental educational effect
- there was very little continuity or uniformity in the description of the subject goals and objectives given to the students
- some content areas overlapped between subjects and resulted in confusion for students due to different terminology and symbols.

#### **'Change is a process not an event'<sup>6</sup>**

It is always challenging to work for change. It is particularly challenging to work for change within engineering faculties. Too many engineers see change as an event and not a long term process. The most successful programs are where a group of engineers have worked collaboratively over time - on curriculum and teaching projects rather than one or two session staff development programs. These former programs are the focus of this paper. Fullan's criteria for successful change are very relevant; the overlap of the individual participants needs with those of the central funding body, the support of hierarchy, and the opportunity for staff to interact with each other, share ideas and have access to support and assistance<sup>6</sup>. Some of the most useful elements from educational development programs inside engineering faculties are where:

- academic staff applied for and were selected for the project on the basis of their interest and commitment to a gender based review of their curriculum and teaching,
- programs started from the individual needs, interests and understandings of the participating academics,
- academic staff were provided with time release and/or research assistance
- data collection phase focused on the local faculty context

- mandatory support of the dean and heads of schools
- academic staff worked together in teams,
- commitment to formal and informal meetings and staff development sessions/programs extending over time,
- ongoing support and follow up from consultants throughout the year,
- external consultants participated in a formative evaluation of the program,
- documentation of the project contributed to the professional profile of the academic staff.

Action research has been another common thread (sometimes unspoken) determining the investigative process within most of the programs. Essentially, action research is a form of self reflective enquiry which aims to improve practice through understanding and to involve others in all phases of an open process. Practitioners research their own practice. Action research leads to formulating recommendations and putting these into practice. It also represents a cyclical process of ongoing change without a pre determined end point<sup>7</sup>.

### Making Connections

"Making Connections" has government university teaching funds and has developed, trialed and evaluated a project based component of design engineering in first year. One of the central rationales for this program was that further improvement in the participation of women in undergraduate engineering may only be achieved through changing the traditional practices within engineering education. This program has implemented the shift from content to context driven curriculum and assists student learning by starting with a familiar curriculum context and building the technical and professional skills components through connecting with the engineering concepts. The gender inclusive model for this project was characterised by:

- open ended problem based learning
- social and environmental curriculum contexts
- collaborative team approaches
- diversity of teaching and assessment approaches.

Students work on design projects in teams, as well as presenting and evaluating their projects in a simulated workplace situation. Students choose the subject of their projects and many semester classes are structured to guide students through the design process, and integrate the social and environmental contexts into their design. Students must work with a client group. Interdisciplinary and group work are emphasised rather than lectures and individual work.

### Maximising Diversity

A cluster of projects at another University arose out of a sequence of staff development sessions conducted over six months. These sessions focussed on factors that create a warm classroom environment for both female students and students from other cultures, as well as inclusive curriculum and teaching issues. Again the focus for this program was a faculty concern over the plateau and possible decline in the number of women within the undergraduate engineering programs. The faculty wanted to improve their educational strategies to teach in gender and culturally inclusive ways.

The culmination of these sessions was the development of a cluster of educational development projects within the engineering faculty. Staff were offered central funds to collaboratively conduct projects that supported student diversity in learning. These projects are linked together with a common faculty reporting and publication timeline. Funded projects are very diverse and cover:

- training of laboratory tutors to be more gender and culturally sensitive,
- analysing the assessment data within the faculty in order reveal any patterns of achievement in different assessment tasks,
- interviewing female and male students about the faculty environment
- videoing mechanical practical exercises in order to understand and intervene in any gender and culture dynamics within the class,
- the development of a multimedia library resource to cater for students from less technical backgrounds.

These programs are providing a model for the development of projects in other WIE programs where educational development funds are being harnessed to encourage engineering academics to collaborate on long term change programs for women students.

### Resistance

Reform programs in engineering faculties are particularly vulnerable to resistance since they can threaten the comfort zone of other staff members and some students. There are a number of resistance discourses operating in faculties and they can be described politely as politics and educational priorities but they can be avoidance, sabotage and attack. They can be directed at educational development staff or the faculty staff participating and owning the programs.

Avoidance statements are the most commonly encountered and centre on assigning all educational problems to the student deficit model - the poor quality of student intake (always decreasing from earlier times) or the poor motivation or preparedness of students. Other avoidance mechanisms involve defending current practices based on the longevity of their degree conferring ceremonies, drawing on one particularly successful woman to justify current teaching practices, or problem recognition equals problem resolution. Sabotage can extend to appointing an unqualified person to a 'women in engineering' position, or appointing the right person in a far too junior position with low salary. It can also take the form of cynicism where everything has been done before or is an assumed part of current educational practice. Attack is often saved for any written material by questioning its grammar, meaning or research validity or the attack targets the staff development session where the facilitator is assumed the enemy and asked the most aggressive question. The forms of resistance can be many and varied.

I remind myself of the following list regularly (generated from a workshop of women in engineering program managers); change is slow, work with the support of others, work with engineers who are open to change and accept that some will never change, encourage ownership, have all the data at your fingertips, be flexible and listen to other views, know where there is the slightest possibility of finding any funds, and use the policies and regulations to the maximum.

### Acknowledgments

The following WIE program managers have contributed to the development of these ideas and projects - Marian Boman, Jane Copeland and Pam Roberts. These programs would not have occurred without the commitment of the faculty staff who are enthusiastic about change for women students in engineering.

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# THE NATIONAL CENTRE FOR WOMEN: EMPLOYMENT, EDUCATION AND TRAINING FOR WOMEN IN NON-TRADITIONAL AREAS

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## What is the National Centre for Women?

The National Centre for Women (NCW), based at Swinburne University of Technology in Melbourne, is a unique university centre in Australia whose current brief is to research and enhance women's recruitment into and equal participation within 'non-traditional' employment, education and training. In the late 1980's, the NCW started as a government funded Centre aiming to increase the participation and retention of female students in engineering and other non-traditional study areas. At that time, the Centre performed most of the recognised advocacy tasks aimed at increasing female recruitment and retention: targeted recruitment through attractive promotional materials, participation in seminars, "hands-on" taster days; support for women enrolled in engineering through support groups, mentors, use of role models, intervention classes in areas from engines to assertiveness.

However in 1993, the NCW reassessed its programs and we shifted our emphasis from changing women's career aspirations and support once they had enrolled, to include working toward change at organisational and cultural levels in education and industry. Much of our work focuses on or intersects with engineering work and study.

## Why do we exist?

The Centre exists for two main reasons:

1. Women continue to be under-represented in a wide range of occupations. Australia has one of the most sex segregated patterns of employment in the OECD. We believe it is important for women to think beyond a narrow range of careers. Many areas in which women are under-represented offer good pay and interesting work. Some industries in which women are under represented have an enormous impact on society — engineering for example. It makes sense to have both women and men shaping these professions.
2. While the numbers of women in non-traditional areas has increased over the last two decades, very little work has been done on exploring the experience of women in non-traditional areas. What sort of climate is it for

them? Why do they drop out? What changes might need to be addressed?

Much of our emphasis at the National Centre for Women is in exploring these issues. For example, we investigate the experiences of women in diverse non-traditional courses and work (career paths, relationships, obstacles to progression etc). We explore the learning environments in male-dominated Technical and Further Education (TAFE) and university courses and conduct work with staff on eradicating gender bias in curriculum materials, assessment practices and teaching and learning styles. We also investigate the organisational cultural factors which might prevent women from achieving within non-traditional areas in industry

#### **What do we do?**

Operate a small business venture within Swinburne University of Technology and direct any revenue raised back into advocacy programs. Provide consultancy and training to industry, government, TAFE and universities. Provide written materials such as Data Matters and Gender Matters. Conduct research. Promote women's achievements in non-traditional areas through events such as the Awards.

#### **Some Current Projects**

##### Workplace Programs

The NCW is currently managing a research and change project within Broken Hill Proprietary Co Ltd (BHP) entitled Maximising Diversity. This project is a long-term ethnographic research project into workplace culture as well as the piloting of change strategies. The research outcomes will assist BHP to maximise the potential of its female and multicultural engineers, scientists and managers and thereby increase its diversity, productivity and competitiveness. The research outcomes will also provide guidance for other Australian companies.

##### Recruitment Initiatives

Trialing of a range of recruitment and retention activities for women in engineering at Swinburne University of Technology. These activities include training women students to speak in schools, support for undergraduate students and the fostering of special relationships with neighbourhood schools for collaborative curriculum and teaching projects in engineering.

##### Awards for Outstanding Women of the Year in Non-Traditional Areas

The NCW awards celebrate the value and importance to Australia of a diverse and talented student and workplace population in all areas, across all sectors. Initiated by the Centre in 1995, the awards highlight the outstanding



achievements of women in a diverse range of non-traditional areas. Not surprisingly, an analysis of the nominations (from 1995 and 1996) revealed a remarkable number of engineers. Awards are presented in four categories, with an overall winner announced as well. Categories cover study in both universities and TAFE in the non-traditional areas as well as the workplace where awards are made for less than and more than 5 years experience.

#### Data Matters

Part of any change program is being fully informed about issues. Having access to clear data is particularly important in framing and understanding those issues. In the 1990s for example, there has been a popular perception in Australia that "things have changed for women" (for the better). But what does the work and study data for female engineers say? After numerous, frustrating calls to government departments to find the relevant data for a paper or submission we have initiated a national data update series on women and engineering. *Data Matters* was first published in late 1995. The goals of *Data Matters* are to:

- provide an accurate and accessible data source on gender and engineering for the education, employment and training communities in Australia
- link this data to the issues and challenges within engineering
- provide a data source for international comparisons
- provide regular updates after these three editions have been published

The first three *Data Matters* will focus on gender and engineering in universities, TAFE and in employment.

#### Gender Matters

*Gender Matters* is the quarterly newsletter of the National Centre for Women, first published in 1994. It is currently sent to over 2000 readers throughout Australia and overseas, including university and TAFE colleges, public sector and corporate sector groups. *Gender Matters* aims to:

- report on national and international initiatives which advance the position of women in engineering
- question and critique existing initiatives to avoid complacency in our practices
- promote an informed understanding of the processes of change
- promote local initiatives on women in engineering (eg. new resources, handbooks, videos) at a national level
- link the four sectors (private, public, educational and community) through the exchange of new ideas, theories and practices, networks, conferences and events



## CAMPUS CLIMATE: PERSPECTIVES FROM COALITIONS

### Moderator

Susan Scheff

Director, Women in Engineering Program  
University of Kentucky

Ms. Scheff has been the Director of Women in Engineering Programs at the University of Kentucky, College of Engineering since 1991. She was Director of the Pre-Freshmen Enrichment Program from 1992-1996, a four week summer program targeting minority and female middle and high school students. She was on the University of Kentucky's Women's Forum Board (1995-1997), a member of The Committees on Sex and Race Equity in the Fayette County Schools, American Association of University of Women (AAUP), and Regional Student Coordinator for SWE. Ms. Scheff received her Bachelor's degree in Business Administration in 1983 and has worked in a university setting for over 20 years in student services, academic advising, publishing, and human resources services.

### Presenters

Karan Watson, Ph.D.

Associate Dean of Engineering and  
Professor of Electrical Engineering  
Texas A&M University

Deidre Hirschfeld, Ph.D.

Assistant Professor, Engineering Fundamentals Division  
Virginia Polytechnic Institute and State University



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



EFFORTS TO RETAIN WOMEN AND MINORITIES IN ENGINEERING:  
A PERSPECTIVE OF THE FOUNDATION COALITION PROJECT

Karan Watson, Jan Rinehart	Jorja Kimball	Karen Frair	Mary Rowland-Anderson
Texas A&M University	Texas A&M-Kingsville	University of Alabama	Arizona State University
College Station, Texas	Kingsville, Texas	Tuscaloosa, Alabama	Tempe, Arizona

The need and efforts to increase the number of women and minority BS graduates in the engineering and science fields are well documented. In addition, many employers and educators have recognized a need to change engineering education in order to better prepare all students. A coalition of seven schools has undertaken the challenges of innovating the educational experience for engineering students, particularly those in the first two years, or foundation years. A special emphasis has been placed on enhancing the experience of a more demographically represented student body. The schools have formed the Foundation Coalition and include: Arizona State University, Maricopa Community College District (Arizona), Rose-Hulman Institute of Technology (Indiana), Texas A&M University-College Station, Texas A&M University-Kingsville, Texas Women's University, and the University of Alabama.

The Foundation Coalition (FC) is one of eight coalitions funded by the National Science Foundation. All eight coalitions have the expressed purpose of enhancing engineering education, in order to improve the quality of the graduates. Members of the FC draw on their diverse strengths and mutual support to construct improved curricula and learning environments, to attract and retain a more demographically representative student body, and to graduate a new generation of engineers who can more effectively solve the increasingly complex, rapidly changing societal problems. An important uniqueness of the FC lies in the fact that it has brought together diverse institutions to implement and assess a common set of experiments in curricula and learning environment in engineering education. This includes development and piloting of an integrated first and second year curricula, uniquely tailored to the student body of each campus. These integrated curricula also must incorporate cooperative learning and technology in the classroom environment. While the FC is striving to link with existing Women in Engineering or Minority in Engineering Programs in order to strengthen the educational experience for students, it also is working to change the classroom and faculty - student relationship in order to enhance the success of women and minorities in engineering.

#### THE FC INSTITUTIONS

The seven institutions are very different in size, student body, location and mission. Maricopa Community College District, MCCD, is one of the largest Community College districts in the nation. Located in the Phoenix area, it serves a very ethnically diverse student body at several campuses. Texas Woman's University, TWU, serves a predominantly female student body, and has no engineering degrees. None the less, TWU has developed strong dual degree and 3-2 programs with several institutions which do have engineering degree programs. Rose-Hulman Institute of Technology, RHIT, was an all male institution until the Fall of 1995. Texas A&M University Kingsville, TAMUK, is a predominantly Hispanic institution. Texas A&M University, TAMU, has one of the largest Colleges of engineering in the nation, and typically is one of the top three schools in graduating Hispanic B.S. level engineers. In addition, TAMU had the largest enrollment of women in engineering in 1995. Arizona State University, ASU, is well known for incorporating teaming into the engineering curricula, and for a significant enrollment of Hispanic and Native American students. ASU also has a significant number of students who enter the engineering program as transfer students from community colleges. The University of Alabama, UA, has a significant enrollment of African American students.

The Foundation Coalition must develop curricula and an academic environment at each institution that are accessible and provides equitable opportunity for success for all students. The focus on underrepresented minorities (African Americans, Hispanics, Native Americans, and Pacific Islanders) and women is

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

necessary because these groups have a history of being significantly underrepresented in engineering graduates. This underrepresentation is due to both low initial numbers in the first year and to higher attrition rates in the engineering programs. This has been pointed out as a concern both nationally and at all of the FC institutions. Table 1 gives a perspective of what the representation levels were before the initiation of the FC.

**Table 1** Percentage of underrepresented groups enrolled in undergraduate engineering programs in Fall 1993

INSTITUTION	African-American	Hispanic-American	Native-American	Women
National	6.9%	6.5%	0.51%	17.7%
ASU	1.8%	8.9%	2.4%	18.1%
MCCD*	n/a	n/a	n/a	n/a
RHIT	1.8%	0.9%	0.08%	0%
TAMU	3.2%	10.8%	0.25%	19.7%
TAMUK	1.5%	52.6%	1.15%	16.3%
TWU*	n/a	n/a	n/a	n/a
UA	17.5%	1.1%	0.49%	20.3%

\*MCCD and TWU data is not available on engineering students since they do not declare majors the same as the other institutions

The FC is focusing on the recruitment, retention, and the graduation of students from underrepresented groups. The graduation focus implies timely completion of the degree and quality placement, in industry, government, or graduate school, of the students receiving B.S. degrees. Since the FC institutions are in their second year of offering courses, and these courses have been focused on the first and second year of the curricula, it is premature to report on graduation at this time. The recruitment of underrepresented minorities and women for the institutions and the FC curricula will be discussed in the following sections.

#### **RECRUITMENT OF UNDERREPRESENTED MINORITIES AND WOMEN**

How students in pre-college are attracted to and successfully matriculated into engineering programs is a very complex issue. Stereotyping any group of people as having a single or unique method for recruitment is dangerously misleading. The FC schools recognize this and have approached recruitment of underrepresented groups through a variety of activities. The common idea for all students is that they must develop an aspiration for engineering and an expectation of success in the field.

Aspiration in an area requires an awareness and valuing of the field, as well as an interest in serving in the roles found in that field. Expectations are influenced by individuals confidence that they can achieve and their aspirations. It is crucial to provide mentors, role models, and sound information networks so that underrepresented minorities and women, whose expectations typically fall well below their aspirations, have opportunities to raise both their aspirations and expectations. Many people who have focused on this issue will confirm that it is never too early to start influencing the students aspirations. In the FC schools, outreach efforts to pre-college students are facilitated by numerous internal organizations. For the engineering programs, most of these efforts are led by personnel in the Minority and Women Engineering Programs.

At ASU, TAMU, TAMUK, and UA, Minority Engineering Programs, MEPS, existed prior to the formation of the FC. In addition MCCD and TWU had numerous activities to outreach to underrepresented minorities and women in their communities. TAMU and TAMUK had existing programs that outreached

to girls. The FC has aided in the formal organization of Women in Engineering Programs, (WEPs), at ASU, TAMU, TAMUK, and UA. These programs now conduct numerous conferences and camps for minorities and girls at the pre-college level. The FC teams on the campuses have all provided some level of cooperation with these programs. It is important to recognize that the directors for the MEPs and WEPs are continually raising internal and external funds to support their efforts, and on most campuses the FC has been only a small part of these efforts. The following table is meant to illustrate examples of the type of outreach and level of FC involvement.

**Table 2 Examples of Pre-College Outreach Efforts**

LEVEL	School	Comment	FC Involvement
Elementary	TAMU	Engineering students and faculty take design activities to the 5th and 6th grade campuses at local schools (250 students)	Several FC faculty have volunteered time and materials
	TAMU	Tours of campus and laboratory activities for local community centers serving 2nd through 4th graders. (45 students)	One FC faculty arranged with MEP and WEP the tours and raised funds for the buses.
	ASU	Collaboration with girl scouts to offer 1 week camps for 1&2, 3&4, and 5&6 graders. (68 students)	WISE program supported by FC
Middle School	TAMU	SWE one week residential camp (50 students)	FC faculty gave many of the tours and demonstrations. FC faculty developed team projects for the camp.
	TAMU	Mentoring for at risk students (20 students)	FC faculty made contacts, MEP and WEP matched undergraduate mentors to middle school students
High School	ASU, TAMU, TAMUK	3 day activities for students to expose them to design and teaming (ASU 78 students, TAMU 305 students)	ASU-direct FC support TAMU & TAMUK-FC faculty facilitated design competition
	RHIT, TAMU	three one week camps: RHIT- 30 women non-residential, TAMU- 100 minority focus in 2 residential camps, and 50 women in one residential camp	FC faculty helped develop activities and design projects. FC faculty and undergraduate students delivered team training
	TAMU, TAMUK	2-3 week camps (sponsored by Young Scholars program in NSF and/or NASA) demographically representative of State	FC faculty PI for the camp. Included integrated course materials, technology and teaming. Faculty also serve as research mentors at TAMUK.
	TAMU, TAMUK	Year round interaction with predominantly minority high schools	FC faculty and students provided tours and activities.

In addition to these outreach efforts, the FC teams had to recruit students into their pilot curricula programs. These efforts included mail outs describing the programs. At TAMU students come to register prior to the start of the semester and sessions are arranged for parents and students from underrepresented groups to discuss campus life and the FC curricula. The initial enrollments for these groups in the FC curricula are shown on the next page in Table 3.

## RETENTION OF UNDERREPRESENTED MINORITIES AND WOMEN

Retention of undergraduates in engineering is also a very complex situation. Many students who enter engineering or pre-engineering leave the field for other science, mathematics, business or educational fields. Across the nation and at the FC schools, the retention of underrepresented minorities and women is below the retention levels of other engineering students. All of the schools participate in numerous activities to address these issues. The NSF has a highly successful program called the Alliances in Minority Participation, which focus on networks of 4 and 2 year institutions targeting the retention and graduation of BS level science, mathematics, engineering and technology students from underrepresented minorities. TAMU and TAMUK are part of the Texas AMP, ASU is part of the Southern Rocky Mountain AMP, and UA is part of the Alabama AMP.

**Table 3** Number and (Percentage) of Students Enrolled in the FC First Year in Engineering  
(Fall '94 & Fall '95)

SCHOOL	Students in FC 1st year Fall 1994	Students in FC 1st year Fall 1995
ASU	Afr.Am 1(3%) Hisp 6(19%) women- 6(19%)	Afr.Am 1(3%) Hisp 4(13%) Nat Am 1(3%) women- 11(35%)
GCC	did not offer curricula in 1994-95	Afr.Am 1(7%) Hisp 3(20%) women- 1(7%)
MCC	Afr.Am 0(0%) Hisp 2(7%) women- 3(11%)	Afr.Am 0(0%) Hisp 2(11%) women- 3(17%)
RHIT	Afr.Am 0(0%) Hisp 0(0%) women- 0(0%)	Afr.Am 2(2%) Hisp 4(3%) women- 27(23%)
TAMU	Afr.Am 4(4%) Hisp 15(15%) women- 25(25%)	Afr.Am 10(5%) Hisp 32(16%) women- 48(24%)
TAMUK	Afr.Am 1(7%) Hisp 8(57%) women- 2(14%)	Afr.Am 0(0%) Hisp 14(58%) women- 8(33%)
TWU	Afr.Am 0(0%) Hisp 1(17%) women- 5(83%)	Afr.Am 1(6%) Hisp 1(6%) women- 14(88%)
UA	Afr.Am 10(28%) Hisp 0(0%) women- 10(28%)	Afr.Am 8(13%) Hisp 0(0%) women- 19(31%)

At these schools the FC teams have worked to get involved in numerous bridge, mentoring, and research programs sponsored by the AMPs. At TAMU, the bridge programs for matriculating first year students and for transfer students were modified to better facilitate entry into the FC curricula. All of these campuses have worked to interface the FC students with programs (such as brown bag luncheons, lecture series, peer tutoring, mentoring, internships, and undergraduate research) and organizations (such as NSBE, MAES, SHPE, AISES, SWE, and SOCNAS). Supported by the Foundation Coalition, the OMEP at ASU has now begun an Academic Excellence Program that clusters underrepresented minority students enrolled in ECE 100, a course designed to teach engineering concepts and computer skills. Non-minority students in the course are also invited to participate in these workshops. The students develop their own community of learners and collectively come to conclusions on how to process information. The Academic Excellence Workshops help to move away from traditional tutoring that is often a short term fix. Rather, these sessions enhance the mastery of engineering concepts as opposed to isolated problems. This process prepares students for potential curriculum integration in the future, as well as team participation in industry. At TAMUK, a chemistry bridge program was developed to address poor freshmen grades in chemistry. This was done in collaboration with the Women and Minority Program and the FC faculty.



Table 4 Course Hours Integrated in First Year Pilot During 1995/1996

INSTITUTION	PHYSICS	CALCULUS	ENGINEERING	ENGLISH	CHEMISTRY
ASU	8	8	4	4	6
GCC	4	6	6		
MCC**	3	3	3		
RHIT*	6	9	15	6	
TAMU	6	8	5	4	3
TAMUK	4	4	4	4	
TWU	4	4			
UA	8	8	4	6	

\*RHIT is quarter hours and all others are semester hours

\*\*MCC offered courses in coordinated clusters: Physics & Engr, Calculus & Engr, Physics & Calculus & Engr

In the FC, curricula research is underway to study the effects of the curricula content, teaming and cooperative learning, and technology on the underrepresented groups. Table 4 shows the courses which have been integrated together at the different institutions in the first year engineering curricula. Table 5 shows the retention numbers and rates for students from underrepresented groups in the FC curricula. The retention data shown is most valid when compared to how well students in the traditional course offerings at an institution are retained. At Texas A&M University, for example, in a parallel set of courses with 488 students who began in the Fall of 1994, 67% of the women and 67% of underrepresented minorities were retained in engineering the following Fall. Comparative numbers in the FC Fall 1994 courses were that 72% of the women and 93% of the underrepresented minorities were retained in engineering in the following Fall.

Table 5 Number and (Percentage within group) of Students Finishing in the FC First Year 1994-95 and 1995-96

SCHOOL	Students in FC 1st year Fall 1994	Students in FC 1st year Fall 1995
ASU	Afr.Am 1(100%) Hisp 5(83%) women- 5(83%)	Afr.Am 0(0%) Hisp 4(100%) Nat Am 1(100%) women- 7(64%)
GCC	did not offer curricula in 1994-95	Afr.Am 0(0%) Hisp 3(100%) women- 0(0%)
MCC	Afr.Am 0(0%) Hisp 1(50%) women- 1(33%)	Afr.Am 0(n/a) Hisp 1(50%) women- 2(67%)
RHIT	Afr.Am 0(0%) Hisp 0(n/a) women- 0(n/a)	Afr.Am 2(100%) Hisp 1(100%) women- 18(67%)
TAMU	Afr.Am 3(75%) Hisp 15(100%) women- 18(72%)	Afr.Am 9(90%) Hisp 27(84%) women- 42(88%)
TAMUK	Afr.Am 0(0%) Hisp 2(25%) women- 2(100%)	Afr.Am 0(n/a) Hisp 9(64%) women- 2(25%)
TWU	Afr.Am 0(0%) Hisp 0(0%) women- 3(60%)	Afr.Am 1(100%) Hisp 0(0%) women- 12(86%)
UA	Afr.Am 7(70%) Hisp 0(n/a) women- 8(80%)	Afr.Am 4(50%) Hisp 0(n/a) women- 13(68%)

All of the FC institutions have confirmed that when the students first begin the year it is important to not have women in teams where they are the only woman. However, after the first term, at some institutions the women do not want this consideration and they do not seem academically affected if a random team

assignment results in their being the only woman on a team. This can be attributed, at least in part, to the students in the integrated courses knowing each other better than most students would in traditional courses. On the other hand, at one institution after the first term, when the students could form their own teams, most of the women clustered with one or more other woman on a team. Team assignments with race and ethnicity are still under review, and vary greatly from school to school. A study of the effects of learning styles on team assignment and team performance was investigated at Texas A&M University using the Gregorc Style Delineator. Initial results indicate that concrete-sequential learners had a positive and significant correlation with course grade. The abstract-random style correlated negatively with physics and English grades. The concrete-random style correlated negatively with the calculus grades. There were no strong interactions with sex or ethnicity in general, although several Hispanic students did show high abstract-random style scores. TAMUK conducted focus groups with women FC students to address the potentially different perceptions of the FC curriculum within genders.

ASU, RHIT, TAMU, and UA offered an integrated set of sophomore level courses in the 1995/1996 academic years. These courses included as little as 14 hours of calculus, mechanics, and materials, and as much as 25 hours of calculus, mechanics, materials, thermodynamics, circuits, and English. The retention rate for these courses was good and is now being studied in comparison with the traditional sophomore curricula.

Most of the FC schools have conducted workshops on gender and cultural issues in the classroom for faculty teaching the FC curricula. These workshops have clearly raised the faculty attention to the differences among students. The programs intend to have all faculty recognize that there are differences between and within different demographic groups, and to teach how to modify teaching styles to assist in the learning environment for all students.

The FC is also supporting assessment efforts at each school. For instance, in July 1994, at ASU, a graduate student developed a new MEP tracking system to monitor student participation and the services of the office. This information will focus on pre-college outreach effectiveness and MEP services. One major objective is to matriculate Mathematics, Engineering, Science Achievement (MESA) participants from local high schools to the ASU College of Engineering. The assessment will guide enhancements of academic and social intervention programs to help students prepare for transition from high school to college. The tracking system will also include industrial internships, graduation rates, and industry placement upon graduation.

### CONCLUSIONS

The FC institutions are working to raise the awareness of faculty to issues of gender and ethnicity in the classroom. These institutions are in the process of developing curricula and learning environments which are more conducive to a diverse set of students persisting in engineering. For the next year the FC will focus attention on design projects, team exercises, and course demonstrations which enhance the visibility of the contributions of underrepresented groups to the fields of science, engineering and mathematics. Finally, the FC institutions will continue to encourage strong linkages between the efforts in MEPs and WEPs and curricula development.

## ENGINEERING EDUCATION FOR WOMEN: A CHILLY CLIMATE?

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### INTRODUCTION

For more than four decades there has been a massive accumulation of higher education research on the effect of academic environments on student growth, student development, student outcomes, and student's subsequent careers. Compendia of these extensive series of studies are provided by Feldman and Newcomb (1969) and more recently by the comprehensive research review by Pascarella and Terenzini (1991). These compilations of the research knowledge-base show the pervasive long-term effects of educational climates at the institutional, college, departmental, and classroom levels.

One of the most highly cited series of papers on the impact of a possibly hostile environment for women students are the reports produced by the Project on the Status and Education of Women of the Association of American Colleges (Hall and Sandler, 1982; 1984; Sandler and Hall, 1986). In these AAC reports, the authors cite an overwhelming "chilly climate" for women students, particularly in SME (science, mathematics, and engineering) programs.

Following these AAC reports, several studies--both empirical and qualitative-- were undertaken to test this "chilly climate" hypothesis (Heller et al., 1985; Constantinople et al., 1988; Crawford and MacLeod, 1990; Brady, 1995). They conclude that there is little support for the presence of a chilly classroom climate for women. Yet, after reviewing many of these studies, Patricia Yaeger (1995) argues that while a chilly climate for women has been difficult to document, this does not mean that it does not exist. Moreover, these former studies have been based on only one or two institutions, with only a small sample of students, and they have included a variety of disciplines and have not focused on a highly male-skewed program such as is generally found in engineering. Hence, this paper exclusively addresses engineering programs and is based on a large multi-institutional sample of students.

## DESIGN AND PROCEDURES

Eight major institutions participate in the Southeastern University and College Coalition for Engineering Education (SUCCEED), a program sponsored by the National Science Foundation for the purpose of reforming engineering education for the 21st Century. Five of these eight institutions participated in a survey for this study. The present study was designed to assess the classroom climate in colleges of engineering. With survey data collected in the spring of 1995, results from this study will provide "benchmark" data for future evaluation of changes in engineering programs into the 21st Century.

The sample for each institution included all female undergraduate engineering students and an exact-size or minimum-size random sample of male undergraduate students by class to compare with the female sample. A two-stage survey design was implemented. A first wave mailing was conducted at all five institutions, with a second wave made to all non-respondents within a month of the initial mailing. Most institutions also made use of a postcard reminder to all sample members within a week of the initial mailing. The overall response rate was 45%, with institutional response rates ranging from a low of 34% to a high of 64%. A response rate around 40% was typical for most institutions.

Climate issues were grouped within two sections based on different scaling approaches: Section A of the survey had students rate events on the basis of their frequency; Section B required students to rate their level of agreement with an issue or event. Each section included items on instruction and advising, departmental/college/institutional perceptions, and various aspects of the student experience. A principal factor analysis was performed on items within each section followed by a varimax rotation of factors with eigenvalues greater than 1.0. Based on the resultant factors, survey subscores were developed by calculating the mean rating for all items with loadings of .40 or more on the appropriate corresponding factor.

Survey subscores were examined by gender at two class levels. Freshmen and sophomore observations were grouped as lower level; junior and senior observations comprised the upper level group. T-tests were conducted for differences between the lower level female versus male group means and between the upper level female versus male group means.

## RESULTS

Four factors were retained for the frequency items and five factors were determined to best summarize the agreement items of the survey. The four frequency factors accounted for about 91% of the variance among items in the first section, with 82% of the variance being accounted for by the five factors resulting from the agreement items. It should be noted that the climate and experiential results in this report exclude engineering dropouts and transfers (especially among upper division students)—that is, those students who likely experienced more negative program aspects as opposed to the "persisters" whose data are reported herein.



### Climate Factors based on Frequency

The four factors resulting from the analysis of items in Section A reflect student perceptions as to the frequency of certain types of events. Items in this section were rated with a Likert-scale where: 1=often, 2=occasionally, 3=seldom, and 4=never. Table 1 presents each factor and the corresponding survey mean scores for each gender/level group. With 750 to 1055 responses in each cell, the margin of error for these results ranges from  $\pm 3.7$  to  $\pm 3.1$  percent at the 95 percent confidence level.

Table 1. Varimax factors and survey subscores resulting from analysis of students' frequency ratings.

Factor	Subscores (mean rating of frequency)			
	Lower Level Females	Lower Level Males	Upper Level Females	Upper Level Males
Program attachment	2.00*	1.88*	1.80	1.75
Departmental support	1.88	1.94	2.32**	2.24**
Faculty interaction	2.09	2.10	2.18	2.19
Negative treatment	1.57*	1.25*	1.75*	1.34*

\* $p < .01$     \*\* $p < .05$

From Table 1 it is shown that significant differences do occur between female and male students on several subscores. The program attachment measure is comprised of five items which were negatively worded--e.g., "I feel as if I don't belong in this program"; "I feel isolated in this program"; and "I have considered switching to a non-engineering program". Responses to these items were re-scaled such that 1=never, 2=seldom, 3=occasionally, and 4=often. Consequently, lower level female students were more likely to observe events that deterred their attachment to the program.

Six items are included in the subscore on departmental support--none of which were negatively worded. Results of the t-test between upper level female and male students on this measure show that female students are less likely to report instances of activities that demonstrate departmental support. For example, upper level females do not find

that the department helps them meet faculty, graduate students or alumni of the same gender or, that the department provides mentoring programs which introduces students to alumni or peers in their field.

The negative treatment measure is represented by three items--all negatively worded: "I have heard women complain about being treated unfairly by faculty"; "I have heard negative comments about men in this program"; and "I have heard negative comments about women in this program". These items were re-scaled in the same way as those for the program attachment measure. From the results in Table 1, both lower and upper level female students were significantly more likely to report that negative treatment occurred.

#### Climate Factors based on Agreement

In Section B of the survey, students were provided a list of statements and asked to indicate the extent to which they agreed with each. Again, items in this section were rated with a Likert-scale, with 1=strongly agree, 2=somewhat agree, 3=somewhat disagree, and 4=strongly disagree. Table 2 presents the five factors resulting from this analysis and the corresponding survey mean scores for each gender/level group. The number of responses in each cell ranged from 680 to 1058, corresponding to margins of error between  $\pm 3.9$  and  $\pm 3.1$  percent at the 95 percent confidence level.

Table 2. Varimax factors and survey subscores resulting from analysis of students' agreement ratings.

Factor	Subscores (mean rating of agreement)			
	Lower Level Females	Lower Level Males	Upper Level Females	Upper Level Males
Program satisfaction	1.69	1.68	1.77*	1.66*
Program Competition	2.39	2.41	2.53	2.54
Study groups	1.85*	2.04*	1.72*	1.89*
Gender neutrality	1.47*	1.19*	1.59*	1.22*
Faculty Advisement	2.10*	2.22*	2.26	2.29

\* $p < .01$



Significant differences were found between female and male students on four out of five subscores developed for Section B. Twelve items were used to calculate the subscore on program satisfaction; none were negatively worded. From the results for upper level students on this measure in Table 2, it is shown that female students did not agree as strongly as males with statements such as, "Department leaders are committed to meeting the needs of a diverse student population from a broad range of backgrounds" or "Individual faculty members have proved to be good role models for me".

Differences in perception of the impact of study groups resulted from mean scores on three items. Lower means for the females indicate that they more often found a sense of involvement, a resource for enhancing their academic success and a means of social interaction than did the males at both the lower and upper level. It should also be noted that the strength of agreement increases from lower level to upper level for both females and males

The area of gender neutrality was measured via five items--three of which were negatively worded and two positively worded. Significant differences between female and male responses were found at both the lower and upper levels for this measure. Due to the mix of positively/negatively worded items for this measure, a review of the frequencies for each item is necessary to understand the combined results. Women students at both levels were much less apt than men to strongly agree that faculty were equally supportive of male and female students--43% female versus 64% male at the lower level and 40% female versus 65% male at the upper level. Similar results were observed for frequencies on the item worded "the climate for women . . . is very comfortable". Twenty-eight percent of females versus 39% of males strongly agreed at the lower level and 32% of females versus 43% of males strongly agreed at the upper level. With regard to the use of humor being used at the expense of women, men more likely strongly disagreed while women somewhat agreed that such a use of humor was being made.

Finally, a measure on faculty advisement was developed based on results from three items. A significant difference between female and male students was found at the lower level. In this case, female students were found to agree more so than male students that their advisor was interested in them as an individual, that meeting regularly with their advisor was important, and that they had been helped at a crisis point by an individual faculty member.

## CONCLUSIONS

The presence of significant differences between female and male engineering students on most of the factors identified through this study is all the more striking in that the data in this report is biased toward those students who persist in these engineering programs. Two of the factors identified in this study--negative treatment and gender neutrality--are

more clearly measures of the “chilly” climate for women in engineering education programs. Twenty to 25 percent of women were less inclined than men to agree that faculty are equally supportive of women and men students--four times as many lower level women than men *disagreed* that faculty were equally supportive. Consequently, given the acknowledgment of female “persisters” that they have more difficulty “attaching” to the program, that departmental support as they matriculate does not serve the needs of a diverse student body, or that their satisfaction with the program is not as strong as males, more questions than answers come to mind.

What enables these women to persist in such a learning environment? Why do other women leave the program? Are the reasons for why women leave engineering programs different from the reasons why men leave? Some insight to these questions may be drawn from the results of this study. Women persisters are more heavily involved in study groups, finding a source of both academic and social support. No significant differences between female and male students were found on the measure of program competition. Female persisters have proven their academic ability and appear to be no more intimidated by the rigor of the program than are their male counterparts. Finally, on measures related to faculty interaction and faculty advisement, female students appear more likely to take the initiative to approach faculty and place a high value on such interactions.

From these latter observations, it may be advisable to facilitate instructional approaches that encourage small group interaction and provide a means of attaching to the program both intellectually and personally. Female students clearly react positively to meeting with faculty and developing rapport. More efforts should be made to engage female students in activities with faculty, graduate students, alumni and peers, particularly those of the same sex. Such initiatives may lessen the chill in the climate and allow more women to succeed in and contribute to engineering programs.



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 OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

Linking Girls and Their Technological Futures Through Informal Science  
An Implementation Model in Iowa

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LINKING GIRLS AND THEIR TECHNOLOGICAL FUTURES THROUGH INFORMAL SCIENCE, is a collaborative project led by the Program for Women in Science and Engineering (PWSE) of Iowa State University (ISU), to create positive permanent change in the Iowa informal education infrastructure by increasing participation of women and girls in hands on science activities. Partners in this effort are the Moingona Girl Scout Council, Selzer-Boddy, Inc., ISU Extension Service's Science, Engineering and Technology (E-SET) wing, and the ISU Research Institute for Studies in Education (RISE). The National Science Foundation (NSF) is funding the project under its Experimental Project for Women and Girls (EPWG) initiative.

We are using a pass-through training model developed by the American Association for the Advancement of Science (AAAS) that trains adult volunteers to train others to conduct hands-on science and math activities in community groups, such as the Girl Scouts and 4-H. In our project adult trainers will train high school volunteers who in turn will train peers and middle schoolers to continue the chain: the idea is to have female role models who the audience can readily identify with, lead the hands-on activities. Dissemination of the model will take place through training sessions across the state and will also make use of the existing fiber optic network that links all 99 counties in Iowa.

The original training module consisted of 14 hours of directed training, two hours of small group planning time, and two hours of video taping/critiquing of activities presented by the trainees to the large group and took place over three days. The directed training included three main components: Gender Equity, Presentation Skills, and Hands-on Activity training. Twenty-eight participants underwent this training in September 1995.

The activities curriculum from AAAS as it stands is very rich in content. But for volunteers without extensive training and comfort level in science, its presentation style can be daunting. Since the success of our project is critically linked to our ability to enthuse and retain volunteers at a diversity of age and experience levels, we felt a strong need to revise the curriculum and customize the training schedule to align with our goals and objectives. The 4-H experiential learning model is serving as a guide in the modification of the activities and preparation of the training and activity manuals. Our proposal to submit the curriculum for inclusion into the national 4-H one has prompted this choice.

The first phase in the revised curriculum incorporates 17 activities into a student (4-6 grade) manual and there will be an accompanying helper's manual to assist leaders (middle school and high school girls, college students and adult volunteers) in delivering it. A Trainer

Training Manual is also under preparation. The educational specialist is working with graphic designers to produce manuals that have visual appeal and are user friendly.

The first group of trainers were invited to critique the revised format. We piloted the activities with groups of target age children in four Girl Scout troops and an after school program at a local elementary school. The response of the children to the activities as well as to the leaders (in pairs, one adult and one college student) has been very positive.

Based on feedback from the focus group with participants at the first training, the training session has been modified to fit a four hour core format with the option available to expand on specific components of the training based on need. For example, Girl Scouts trainer/trainees indicated the preference for expanded hands-on activity training while the College students expressed a greater need for the presentation skills component.

The college women who were trained at the first training session had the opportunity to practice the gender equity and effective presentation strategies in leading elementary school age girl scouts in hands-on science activities developed by the national science Partnership project funded by NSF. There was a total of 310 girl scouts reached in three activity sessions. The first trainer group is also providing support in piloting the modified curriculum.

A total of nine focus groups were conducted with the project target audience throughout the state in order to 1) assess overall attitudes and awareness levels about math and science among youth, 2) examine the potential for linking this project to existing organizations, 3) evaluate respondent interest in participating in the project and response to proposed activities, and 4) examine the role/need for gender equity awareness/training. The results from the analysis of the focus group information are being fed back into our project design and delivery. The key results from the focus group research are being presented at the WEPAN poster session.

The first year focus of the project has shifted more towards development and refinement of the activities and training modules. Extensive piloting with test groups is an ongoing process. Focus group findings from our target audience are being used to refine the project and optimize delivery. We are collecting data with all participants relating to the training, interest level in continued participation as well as any attitudinal changes relating to math and science.



**Careers of Women who Study Physics:  
Findings from a Survey of Sigma Pi Sigma Members**

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**Overview.** In the summer of 1994, we surveyed members of the Sigma Pi Sigma national physics honor society by mail, with the goal of obtaining information about the kinds of careers former physics students pursue. Because women have historically been, and continue to be, severely underrepresented in physics, they were oversampled at a rate of five women for every two men. Their responses provide a glimpse of the range of careers which women who have studied physics pursue. The data also provide a basis for comparison with men of like abilities and educational backgrounds. In addition, since engineering is one of the most common fields of employment for physics degree recipients at the bachelor's and master's level, it is possible to examine the responses of engineers in some detail.

**General findings.** A total of 454 women and 1125 men participated in the survey. Of this total, 330 women and 913 men majored in physics as undergraduates. Although the majority of women who had earned bachelor's degrees in physics went on to earn advanced degrees, a significantly smaller proportion of women (59%) than men (73%) did so ( $p < .001$ ). Only 18% of women went on to earn PhDs (11% in physics). Among men, 36% obtained PhDs (27% in physics). Women who earned PhDs in physics took about 8.4 years after their physics bachelor's on average to complete their degrees, while men took significantly less time, 6.7 years ( $p < .001$ ). The difference was slightly smaller for the subset who had been in the workforce for less than ten years: 8.2 years for women and 7.0 years for men.

Among respondents who were eligible for employment (i.e., were employed at least part-time or unemployed but were not students and were not retired), women experienced significantly greater rates of both unemployment and part-time employment. Ten percent of women were unemployed, compared to about 4% of the men ( $p < .001$ ). An additional 10% of women and 3% of men were employed part-time ( $p < .001$ ). The remainder of this paper will focus on respondents who were employed at least part-time when they completed the survey.

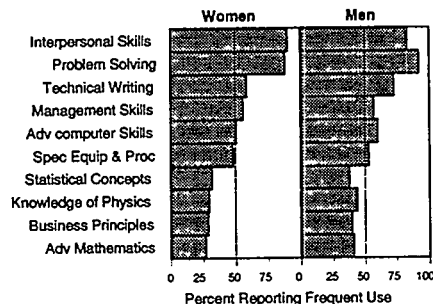
For employed respondents who majored in physics as undergraduates (186 women and 684 men), the distribution by employment sector was similar, but not identical, for women and men. Private industry was the largest employer of both groups. Large companies employed 29% of the women and 35% of the men in the sample. The next largest employment sector was education, where about 30% of women and 23% of men were employed. Government, including the military, government contractors, and federally

funded research centers, employed another fifth, approximately. Small businesses and professional firms accounted for an additional 16% for both men and women. A small percentage of respondents worked in nonprofit organizations.

Engineering was the most common field of employment for women who participated in the survey. Over a fifth of the respondents—both women and men—were employed as engineers. Management was the most common field of employment for men, and the second most common field for women. A quarter of men and one-sixth of women held management positions. About 12% of women and 18% of men held positions as research scientists, primarily in universities and government labs. Roughly equal proportions of women (10%) and men (12%) worked in higher education as teachers. In contrast, 14% of women, but only 4% of men, identified themselves as high school teachers ( $p < .001$ ). Another 10% of the respondents held computer science-related positions as software developers, programmers, systems analysts, and so on. Of the remainder, about 5% held other scientific/technical positions, and the rest worked in nontechnical fields.

When asked to rate how often they relied on various skills that may be relevant in the workplace (listed in Figure 1), women overall reported less frequent use of these skills than men did, with one notable exception: interpersonal skills. Although the vast majority of both women and men used interpersonal skills frequently, a significantly greater proportion of women (90%) than men (83%) did so ( $p < .025$ ). Admittedly, this difference is not large. Other differences, though significant, were modest also, as in the case of advanced computer skills and business principles. The most striking differences between women and men were seen in their reported use of physics knowledge, advanced mathematics and technical writing in their work ( $p < .001$  in each case). Although only a minority of men used their knowledge of physics and advanced mathematics regularly on the job, even fewer women did. About three-quarters of men and three-fifths of women used technical writing regularly. Women and men did not differ significantly in the frequency with which they used problem solving, statistics concepts, management skills, or specialized equipment in their work.

Figure 1. Skills Used Frequently in the Workplace, by Gender.



Less than half of the respondents felt that their careers had “gone pretty much in the direction” they intended. Forty-seven percent of men and 39% of women agreed with this statement. Nevertheless, relatively few would get a degree in a different field if given the chance to do it over again. However, women were more likely to say they would do so than men were: 26% of women and 16% of men would get a degree in a different field ( $p < .002$ ). And, while the majority agreed that their undergraduate physics education provided a solid background for their careers, a significantly smaller proportion of women (60%) than men (75%) felt this way ( $p < .001$ ). In light of these differences, it should not be surprising that a greater percentage of women (54%) than men (38%) wished that they had gotten more useful career counseling as undergraduates ( $p < .001$ ).

**Focus on engineers.** Fifty-six women identified themselves as engineers. Of these, 57% had majored in physics as undergraduates. Another 30% had majored in engineering. The breakdown for the 180 men engineers was similar. As in the larger sample, significant gender differences in degree attainment were found. Fifty-three percent of women engineers stopped at the bachelor's level, compared to 35% of men ( $p < .02$ ). About two-thirds of women with advanced degrees (virtually all at the masters level) earned them in engineering. This was true for just under half of the men in this group.

Over 95% of the engineers in the sample (both women and men) who were employed held full-time positions. No data were available on the number of unemployed engineers who participated in the survey. For both groups, computer systems/software engineering and electrical/electronics engineering dominated. Together, they accounted for about half of the engineering specialty areas cited. Aeronautical/astronautical engineering ranked third among women, followed by mechanical, nuclear and industrial. Men cited aeronautical/astronautical, mechanical, and nuclear engineering with equal frequency. Industrial engineering was mentioned by less than 5% of men.

Not surprisingly, three-quarters of the engineers worked in private industry. Virtually everyone else worked in government. Nearly half of the engineers worked in the manufacturing sector (including computer hardware and software manufacturing). Another fifth worked for employers whose primary function was research and development. About 10% of women engineers and 15% of men were employed in service-producing industries, including transportation, utilities, and communications. Another 15% of women and 10% of men worked in or owned companies that provided direct services in the form of engineering consulting, equipment repair, health care, and business support.

Interestingly, three-quarters of women engineers reported that they were working in the field of their highest degree, despite the fact that less than 40% had earned their highest degree in engineering. Significantly fewer men, about half, said they were working in their highest degree field ( $p < .01$ ). This seeming contradiction on the part of women in particular may be a function of the types of courses, internships, and research opportunities individuals had as students. Indeed, there is evidence to suggest that women's and men's educational experiences had differential impacts on their careers. For example, while three-fifths of both groups reported that they had participated in internships as students, 88% of women and 75% of men who had had such experiences found them helpful in obtaining their first positions ( $p < .125$ ). More strikingly, Two-thirds of women and half of men reported that they had participated in extracurricular activities, and of these 57% of women but only 33% of men had found them useful ( $p < .02$ ). Exactly what the extracurricular activities entailed is not known.

Just as we saw in the full sample, a greater proportion of women than men engineers relied on interpersonal skills frequently as part of their job (91% of women, 80% of men,  $p < .055$ ). Men and women did not differ markedly in their use of the other skills, with the exception of statistical concepts. Half of women and a third of men reported using statistical concepts frequently ( $p < .065$ ). These findings for women engineers, while suggestive, are inconclusive and warrant further research.





CAREERS IN SCIENCE AND ENGINEERING: A SPEAKER'S SERIES IN  
COLLABORATION WITH AN NSF VISITING PROFESSOR

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Research shows that vicarious learning is an important source of information<sup>1</sup>. In other words, one need not experience something personally in order to learn. For example, simply seeing someone walking in front of you trip over an obstacle on a path is sufficient for you to avoid that obstacle yourself. You don't have to trip over that same obstacle to learn that it can impede your progress. By the same token, if you see that same person enjoying their journey on the path despite the occasional trip-up, you are more likely to venture down the path yourself. You would have learned, vicariously, that the journey is worthwhile. It is this principle of vicarious learning that underlies why role models can be important sources of information for young women entering engineering: Role models can point out the pitfalls while demonstrating how rewarding a career in engineering can be.

In collaboration with Dr. Renee Diehl, a National Science Foundation (NSF) Visiting Professor in ASU's Physics Department from Pennsylvania State, the Arizona State University's (ASU) Women in Applied Science and Engineering (WISE) Program hosted a Careers in Science and Engineering speaker's series during the Spring semester, 1995. With funds provided by the NSF grant, six renowned women scientists and engineers were brought to campus to speak with students. The speakers came from a variety of working environments and backgrounds, but shared two common elements: 1) They are women in non-traditional fields and are able to point out the obstacles they have encountered; and 2) They are testaments to how rewarding a career in science or engineering can be.

A list of potential speaker's names was generated by Renee Diehl and the WISE Program. The first speakers contacted were encouraged to recommend other speakers. The speakers were chosen based on their experiences, accomplishments and current position. The speakers were: Christine Platt, Ph.D., Assistant Director for Corporate and Federal Programs, Science and Technology Center for Superconductivity; Donna Chapple, Director of Information Technology, Ameritech; Carol Kemelgor, MSW, ACSW, co-author of "The Paradox of Critical Mass for Women In Science"; Elcira Villarreal, Ph.D., Senior Virologist, Lilly Research Laboratories; and Joan Gosink, Ph.D., Director, Division of Engineering, Colorado School of Mines.

Approximately every three weeks a speaker visited campus. Each speaker's travel arrangements were made through the WISE Program and speakers received a \$500 honorarium. In general, the speakers participated in activities on campus for one to two days. They first attended a breakfast with the Deans of the College of Engineering and Applied Science and College of Liberal Arts and Sciences (CLAS), as well as the Vice President of Research, and other high-visibility administrators. Each speaker received the vita of the breakfast participants, and participants received copies of each speaker's vita before the breakfast.

The breakfast meeting was a unique way to educate administrators about the issues that face women in science and engineering through highly credible individuals with first-hand experience. Also, the Careers in Science and Engineering series was the WISE Program's first collaboration with the College of Liberal Arts and Sciences. The speakers' breakfast allowed the participants to

explore the possibility of expanding or creating programs, while building the WISE Program's credibility university-wide. As a result of these meetings, the Dean of the CLAS is planning to develop a program similar to WISE.

During the morning, speakers met with WISE staff and were given tours of campus or specific labs of interest. Over lunch, the speakers met with graduate women and faculty in small group settings to discuss personal trials and achievements. Faculty and graduate students who were in closely related fields to each speaker were contacted by phone and invited to the luncheon. Through this forum, graduate students and faculty were able to communicate with one another across Colleges, and in unprecedented ways. In particular, junior and senior female faculty began to network with each other to share tips on getting tenure, how to win the respect of students, and other professional and personal issues. In order to continue this spirit of cooperation, it was decided to offer women engineering faculty lunches once a semester, to be coordinated through the WISE Program.

Speakers provided a presentation/discussion in the afternoon, open to all students. Sessions generally took the form of round-table discussions, due to the small number of students in attendance. The greatest number of attendees were in sessions which were heavily advertised in the CLAS. Speakers shared the professional and personal development that lead them to their current position. The stories were all very different. Christine Platt was in the midst of a job change and shared her dual career marriage struggles. Donna Chapple discussed the additional challenges she faced as an African American. Carol Kemelgor talked about stories she collected from the female engineering graduate students she interviewed for her research. Elcira Villarreal explained how she went from participating in the war in El Salvador to attending college in Texas. Joan Gosink described what it's like to be one of a handful of women engineering deans.

The speakers all encouraged students to aim high, and provided thoughtful answers to students' questions about marriage and families, finding mentors, office politics, negotiating for salaries, and sexual harassment. Student participants completed brief evaluations of the afternoon session. Evaluations were positive, indicating that these sessions were helpful and motivational.

The capstone of the Careers in Science Series, "What good is your Ph.D.?", was directed toward graduate students. This seminar included seven speakers from around the country in various fields of science and engineering. The speakers, all of which had earned a doctoral degree in engineering or science, included a Stock Market analyst a community college physics professor, an independent consultant a corporate president, a chemical engineering professor at a state university, a consulting firm partner, and the owner of a research company. The seminar focused on alternative careers for higher education graduates. The seminar was held on a Thursday in July and was a full-day event, including a hosted lunch. Fifty-two students attended this seminar.

Two problems emerged from the Careers in Science speakers series. First, student participation was disappointingly low, particularly for engineering students. Personal phone calls did increase participation, but such calls are energy intensive. Some of the speakers did not have engineering backgrounds, which may have contributed to the problem. Also, while the speakers' visits were evenly spaced throughout the semester, perhaps

concentrating the visits at the beginning of the semester would allow for more student participation before the mid-term "crunch" sets in.

The second major problem is finding funding to offer this program again. Providing airfare, lodging, per diem and honorariums for speakers is expensive, and program costs also included providing breakfasts and lunches for participants. The total cost for the Careers in Science series was approximately \$15,000. It is difficult to leverage this type of money from industry. However, the program could be modified and offered on a smaller budget. For example, local speakers could be utilized, and lunches could be paid for or subsidized by participants. Of course, local speakers do not tend to have the same impact as bringing a speaker in from another state. On the other hand, local speakers would have more experience with local companies, which may be

of more interest to students. Charging for lunch might decrease the already troublesome participation level. On the other hand, people tend to expect what they pay for and charging a nominal fee might help them to realize what a valuable experience they are receiving!

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# CRITICAL CONNECTIONS: THE SECRET TO THE SUCCESS OF WOMEN IN MATH, SCIENCE AND ENGINEERING

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At Washington State University, there is a strong commitment to supporting women in math, science and engineering. Two units established for this expressed purpose are the Committee on Women in Math, Science and Engineering and the Women in Engineering Program. The two units operate cooperatively, but separately to support the success of undergraduate women in fields in which they have been traditionally under represented. Most of the programs foster the connections between women that are critical to their success.

The Committee on Women in Math, Science and Engineering is an organization of faculty, students, staff and administrators concerned about the under representation of women in math, science and engineering. Nationally, the science and engineering fields are traditionally dominated by males. In the biological sciences, the new generation entering the work force is more gender balanced. However, in the physical sciences and engineering, women continue to be under represented. The national trend is realized at Washington State University. During the five year period from 1989-1993, out of all of the entering freshmen who declared an interest in the biological sciences, 54% were women, whereas for the physical sciences, 40% were women, and for engineering, 17% were women. For that same period, out of the bachelor's degrees granted in the biological sciences, 53% went to women, in the physical sciences, 34% went to women, and in engineering, 12% went to women. The Committee seeks to understand why women are under represented and then designs programs and services that counteract the negative influences. Studies<sup>3,4,5,6</sup> point to poor teaching by science and engineering faculty, inappropriate reasons for choosing majors, inadequate advising or help with academic problems, and lost confidence due to low grades in early classes as factors contributing to students' decisions to leave math, science and engineering fields. Other studies<sup>1</sup> claim that student-student interactions and faculty-student interactions are extremely important to the academic success of undergraduates. A local study<sup>2</sup> found that lower than anticipated grades, the paucity of women in the entry level classes, and the competitive atmosphere in entry level classes also contributed to decisions to change majors. Critical to the success of those who persisted are the socialization systems provided by the Math, Science and Engineering Residence Hall, peer tutoring, and contact with women a couple of years ahead in their studies.

The Committee, in close cooperation with other units on campus, initiates services and programs that promote the success of women (and men) in MS&E. Some of these include the Math, Science and Engineering (MS&E) Residence Hall, the tutor-assisted study hall, and an Advising Fair. The MS&E Hall started six years ago with 25 women and 25 men as a "house" in one of the freshman towers. Three years ago it moved into its permanent home in the Gannon-Goldsworthy complex and this year 142 women and 326 men participated. During this rapid growth period, we have allowed a gender imbalance, but the ultimate goal is to have six floors of women (approximately 300) and six floors of men. The philosophy behind the MS&E Hall is that by clustering students with similar academic interests and demands, it is easier for the students to build the academic/social network that supports

their goals. In this hall it is easy to find study partners in the same entry level math and science courses. The floor lounges are routinely used for small study groups working together on homework or projects. In the non-MS&E halls, women in particular have difficulty finding others close by that are also taking these entry level classes. These classes tend to be a shock for freshmen because of the pace and level of difficulty compared to high school math and science classes. Furthermore, the grades students receive are often lower than what they are accustomed to receiving. Students that are isolated do not realize that this is common and hence have a harder time putting lower grades into perspective. Instead they interpret them as an indication that they are not cut out for a scientific or technical career. Women seem to be much more susceptible to this confidence crisis than men. Hence a supportive environment is all the more valuable to them. The benefits of the MS&E Hall are enhanced by the presence of a computer lab equipped with state-of-the-art equipment and the software used in the MS&E courses, programming directed towards the MS&E community, and the tutor-assisted study hall. The study hall is organized and run by the Committee. Help for entry level math classes, physics classes and biology is available Sunday through Thursday evenings from 6:30 p.m.-9:30 p.m. The study hall is open to all students in these courses regardless of whether or not they live in the hall.

Many (if not most) of our students enter the university with a general interest area, and use the freshman and sophomore years to identify the specific major they want to pursue. Upon entry to the university, students are assigned to an advisor in their general area. In the literature<sup>6</sup>, one factor contributing to the decision to leave MS&E fields was inadequate advising. In an attempt to supplement the official advising and to make information about all MS&E majors readily available to our students, an advising fair was initiated in Spring 1995. This is held two weeks before students meet with their advisors for pre-registration and is intended to help students prepare for their official advising sessions. Representatives from MS&E departments are there with details about specific courses, majors and minors, student clubs, scholarships, career options, and research and work opportunities within their department. Other units on campus are represented including the Honors Program, International Studies, Career Services and Service Learning.

The Committee also works with the undergraduate group *Women in Technology and Science* and the Palouse Chapter of the *Association of Women in Science* to organize special programs and to bring speakers to campus for public lectures and informal contact with MS&E students.

The Women in Engineering Program was organized in 1989 to assist women students in their adjustments to the WSU campus and to provide a supportive program for them throughout their academic programs. Presently the program offers the following: Bridge Workshop for new students, scholarships, organized tutorials and study groups, a study room for group or individual study or relaxation, academic and personal advising from the WEP director, opportunities to meet and network with other women students in upper division classes, a resource center for internships and summer jobs, numerous publications of interest to women students, and an introduction to the student chapter of the Society of Women Engineers.

The Bridge Workshop, which is held one week before the fall registration, provides a complete orientation of all support areas available to students in the university and community. The students are pre-advised and enrolled in "cluster" classes which allow them to be in the same sections with other students they have met through Bridge. (Some cluster classes allow for as much as half the class being women.) In addition, the students have a sample of what to expect in the math and chemistry classes through an orientation presented by the faculty teaching those classes. A one-day computer center orientation with practice on using the features available through the internet provides the comfort necessary so the students will take advantage of the computer services.

Students using the WEP tutoring range between 20 and 40 weekly. Tutors are upper division students who have mastered the subject and have shown an interest in tutoring. The tutors are Tau Beta Pi students providing a service to the program, scholarship recipients who are volunteering time, or paid tutors. The sessions are held twice weekly and students sign a contract for the entire semester specifying that they will attend each session. There could be one student assigned to a tutor or as many as four to ten students assigned to one tutor.

The WEP study room provides a place for students to gather to study or relax. The present room accommodates 20 students comfortably, but through two other adjacent study rooms, any student wanting to find a place to study, can.

In conclusion, both programs strive to create a supportive environment aimed at the academic success of women in math, science or engineering fields. A key to this success is the academic and social networking among the women in these fields which is accomplished through special programs, a unique living environment, peer tutoring and undergraduate organizations such as the Society of Women Engineers and Women in Technology and Science.

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## **AN INTERVENTION STRATEGY TO RETAIN WOMEN STUDENTS IN ENGINEERING: ENGR 194 SEMINAR AND SMALL GROUPS**

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The longevity of the Women in Engineering Programs at Purdue University has provided the opportunity to analyze and perfect an effective intervention strategy for the retention of women students in engineering. The strategy described here is a one credit course for first year women engineering students, ENGR 194: Women in Engineering Seminar. The course is an elective which does not carry credit towards an engineering degree and 50-60% of first year women students elect to take it each fall. Depending on the particular cohort group, students who take ENGR 194 are retained at a rate four to sixteen percent greater than students who did not take the course. The current format includes a weekly lecture/discussion, which has almost 100 students enrolled in each of its two divisions, supplemented by a weekly small group meetings of 8 to 10 students. The lectures are given by dynamic women engineers and the small groups are led by dedicated and inspirational senior or junior women engineering students.

As part of the course requirements, students frequently elect a writing option to keep a weekly journal. For the instructors, the journals provide a valuable reflection of student concerns, challenges and satisfactions. This has led to adjustments in the course content and format to keep pace with the evolving needs of college students as they prepare to enter a rapidly changing profession.

### **CHANGES IN COURSE CONTENT**

Twenty years ago, lecture topics focused on areas of engineering that were thought to have special appeal to women, such as the environment and energy and speakers emphasized survival skills for being the first or only woman in a particular engineering position. Presently, speakers continue to highlight areas of engineering popular with women students, but a concerted effort is made to also include speakers from areas of engineering with lower proportions of women such as electrical and mechanical engineering. Students still show interest in information on specific fields of engineering, but they also want to learn more about the viability of engineering as a career for women. In response this concern, several dual-career couples are invited to speak each semester; all speakers are asked to share strategies for pursuing personal interests; and speakers with non-traditional career paths such as law, medicine, management and teaching participate to show the flexibility that an engineering career could provide.

### **CHANGES IN COURSE FORMAT**

At its inception, in 1977, the course consisted of three major components: lectures/discussions, hands-on laboratories, and career planning sessions (LeBold, 1982). The hands-on labs and career planning modules eventually developed into independent

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

courses at Purdue, however the lectures/discussions remain a primary focus of the current course. The increased participation of women engineering students (647 in 1977 to 1,434 in 1995), and those enrolled in the course (from 58 in 1977, to almost 200 the last three years), suggested other changes to course format. Participating in an engineering class with relatively large numbers of other women became less important as a critical mass of women engineering students provided multiple opportunities for interactions. Journal comments such as, "I didn't expect the class to be so large, I expected something more personal" implied, instead, the students' need for a sense of community.

Before 1991 speakers had been providing information on what it is like **to be** an engineer, but students seemed to be struggling with what it means **to become** an engineer. It was helpful for course instructors to focus on the first year as a transition period—providing support for the personal development of students as well as for their academic progress. Course content traditionally included presentations on self-esteem, assertiveness, time management, study skills and/or other types of personal competencies. Although students' journals frequently indicated that they had already heard "all this stuff" from their parents, it was evident that the students were still struggling with these issues. These young women were in an important developmental stage—concerned with becoming independent, becoming academically competent, becoming an engineer. They needed to hear the same content, but the delivery of that content needed to be changed.

In response to the need for connecting and belonging, as well as the need for a new delivery system for personal development content, small peer groups were added to ENGR 194 and juniors and seniors were trained as leaders. The student leaders had knowledge about engineering courses and student work experiences; they were motivated to listen and to help freshmen deal with the myriad of problems; and they were eager to learn and be trained in group counseling skills and small group dynamics. In addition to "who" should deliver the content, student journals helped to pinpoint the issues that needed to be discussed in group leader training. Group leaders were reminded of the low period first year students face before and after the first round of tests. They were told to expect problems with homesickness, with roommates, with loss—whether it be the death of a grandparent or breaking up with a boyfriend. The importance of confidentiality was stressed and group leaders learned about appropriate and immediate referral sources. Shared goals and expectations among the group leaders added structure to the small group sessions, while additional social times outside the classroom group setting aided in bonding among group members. In the sharing of common concerns, the age old power of universality as a therapeutic factor came into play. In the safe confines of a same sex group, over time, amid the laughter and the tears, students got and gave each other the confidence and encouragement that was needed for this time of transition.

## EVALUATION

Both formative and summative evaluation indicated that the changes to content and format over time resulted in positive experiences and increased retention for first year students. Sample comments for end-of-course surveys and journals showed how well students responded to the addition of the small groups (from Fall, 1995):

"I loved my small group. We got along so well. I always looked forward to going. I cannot think of any suggestions (for improvement of format)."

"The small group was a vital part of my making it through 1st semester. It was wonderful having a scheduled break where I could talk to friends."



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

"I thought that the small groups were extremely beneficial...It was a way to meet people and a place to ask the "dumb" frosh questions..., as well as an outlet for problems/frustrations."

"My small group was awesome, my favorite part of this class."

Summative evaluation using data provided by the university Registrar indicated the positive effect on retention:

**Table 1**  
**Engineering Retention of Female Students**

Year	ENGR 194	Cases	Percent Retained in Engineering		
			Semester 2	Semester 4	Semester 6
1990	No	187	90	68	57
	Yes	173	95	71	61
1991	No	217	93	67	55
	Yes	183	93	75	61
1992	No	229	93	73	58
	Yes	170	96	82	74
1993	No	196	95	70	
	Yes	197	97	70	
1994	No	154	92		
	Yes	185	91		

## CONCLUSION

Few students leave engineering because they are academically ineligible to continue, so it is reasonable to believe that positive experiences for education and personal growth may be strong contributing factors to retention. The journals and small group discussions, supported by retention statistics, indicate that ENGR 194 provides such a positive experience for first year women students in engineering at Purdue University. More detailed information on course organization and delivery is available (Reklaitis, 1990).

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## CLUSTERING TO IMPROVE RETENTION OF WOMEN IN ENGINEERING

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In an effort to improve retention rates of women in its engineering programs, Virginia Tech has instituted voluntary gender clustering in the first engineering class (EF1005 - Engineering Fundamentals, Problem Solving and Computer Programming) offered to incoming freshman and transfer students. This clustering was not intended to produce women-only sections of this class but to create multiple sections which are ethnically diverse and contain a greater number of women in each section. Gender clustering facilitates the formation of study groups by the students with their gender peers. The clustered sections were also supported by academic workshops conducted by upper-class students who were specifically trained as workshop leaders. The workshops were modeled after the program developed by Dr. Ray Landis and Dr. Kay Hedspeth, California State University-Pomona, for enhancing the retention of minority students in engineering. The instructors involved in the clustered sections have attended training sessions on improving minority retention.

### INTRODUCTION

Virginia Polytechnic Institute and State University will award bachelor degrees to roughly 4300 students this academic year. Of these degrees, about 42% or 1800 will be awarded to women. Virginia Tech's College of Engineering will award 950 bachelor degrees along with 450 Masters and over 100 Doctorates. Of these Bachelor of Science Degrees in various engineering disciplines, only 160, or roughly 16% will be awarded to women.<sup>1</sup> Nationwide, more than 10,000 women will earn engineering degrees this year, whereas over 50,000 men will attain this academic level.<sup>2</sup> Despite the fact that women are over 50% of the population of the United States, engineering school enrollments do not reflect this gender dominance, and the engineering profession remains a predominantly white male bastion.

Undergraduate enrollment at Virginia Tech, currently at over 19 thousand per year, has seen a markedly consistent male to female ratio for the past six years. It is anticipated that Tech's 1996 enrollment statistics will show nearly 11,500 men and 7,600 women, matching the 6 year ratio trend of 60/40 male/female. Not surprisingly, the male to female ratio is higher in the College of Engineering. This ratio has also remained steady over the past six years at 83 percent male, 17 per cent female. Numerous studies have been conducted over the past decade addressing low enrollment rates and poor retention rates among females in the engineering field.<sup>3 4 5</sup> Collaborative learning processes have received extensive study. One study was initiated in the Fall of 1992 at Virginia Tech,



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES

1996 WEPAN National Conference

funded through SUCCEED, to investigate the effects of voluntary collaborative learning or group study among freshman engineering students. Although many collaborative learning programs are structured, requiring students to participate and attend scheduled study-group sessions, Virginia Tech's program was voluntary. Two goals of the clustering program were to 'shape students into a supportive group in which every student knows the others.....and has a sense of group spirit and cohesiveness' and 'to encourage students to study together.'<sup>6</sup>

## GENDER CLUSTERING

Virginia Tech instituted a pro-active minority engineering program in 1992. This program was aimed generally at increasing the enrollment, retention, and graduation rates of racial minorities within Virginia Tech's College of Engineering. Success with this program has resulted in its expansion to include all under-represented groups, including women of all races.

The cluster schedules were devised to provide a reasonably representative proportion of females in their engineering classes. The intent was to provide a 50-50 ratio in the clustered sections. In prior years, typical class make up has resulted in three or four female students in any one section of EF. This proportion is not seen as conducive to promoting non-organized clustering of female students. With only a handful of gender peers in each section, it is unlikely that these students would share similar schedules, the same sections of their other 6 freshman classes, residence in the same dorm or on the same floor, racial similarities, or other factors which would normally promote clustering among their male counterparts. The males in each class (at least the white males) have a much larger population of gender peers from which to generate study groups. Clustered sections were therefore devised with 10 or more females in each — intended to be sufficient to provide the same clustering opportunities enjoyed by males. It was explicitly intended that no sections be women only. On the other hand, clustering the majority of the women in 8 sections of these introductory classes effectively reduced the number of women in the other 32 sections of these classes. The result is that although more group study opportunities were presented to the majority of the freshman women, those that did not enter a clustered section were more gender-isolated.

Of the eight sections of EF1005 that were intended to be gender clustered sections in the fall of 1995, only one had a 50% female enrollment. Three others had roughly 30% females, and the remaining 4 sections, fewer than 10 female students. In addition, instructor scheduling conflicts resulted in the two Chautauqua-trained instructors teaching 7 of the clustered sections, with the 8th taught by another member of the faculty of the freshman division. None of the spring semester EF1006 classes were intentionally gender clustered. At least one section had a greater than 50 percent female membership, in part due to the tendency of students to request the same instructor and class time for the second semester EF class. This may also be a successful result of the clustering begun in the fall semester. Female students in fall semester study groups may have attempted to schedule the same sections of their engineering classes for the second semester.

## RESULTS

A survey was distributed at the end of the spring semester to students in the EF1006 and EF1005 classes. Thirty-five percent of the freshman (519 of 1466) returned the survey forms. Distribution of the survey was voluntary among faculty, with some faculty members refusing to use class time to distribute and collect forms. In addition, about 200 freshman are not enrolled in either EF class.

Of those respondents, 53% participated to some extent in study groups. On a gender basis, 66% of the women and 55% of the men participated in these groups. Of those in study groups, 69% indicated that their study group was non-gender segregated. Again, within study groups, 55% of the men indicated that their study group was single-sex, whereas 33% of the women had same-gender study groups.

Fifty-three percent of the students in study groups indicated that the study group was effective and accomplished its goals. By gender, a larger portion of the women (64%) than men (51%) felt the study groups effective.

Seventy-one percent of all respondents indicated that they were 'comfortable' in their engineering classes - 72% of the men and 68% of the women. Eighty-two percent of the respondents indicated that they were not 'isolated' from their ethnic/racial/gender peers - 79% for men and 84% for women.. Sixty-seven percent of the respondents indicated that they received a fair grade in their introductory engineering classes - 65% male and 69% female. Results, at best, can be described as tentative. In the fall semester, participation in the WEST workshops was less than had been anticipated. Instructors in clustered sections have not, intentionally, modified their approaches to the topics to accommodate these students. Because of the administrative difficulties of registering these students in special sections of EF1005, and the associated complications with the rest of their academic schedules, faculty support of the clustering process has not been overwhelming. More than one faculty member felt that 'all students should be treated *exactly* the same.' Questions need to be addressed as to whether this year's entering freshman class is a statistical norm, as evidenced by SAT's, high school class rank, and college level success.

## ACKNOWLEDGMENTS

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<sup>1</sup> Projected data based on 1990 through 1994 graduation statistics. Institutional Research and Planning Analysis, Virginia Polytechnic Institute and State University

<sup>2</sup> Virginia Myers Kelly, 'Briefings', ASEE Prism, ASEE, 11/95.

<sup>3</sup> Dr. J.B. O'Neal, 'Engineering Education as an Ordeal and its Relationship to Women in Engineering', 1994 ASEE Annual Conference Proceedings, p. 1692.

<sup>4</sup> ASEE PRISM, March '96, 'Briefings', pg 15

<sup>5</sup> Dr. B. M. Vetter, 'Women in the Engineering Workforce: Progress in Century I', 1993 ASEE Annual Conference Proceedings.

<sup>6</sup> Schwartz, R.A. "Working Together to Succeed", ASEE PRISM, March 1996, pg. 30.





## 1996 CSU SWE AND BEATTIE ELEMENTARY GIRLS IN MATH AND SCIENCE CLUB SLED DESIGN CONTEST

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### INTRODUCTION

The Colorado State University (CSU) Society of Women Engineers (SWE) student section held a snow sled design contest for the Beattie Elementary Girls in Math and Science Club during February and March of 1996. The purpose of the Club, which meets two afternoons per month, is to spur the girls' interests in math and science careers, including engineering. The teachers formed the Girls in Math and Science Club after a similar club for both boys and girls had dwindling female participation as the school year progressed.

The club's activities include speakers discussing their technical careers, and field trips. This year, in addition to giving the girls a tour of the CSU Engineering Research Center, Dr. James and the SWE students created the Sled Design Contest which introduces the girls to engineering, shows them how fun and important engineering can be, and encourages interaction between the elementary school-age girls, the college-level engineering women students and women engineers from industry.

### PARTICIPANTS

Dr. Susan P. James, Assistant Professor in the Department of Mechanical Engineering at CSU and SWE Faculty Advisor, teamed the CSU SWE students up with Kathie Hagen and Nancee Codd, who teach 4th, 5th and 6th graders at Beattie Elementary School in Fort Collins, CO and run the Girls in Math and Science Club. Beattie is one of 26 elementary schools in Fort Collins' Poudre R-1 school district. Thirteen 4th, 5th and 6th grade girls from the Beattie Club girls participated in the event along with their teachers. Approximately 10 SWE students helped build and design the sleds, and run the contest, while others helped with fund raising, supply purchases, etc.. There were also 5 volunteers from industry (Woodward Governor, Hewlett Packard) who helped in sled building and contest judging.

### SPONSORS AND BUDGET

The sled contest sponsors donated \$1,100 in cash which was used to purchase tools, sled building materials and hardware, event banners, T-shirts and prizes. In addition, the sponsors donated sled building materials, T-shirt logo design and printing, two prizes (calculators), and most importantly several hours of their employees' time. The women engineers from industry helped the girls design and build their sleds and then helped SWE judge the final contest. The sponsors were Woodward Governor, Hewlett-Packard, CSU Civil Engineering, Hach and Fiberlok.

## OUTCOME

### Participant Quotes

*"I thought it was really cool. We got to use power tools, and there were no boys around."*  
-- Adrienne Morgan, age 12.

*"It was a lot of fun. I got to meet a lot of people and made a lot of friends. I'm going to be an engineer when I grow up."* -- Mai Abdulrahman, age 11.

*"I liked that we designed our sled. We got to design and model them ourselves. It was really fun."* -- Ana Delgado, age 11.

*". . . the girls have realized that there was a lot they didn't know that was math- and science-related. There was a lot of enthusiasm."* -- Nancee Codd, Beattie teacher.

### Design/Building Sessions

There was a total of four sled design and building sessions, each 1.5 hours long, held after school at Beattie Elementary on Tuesdays and Thursdays. We began by discussing with the girls some of the engineering principles involved with sled building (friction, aero(snow)dynamics, strength, stiffness). We also explained the various contest categories (see below) to the girls and encouraged them to design sleds which could meet some or all of the categories.

The girls were divided into five teams and each team built one sled. All the adults helped all the teams come up with a design and then construct the sled. A wide variety of supplies were made available to the girls, including wood, plastic sheets, inflatable rafts, foam, wax, old skis, rope, oars, PVC pipe, and plastic containers. They were also allowed to make requests for additional supplies.

It was during the actual design and building that the girls learned the most about engineering. For example, one girl requested a steering wheel for her sled. When asked why she explained that she wanted to be able to steer and thus need a steering wheel. The adults helping her design got her to start thinking about steering mechanisms and sent her home to climb under her parents' car to investigate how the steering wheel on the car worked. In the end she went with a simpler steering mechanism. Many of the girls learned about strength and stiffness and joining methods.

Both the adults and the kids learned about group dynamics with the help of the Beattie teachers. We wanted everyone to learn, have fun and work together. Designing by a group is not easy and we did have to settle occasional small disputes within teams. There was some jealousy from the boys who peered in the windows at their female counterparts hammering and drilling away at their sleds.

### Contest

The biggest obstacle to the contest was the lack of snow in Fort Collins during February and March. The contest had originally been planned for the Saturday after the sleds were built but had to be postponed almost three weeks due to a lack of snow. The contest was finally held on Monday, March 25 after school at the Pine Ridge Natural Area in Fort Collins. There was enough snow for sledding but it was very cold!



There was a grand prize for the team whose sled won the most overall points, plus prizes for each team that won the most points in each of the following four categories:

- 1) Best Engineered (as presented by each team to the judges): most original, most elegant, most durable, simplest, least expensive, most user-friendly (easy to get up the hill, stores in small space, comfortable to ride);
- 2) Fastest: fastest time down the alpine course;
- 3) Most Maneuverable: best steering through the slalom course;
- 4) Safest: shortest breaking distance on alpine course (pilot must stay in sled).

The grand prizes were a scientific calculator for each team member. The other category prizes were book store gift certificates, movie theater passes and ice skating and swimming pool passes. Everyone won a prize and each team got a certificate. All the girls, teachers, SWE and industry participants received contest T-shirts.

It is difficult to gage whether the girls or the adults had more fun! It was a positive (albeit cold) experience for all. Several of the sleds broke during the contest and had to be fixed on the spot (duct tape!). Although the designs were far from perfect, some of the sleds were quite fast and some could stop on a dime. Steering through the slalom course proved to be the most challenging event with no one successfully clearing all the pylons. The girls presented their sled designs at the end of the contest to the judges and discussed which design aspects worked well and which did not. It was at this point that girls learned by consensus from all the adult engineers present that failure and redesign were a part of engineering.

## LESSONS FOR THE FUTURE

### Participants

Next year we hope to involve more girls from the Poudre R-I schools. We will have a better budget and more experience on how to run things so involving more girls should be relatively easy. We will encourage the girls who participated this year to be advisors to next years' teams.

### Sponsors and Budget

The costs for running the sled contest will be lower (per sled) next year because we now have all the tools needed and event banners made. Raising the sponsor money should be even easier next year since we can demonstrate how successful the event and because Dr. James has NSF funding for next year which can be used to match industrial contributions.

### Design/Building Sessions

Next year we will allow more time for instruction, design and building of the sleds. We will also have them try out their designs before the contest so they can redesign if necessary. We now have a better idea of what types of materials and designs work better than others. In an effort to be more efficient we will not buy any building supplies ahead of time but will go shopping with lists specified by the various teams. In fact, we may even try to get the parents to help with the shopping and reimburse them for costs.

### Contest

We will hold the contest next year up in the mountains where there is always snow (i.e., CSU Pingree Park campus).



**MATH OPTIONS**  
**A MATH AND SCIENCE EQUITY PROGRAM FOR YOUNG WOMEN**  
**THE PAST, THE PRESENT, AND THE FUTURE**

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**Introduction**

Since the Math Options program was first introduced to the Women in Engineering Professional Advocates Network in June of 1994 in Washington, DC, the program has experienced an increase in demand and the need for further expansion. The program, which is a gender equity program for young women, has been able to grow and move forward through the sustained help and support of individuals in both industry and academia.

**Background**  
**(The Past)**

The Math Options program began in 1990. It started with the inspiration of two women who were members of the Philadelphia chapter of Women and Mathematics (WAM). These women saw a need to encourage young girls to opt for careers that were otherwise unattainable once the girls reached college age. As these women viewed it, the problem was caused by the girls not taking appropriate mathematics courses in high school. One of the women, an Instructor of Mathematics at the Penn State Abington-Ogontz campus, and the other, an accountant in private industry, brought their ideas to a female colleague in Continuing Education, and so, Math Options was born.

**Math Options**  
**(The Present)**

Math Options is a program for 7th, 8th, and 9th grade girls. It is a gender equity program that presents young girls with career options in mathematics, science, and engineering, i.e. careers which share mathematics as a foundation stone for success. Career options are presented in a sequence of programs consisting of a Career Day, a Panel Discussion and Social, and a Summer Institute.

## **Career Day**

The Career Day is a one-day Math Options program. This program is held on a local Penn State campus and is for girls who are completing 7th grade. During this one-day program, the girls are exposed to women in various mathematics related professions.

As the girls arrive with their teachers and/or counselors, they are assigned to a group. The purpose of the group is to allow the girls to meet and interact with girls from other schools. Separation from friends and classmates is ensured to allow the girls' attention to be focused on the many activities they are about to experience. Each group is assigned a female mentor who remains with the group throughout the day. The mentor may be a Penn State student or faculty member or a former Career Day participant.

The first activity the girls experience is a tower building contest. It is a group activity which "breaks the ice" and enables the girls to have fun and coalesce as a group. It requires the group to build the tallest tower of straws given a box of plastic drinking straws, a roll of scotch tape, and a lid from a xerox box which serves as the base.

The second activity consists of separate hands-on sessions with female presenters from industry or academia. The sessions begin with the presenter relaying pertinent information about her educational background and personal life. She then follows suit by involving the girls in an activity which is in some way related to her profession. Each group of girls will experience a total of three of these different sessions during the course of the day.

The third activity during the Career Day is an open forum called the Panel Discussion. Here a group of women panelists, usually no more than four, are asked to talk about their personal and professional lives and address questions posed by the audience of 7th grade girls, their teachers, and counselors.

The fourth, and final, activity of the day is the Career Fair. Here the girls are encouraged to chat with women whose careers may be of direct interest to them. This is a time when the girls have the opportunity to speak with whomever they choose on a close and personal basis.

### **Panel Discussion and Social**

Currently, this program, which targets 8th grade girls, is held during the course of one evening and is for previous Career Day participants and their parents. Parents are

specifically invited to this program in order to provide them with information to support the future career plans and aspirations of their daughters.

The panelists who participate in the Panel Discussion and Social are corporate representatives to the Math Options Advisory Committee on campus. They will not have served as panelists for Career Day and, as such, offer fresh, new anecdotes for the girls and their parents.

#### **Summer Institute**

The Summer Institute is a one-week Math Options program. It is held on a local Penn State campus and is for 8th and 9th grade girls. It is open primarily to girls who have attended the Math Options Career Day, however others are encouraged to apply.

The intent of the Summer Institute is to provide the girls with a more in depth interaction with women in the sciences and engineering. Each girl is placed in a group headed by a student mentor. The mentor acts as a resource and provides guidance and cohesiveness for her group. Group activities include on-campus laboratory and field projects, trips to sponsoring corporations, and daily journal writing exercises. The latter, which stimulates interaction and bonding between the girls, also serves as an informal means to assess the girls' level of interest in the day's activities.

#### **Mentoring Program and Longitudinal Assessment (The Future)**

The newest component of Math Options program is the one-on-one Mentoring Program. It is a program for alumnae of the Summer Institute and selected Career Day participants. The purpose of this newest venture is to put young women in touch with professional women in career fields of their choice.

Another new component is the longitudinal assessment study. This study is being undertaken to determine the influence of Math Options on the girls persistence in mathematics and science as well as to track the girls in their future career goals. Data has been collected for the Career Day which has been in existence since 1991 and similar data has been collected for the Summer Institute which begins its third year this summer.

#### **Update**

Early in 1995, a regional Director was hired to coordinate all Math Options activities and assist in the development of future programs. This position is housed under Continuing Education and is supported solely by external funding.





## **FRESHMEN P.O.W.E.R.**

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### **BACKGROUND**

One of the goals of the Women in Engineering Program at The University of Akron is to increase the number of engineering bachelor's degrees awarded to women by improving student retention. Estimates of retention rates revealed the greatest loss of female students was between the freshmen and sophomore years. This attrition is attributed to: a lack of adequate scholastic preparation, difficulty in making the transition from high school to college, a lack of strong motivation to earn an engineering degree, and difficulty handling the "chilly classroom climate" in engineering. To address these problems The University of Akron has developed an orientation for first-year women engineering students. This program, entitled Freshmen P.O.W.E.R. (Preview Of Women Engineers Retreat), was held for the first time in August 1995. The goal of the retreat was to provide these students with experiences to aid in the successful completion of their engineering degrees.

### **PROCEDURES**

#### **General Information and Opening Activities**

The half-day retreat was held on a weekend day before the start of the fall semester. An off-campus location was selected to provide students with a more relaxing environment. All incoming female freshmen were invited to the retreat. Thirteen students attended, out of a total of 26 new women in engineering. The retreat began at 9:00 a.m. and concluded at 4:00 p.m. Several of the day's activities were adapted from a retreat held at The University of California at Davis<sup>1</sup>, with new activities also created. The major program cost was for refreshments. Upon arrival, students completed an incoming survey, which assessed their knowledge about the different engineering disciplines and college life. The program then began with an ice breaker activity called "Human Bingo" which involved students obtaining background information about each other to complete a Bingo board.

#### **Transition Seminars**

Three seminars were featured to assist students in making the transition from high school to college and to help them achieve scholastic success. In the first seminar, students were informed on how they could take advantage of campus services and activities, such as tutoring. Special focus was placed on developing good study habits and becoming involved in engineering student societies. The second seminar prepared students for the "chilly classroom climate", through a discussion of a video on gender bias<sup>2</sup>. Students were informed on how to properly handle any gender bias that they might encounter. The third seminar showed students how to develop an assertive communication style.

## **Hands-On Activities**

Activities were designed to cover hands-on applications in the four engineering disciplines offered as undergraduate majors at The University of Akron. The purpose of these hands-on activities was to expose the students to engineering terminology and to familiarize them with some of the problems that an engineer might address. The overall goal was to provide motivation to succeed in their pursuit of an engineering degree. Women engineering professors and students were recruited to demonstrate the different activities.

### Mechanical Engineering

Teams of students were asked to design a system to help prevent the driver of a car from hitting the back wall of the garage when parking. This activity familiarized students with the process of brainstorming, and also illustrated that a variety of designs could solve the same problem. Following this activity, new teams were formed and each team was given a device with mechanical parts (i.e., cassette player, typewriter, doorknob) and a variety of hand tools to disassemble the device. This familiarized the students with different tools and to allowed them to understand how mechanical components operate.

### Civil Engineering

Students were led through calculations of material stress, strain, and modulus of elasticity. To illustrate these concepts, each student was then given two pieces of chalk and instructed to break one piece in bending and one piece in torsion. This exposed students to terminology used in discussion of strength of materials and helped them visualize the concepts they discussed. Students then worked in teams to calculate the deflection of a "bridge" (a yardstick simply supported by soup cans). This activity showed students how to make structural measurements and calculations and enhanced their teamwork abilities.

### Electrical Engineering

Students learned the basic concepts of Ohm's Law, first by seeing circuit diagrams drawn on the board, and then through experimental validation. Students worked in pairs to construct two different circuits and to measure the resulting current. This illustrated electrical engineering concepts and showed students how to verify the concepts experimentally. A second activity involved a demonstration of electromagnetic fields through a "homemade motor" to illustrate some additional electrical engineering concepts.

### Chemical Engineering

A demonstration of particle separation was provided for the students to familiarize them with concepts in chemical engineering. Different "filters" were used to separate different sized "particles." A second activity required the students to work in teams to solve an environmental engineering problem. Each team was to make a recommendation of how to contain a toxic spill using one or more different types of sealants. This illustrated the application of chemical engineering concepts to an environmental problem.

## **Closing Activities and Follow-Up**

Students completed a post-program survey to assess their perception of how much they learned. In the final activity, the students worked together to untangle a "Human Knot" showing them "by working together, you can unravel any problem." As a follow-up, students were encouraged to meet with the Director of the Women in Engineering Program for any assistance. Students were also encouraged to attend meetings of the Society of Women Engineers. To assess the short-term effects of the orientation, the pre- and post-program surveys were reviewed. The long-term effects were assessed by comparing the grade point averages of the students who attended the orientation with those who did not.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

## RESULTS

### Short-term findings

The surveys indicated that the participants increased their level of understanding of the different engineering disciplines, increased their knowledge of campus life and increased their confidence level in themselves. All students indicated that their understanding increased either "to some extent" or "very much." All students indicated that the orientation met their expectations "very much." Some of the comments included: "the hands-on experience was most valuable", "this helped me see some problems that I might encounter in a future job", "learning about communicating assertively was helpful", "the program was very informative, helpful, and fun". Some suggestions for future orientations were: "include some aspects of computer use", "involve more students to illustrate the concepts", "more hands-on experience!".

### Long-term findings

There were a total of 26 new first-year female students with a declared major in engineering. By the end of the Spring 1996 semester, 2 of these students had disenrolled and 4 students had changed majors. This resulted in a total of 20 female engineering students remaining after two semesters (76.9% all first-year female students retained). Of the 13 students who attended the Freshmen P.O.W.E.R. program, 2 disenrolled or changed majors. This resulted in a total of 11 students remaining from the orientation program after two semesters (84.6% orientation students retained). The median GPA for the 11 remaining P.O.W.E.R. students was 3.141, which was significantly higher than the median GPA of 2.902 for the other 9 remaining students who did not attend the orientation (median test,  $p=0.035$ ).

## CONCLUSIONS AND FUTURE DIRECTIONS

The short-term effects of the orientation were very positive. The participants developed a camaraderie, and also left the program with increased knowledge and increased self-confidence. The students became well acquainted with the Women in Engineering Program and the Society of Women Engineers, which may facilitate their use of these resources for ongoing support. The long-term effects (two-semester post-orientation) are also positive, yet somewhat inconclusive. The students who attended the Freshmen P.O.W.E.R. orientation program had a higher median GPA as compared to the median GPA for those who did not attend the orientation. This may indicate that the orientation helped students achieve scholastic success; however, the possibility remains that the students who attended the orientation were simply "better students" in the first place. Although the specific benefits of the orientation program are difficult to quantify, we believe that the program is an excellent way to help students make the transition from high school into college, and our initial results suggest that this type of orientation program may help improve retention during the freshman year. We intend to feature a similar orientation for the female engineering students who will begin their studies in the Fall of 1996.

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WONDER TO EXPLORATION: A COLLABORATIVE EFFORT BETWEEN A  
WISE PROGRAM AND THE GIRL SCOUTS TO INTRODUCE  
GIRLS TO ENGINEERING

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The Arizona Cactus-Pine Girl Scout Council has been attempting to involve science and engineering activities in individual troop sessions. The stumbling block was not a lack of interest on the girls' part, but a lack of knowledge on the troop leaders' part. The Girl Scout Council approached the Arizona State University WISE Program for assistance. In a collaborative effort, an experimental program was developed to incorporate science and engineering activities into the local Girl Scout Day Camp. The program, "Wonder to Exploration," was facilitated by WISE and Arizona State University female engineering graduate and undergraduate students.

The ASU student facilitators were trained both by the Girl Scout camp director as well as by the WISE Program. The Girl Scout camp director required that the engineering students be trained on issues such as child abuse, personality differences, children's health and safety, emergency procedures, and crisis management. The WISE Program training included how to encourage young women to excel in math and science, how to be a good role model, and how to run the various labs with enthusiasm and confidence.

The camps were designed for three age groups: 2nd-3rd grade, 4th-6th grade, and 7th-8th grade. For each group an age-appropriate, hands-on introduction to science and engineering was researched by WISE and ASU engineering students. During the week sessions, we met with each age group for 45 minutes daily for three weeks. Each day the girls were performing a science or engineering activity and learning about women in these fields.

"Science Wonders", the camp targeting 2nd-3rd graders, focused on elementary engineering and science concepts. The "Magical Egg Experiment", taught the girls that a vacuum can be created by extracting of oxygen. In another lab, the campers learned that air has weight by placing two identical balloons on a balance, puncturing one of the balloons, and observing the shift in weight. The well known, although not well understood,



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

fact that the sky is blue and the sunset is red, was easily illustrated using water, which represents the atmosphere; milk, which represents the particles in the atmosphere; a flashlight, which represents the sun; and a dark room, which represents space. The simple concept that heat causes expansion was demonstrated through the "Bottle Fountain." A bottle containing cold water and air was submerged in a bowl of hot water. When the air was warmed, it expanded and pushed the water out a straw on top of the bottle. Finally, the girls were introduced to the states of matter when they made a thixotropic substance we called "goo." The substance was made of cornstarch and water. To encourage continued interest in science, we provided the girls with a mini book of science and engineering activities to do at home.

The 4th-6th graders participated in "Fly Me to the Stars." In the first project, campers were given background information and limited supplies and were instructed to make a scale model of a planet. An understanding of the distances between the planets in the solar system was achieved when they used string to show the scaled length of their planet from the sun relative to the other planets. They reinforced their knowledge of the planets by sharing what they had learned with the rest of the camp. Stories were created using star constellations to form characters and events, similar to Hercules battling Serpens. During another experiment we discussed what makes an airplane fly. The concepts of lift and drag were introduced, and, using these ideas, the campers competed in a reengineering contest. Given specific criteria, they were challenged to redesign a paper helicopter. In the final lab, the 4th-6th graders worked with the older girls to make a space bubble out of plastic and a fan.

The experiments for the oldest group of girls, 7th-8th graders, were drawn from the theme "Space Exploration." They got a taste of environmental engineering during the global warming lab. Campers used plastic two liter bottles and a thermometer to study the greenhouse effect. The girls made balsa wood planes and perfected their flight by tweaking the control surfaces. Physics, astronomy, and chemistry principles were clearly illustrated during "Comet in a Bag." Several ingredients were placed in a freezer bag and, after a few minutes, a simulated comet was formed. Rusty nail shavings (iron) interacted with charcoal pieces (carbon), sand (debris), water, and dry ice (solid icy core of comet). In another demonstration, a police helicopter was flown into the camp giving the girls the opportunity to see applied aerodynamic principles. Teamwork was emphasized when the girls worked together to make a space bubble. Once the space bubble was made, a planetarium was used in simulating an actual flight in space.

For each activity, we focused on a woman who had made a contribution to that particular field. The major information for this part of the activities was taken from *The Scientist Within You*<sup>1</sup>.

As the camps went on, we quickly realized that we had underestimated the knowledge base and previous exposure to basic scientific principles of the girls. The level of difficulty was increased by one of two methods: expanding the background information or using the labs designed for the higher age groups. An unforeseeable obstacle occurred when some of the girls attended the camp multiple times. We did not alter our programming to compensate for this. However, we allowed the girls who had done the experiments previously to explain the underlying concepts to the new campers. A motivational factor for the girls was that the labs filled badge requirements. Overall, the feedback and evaluation indicated positive response. The girls stated that they enjoyed the "Comet in a Bag" and the "Space Bubble" the most.

The Girl Scouts have been educating girls and women for many years, operating on the principle that girls grow, learn and have fun by making decisions, doing and discovering for themselves. A collaboration with them was an opportunity for the WISE Program to reach out to younger girls. The activities were designed to stimulate curiosity and to teach science and engineering through interactive and participatory learning. A planned extension of this project is to incorporate these sorts of activities in the Girl Scout's residential camps and the individual troop meetings.

Working with the Girl Scouts is a unique opportunity for WISE programs because they have an established national organization that supports girls ages 5-17. We suggest other WISE organizations interested in pursuing this sort of program completing all monetary arrangements, program expectations and time commitments (in writing) with the outside organization prior to initiation of the activities.

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## EARLY COOPERATIVE WORK EXPERIENCE: A COMPARISON FOR MALE AND FEMALE FRESHMAN ENGINEERING STUDENTS

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### ABSTRACT

Because the vast majority of students at GMI Engineering & Management Institute major in engineering, female students are less likely to feel "isolated" than their peers at universities offering degrees from a variety of disciplines. Women student at GMI usually report a strong sense of "fitting in" while on campus. However, it is feared that the cooperative work experience which every student must undertake for one half of each academic year may be disproportionately stressful for young women engineers. Because research indicates that young women are more likely than young men to blame themselves for failure and to quit without complaint<sup>1</sup>, there is concern that a segment of the prospective female engineering student population may leave before graduation due to stressful or difficult assignments in industry. These concerns have resulted in the creation of a survey for freshman students when they return from their first cooperative work experience. The results of this survey show differences in perception of work assignments based on gender. These results will assist in the design of an orientation program for female students about to begin working in industry.

### BACKGROUND

Many studies have been conducted evaluating the experiences of women in engineering programs, and most return with disappointing results.<sup>1-3</sup> At the high school level, girls are less confident in their academic abilities than boys<sup>4</sup> and research suggests that the disparity in confidence levels only increases throughout the undergraduate years.<sup>1,5,6</sup> In a study reported in the *Journal of Engineering Education*<sup>1</sup> last year, a group of students were followed throughout their chemical engineering curriculum. While freshman, the women showed signs of being far more likely to succeed in the program (more educated parents, better entrance examination scores, better concentration and study skills.) Yet there was no statistical significance favoring their success in the undergraduate engineering program. On the contrary, they were more likely to drop out of the program while in good academic standing, and they were far less likely to retake a course in which they had failed. Experts agree that recruitment programs that boost confidence and mentoring programs that bolster retention are critical<sup>3,7,8</sup>, and steps have been taken at GMI Engineering & Management Institute to provide these mechanisms within the academic setting on campus. The purpose of this study was to examine the differences in perception that men and women experience regarding their cooperative work experiences so that appropriate mechanisms of support could be provided to these students while at work as well.



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

## RESULTS

Fifty five freshman students, all enrolled in the same Problem Solving (ENGR100) course, were given a questionnaire to complete via spreadsheet as part of an assignment in the Fall of 1995. All students had begun their cooperative work experience during the Summer term of 1995. Thirteen of the students were women (24%) with the mean age for both genders being equal (18.2 years).

Students were asked to identify the three job assignments they received most often during their first three-month work term. They were then asked to rate each of these assignments on a scale of 1-10 according to: Input, Preparedness, Enjoyment, Absence of stress, Level of Support, Self Evaluation, and Supervisory Evaluation. In all cases, a score of ten meant a positive feeling regarding that assignment and a score of 1 indicated a negative feeling.

The surveys were collected, and ten major job types were identified from the assignment described. These job types were: sitting, cleaning and painting, observing others, clerical tasks, machining and light assembly, testing and equipment calibration, reporting and conducting meetings, CAD/CAM support, customer support, and computer programming.

Examination of the distribution of job types showed that the five most frequently assigned tasks were the same for men and for women, in the same order. These were (1) reporting and conducting meetings, (2) clerical tasks, (3) testing and equipment calibration, (4) CAD/CAM, and (5) sitting. The least frequently assigned task for women was machining and light assembly and the least frequently assigned task for men was customer support.

When asked how much input they felt they had in determining their job assignments, women usually rated their level of input higher, even in the assignments they liked least. Because this survey examined the perceptions about work, this response may be biased by different expectations between men and women; perhaps women felt they had more input because they expected little input.

Women reported a high sense of preparedness in the areas of "sitting", "observing others", and "customer support", and a low sense of preparedness in the areas of "testing and equipment calibration", "CAD/CAM", and "computer programming". Men felt most prepared in the areas of "cleaning and painting", "clerical tasks", "CAD/CAM", and "computer programming". They felt a low sense of preparedness in "machining and light assembly" and "testing and equipment calibration".

When asked how much support they were given in undertaking their assignments, men tended to feel well supported for most assignments. Women felt particularly more supported in the areas of "observing others" and "customer support" and particularly less supported in the "cleaning and painting" and "machining and light assembly" areas.

Women reported high feelings of stress for the "cleaning and painting", "machining and light assembly", "CAD/CAM", and "computer programming" job assignments. They reported low levels of stress for the "sitting", "observing others", "clerical tasks", and "customer support" assignments (tasks which they tended to feel prepared for and supported in). Men found all tasks to be reasonably stress free.

When asked how much they enjoyed their work assignments, women responded less positively in all areas except for "reporting and conducting meetings" and "customer support".

When asked how well they felt they completed their assignments, men and women both responded favorably. When asked how well they expected to be evaluated by their superiors, again, men and women both gave positive responses for all tasks.

## CONCLUSIONS

For all job types, even the ones which they liked the least, women were more likely to feel that they had input into determining their assignments than did their male peers. While this may indeed be the case, it should also be considered that women simply perceive that they have more input, based upon their level of expectation when entering into their work assignment. A followup survey is currently being conducted to measure how this perception might change with maturity and experience.

When drawing correlations between the stress experienced with a specific job type and other factors, a clear correlation was found for men between the level of stress they felt and a feeling of being unprepared. For women, a combination of two factors - feeling unprepared and feeling unsupported - correlated to feeling highly stressed.

Most assignment types were given as often to men as they were to women with a couple of notable exceptions. Men were more frequently assigned to "cleaning and painting" and "machining and light assembly", jobs identified by women as unsupported and highly stressful. Women, on the other hand, were more frequently assigned to the two jobs they reported enjoying most, "reporting and conducting meetings" and "customer support" job types. In addition to this, women responded positively regarding their level of preparedness, their level of support, and their freedom from stress in the area of "customer support".

These results will be used to design an orientation program for women about to undertake their first cooperative work experience. Areas where women tended to feel unsupported, unprepared, or stressed, will be targeted for discussion. In addition, followup surveys will be conducted with this specific group of students to identify how their perceptions change over time.

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## **IDAHO JEMS: A PRE-COLLEGE ENGINEERING EXPERIENCE FOR HIGH SCHOOL STUDENTS**

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### **INTRODUCTION**

The University of Idaho College of Engineering has offered a summer experience for high school students for twenty-eight years called Idaho JEMS (Junior Engineering, Math and Science -- previously Idaho JETS). While the program has helped to identify students interested in engineering, it has not been as successful in attracting young women into the summer workshop or into engineering at the college level. There continues to be a problem with the way young women perceive their abilities in math, science and engineering.

To change the perception that young women have about themselves and the fields of engineering, we offered a two-week summer engineering experience for young women and men. The workshop incorporated strategies to improve the instructional climate provided by the faculty; the understanding of gender and cultural diversity issues by students, faculty, and counselors; and the self-esteem of the young women.

The project offered, for most of the students, the first opportunity for a university experience. Students registered for a two credit pre-engineering course, lived on the University of Idaho campus, attended courses and laboratories in university buildings, and used other university facilities. The college atmosphere provided a transitional experience for the students that will be valuable when they attend college for the first time.

### **PROGRAM CONTENT**

One problem with learning environments has been that engineering tends to be a male dominated field. As women enter college to study engineering, they often have their first experience in taking a class that is predominately male. Often they feel uncomfortable or inhibited and may have a sense of not belonging in the class. The male students frequently ignore the few female students who are in the class and tend to gravitate to other male students when forming study groups or when working on group projects. The attitude of the male students can sometimes affect the way the female students perceive their role in engineering and their sense of belonging.

**WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES**  
**1996 WEPAN National Conference**

While it has been shown that female students are often less inhibited in classes/summer workshops that are all or predominately female, this approach ignores the problems they will face once they enter a college of engineering or another math or science field. If the culture of the college and the student population is not changed to become more inviting for female students, the graduation rate of female students in engineering may not improve significantly. This project tried to improve the climate of the workshop to make it more welcoming for female students and to influence the attitude of the male students and the faculty through workshops on gender and cultural diversity.

Most students have their first university experience by enrolling in the two credit summer workshop. By creating a situation similar to what they will encounter when they enroll in college, the project helps ease the transition from high school to a college or university. The students become familiar with dormitory living, library facilities, classrooms and laboratories, and faculty and staff in a college. Upon completion of the workshop, the students receive a letter grade and graduate from the program. They receive a certificate of completion along with a group picture of the workshop participants. Students select from among themselves four students to speak at the ceremony and to reflect upon the experience/knowledge they gained while participating in the workshop.

In order to make the content relevant and interesting to all students, the workshop focused on a human factors engineering problem involving the design of small home appliances such as entertainment centers. During the workshop, student teams were responsible for a group project. The project incorporated concepts learned in all courses to reinforce the information gained. On the final day of the workshops, the teams presented the results of their project to their families and other visitors. The presentation included a description of the design process, rationale for the particular design selected, and final results of the research project. Students used computer-aided-design tools to assist with the design of their project and to prepare posters and visual aids for the presentation.

Instruction for the design process included sessions on human factors engineering. Frequently, the human/machine interface part of the design process is neglected by engineers. Students attended a one and one-half hour per day course which provided information about the impact of a design upon the people who will use the product. The teams used the principles they learned about human factors to complete their design project and described the principles used in their design during their group presentation. In addition to the human factors course, students also attended courses in computer-aided-design and usability testing.

It is important that students realize the need for critical learning skills and the understanding of group dynamics. During the workshop, students were assigned different roles within a group. Over the two-week period each student had the opportunity to assume the responsibilities for each role in the group. The students also attended leadership training courses to help them understand the roles within a group,

why the different roles are important, and how motivational concepts work. Part of the leadership series included presentations on gender and cultural diversity.

The workshop included adequate leisure time for students to become acquainted with one another and to learn about the area, the university, and the college. The students participated in dances, picnics and other forms of entertainment to make their experience more enjoyable. To enforce the ideas they learned in the leadership course, the students participated in an adventure bound field trip. In this setting, students were encouraged to help each other complete physical tasks, such as rope climbing and rock climbing. The activity helped to reinforce the team concepts.

## SUMMARY

Partial funding for Idaho JEMS was provided by a grant from the National Science Foundation. Funding for the grant provided scholarship waivers for all participants of the workshop. As a result, a sufficient number of applications were received to increase the number of female participants to 50 percent of the total attendees. Participation by female students in previous years has been only 20 percent.

The NSF funding provided an opportunity for significant change in the content of the Idaho JEMS program. As a result, the program is now a model for future workshops which should enable the college to reach its goal of encouraging more women to enter engineering and computer science fields.

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OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES

1996 WEPAN National Conference





## **"ARMED & DANGEROUS - CAMP GMI, A PLACE FOR GIRLS"**

**Edith Withey, Director - Women's Resource Center**

**GMI Engineering & Management Institute, Flint Michigan**

Although GMI Engineering & Management Institute has been in existence for over 75 years, few efforts have been made to offer campus experiences for younger girls in the Flint and surrounding environs. This investigator began by gathering national statistics on girls in science and math and comparing those figures with local findings. The data collected from Flint's middle schools supported the national data documenting a steady decline in girls science and math test scores after they enter 8th grade. By the time these young women are ready for college, many do not have the academic preparedness to enter the technical fields. We concluded that there was a crucial need to provide services for middle school aged girls.

In 1995 with the help of Genesee Intermediate School District and a grant from the Community Foundation of Greater Flint, we began *Camp GMI* for 7th and 8th graders. This program was modeled after our *21st Century Woman*, a three year old science program for senior high school girls.

### **COMMUNITY INVESTMENT**

*Camp GMI* began as a total community effort. The school district coordinator was instrumental in getting applications to all 22 school districts in a three-county area. The grant provided sufficient funding for the start up. We also received funding from GMI for faculty stipends and equipment. In our pilot year, we served 24 campers and four older students trained as "fellows."

### **CRITICAL FACTORS**

#### *The Students - The Parents*

Orientation, at which time the entire program concept was discussed - was mandatory for both student and at least one parent/guardian. Parents were given factual data on why girls begin to lose interest in science and math courses.

They were also advised to continue encouraging their daughters to explore technical fields and to actively seek out programs that would provide additional exposure and opportunities. Research shows that parental support is a strong indicator of a daughter's decision to continue in these fields. It was also important to dispel the myth that young women in the technical fields do not lead normal healthy lives which include marriage and families.

## **FACULTY**

### *The Recruitment/Training*

We first requested and received support from our Women Faculty Task Force. We invited our entire faculty to take part in the program. Several brainstorming and planning sessions lead by Dr. Laura Sullivan, Industrial & Manufacturing Systems Engineer. In addition, several top science and math teachers from Genesee Intermediate School District provided a two-hour orientation for faculty who had not previously taught this age group. We also provided all interested faculty members with an activity book of experiments developed to introduce this age group to many different fields.

This project from the very beginning received strong support from GMI's President and Vice-President for Student Affairs. The Vice-President was able to secure an agreement with the Provost that allowed an overload for the three faculty members involved in curriculum development. All faculty/staff who taught were paid based upon contact hours.

## **THE PLAN**

Camp GMI ran from 8-4 p.m., Monday through Friday for one week. The girls were in classes/laboratories all day with one hour provided for lunch. The Thursday field trip involved a luxurious bus ride with movies, to the Detroit Science Center.

Each morning the girls were given their assignments, discussed the prior day's activities and shared their experiences. Because GMI is a year-round campus, they experienced regular campus life. They shared the cafeteria and conversation with the freshman engineering students. A panel of our female students provided for both personal and professional information. This was one of the program's highlights.

## **OTHER CRITICAL FACTORS**

Other important elements included a GMI student coordinator and trained peer leaders.

These "fellows" attended a one day leadership training seminar and were paid a weekly stipend.

A variety of personal and professional development activities, were included (motivational sessions, personal image building, team building and games).

We wanted to promote multicultural understanding and facilitate exposure among the girls who represented a diverse racial and socio-economic mixture. The girls were divided into two groups and given the responsibility of creating a 10 minute project to present at their "Grand Finale" banquet. Many of the girls formed new friendships as a result of this team activity.

Another important component of the project was a daily journal requirement. We wanted to instill the idea that writing skills are crucial regardless of chosen fields. Too many of our young people have never developed basic writing skills and others have not been encouraged to become more creative. Although some girls expressed a dislike for daily reflections, we found the journals provided insight into their true feelings about their experiences. They were also given the opportunity to enter a creative essay writing contest with the winner presenting at the Grand Finale.

### EVALUATION TOOLS

We modeled our process after that presented at a regional *WEPAN* conference. The pre and post program evaluation surveys were adapted from those utilized by Susan Metz (Stevens School of Technology) and Dr. Cinda Sue Davis - University of Michigan. Self-administered surveys, structured questionnaires, observations by faculty/staff and an analysis of the data base were used to determine success.

### FOLLOW-UP

All participants will be sent questionnaires to find out if they are taking more math and science courses. We plan to set up a monitoring system for tracking girls from our high school project to determine their fields of study upon entering college.

### FUTURE EXPECTATIONS

We received excellent media coverage of our programs this year and as a result, both projects received numerous applicants. This summer, *Camp GMI* will expand to provide campus experience for all applicants. Two weeks of camp will serve 60 campers and peer leaders. Another 60-70 girls will be offered a shorter version called "*Week-End Camp GMI*," which will consist of two Saturdays of classroom experiments, labs and a field trip.

Our biggest limiting factor is the year-round academic structure that limits the availability of laboratories and faculty during the summer months. Our "Super Saturday Series" (year round) help keep the girls interested and allows them to continue to expand their horizons.

In 1995 we served 24 Campers, combined programs this year will allow approximately 120 girls this unique opportunity. In conclusion, we have generated an academic atmosphere in which girls are expected to succeed!

## **APPENDIX A**

### **WEPAN National Conference Participants**



# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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June 1-4, 1996 • Denver, Colorado

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 WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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June 1-4, 1996 • Denver, Colorado

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WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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June 1-4, 1996 • Denver, Colorado

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# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES

1996 WEPAN National Conference

# Women in Engineering Conference

June 1-4, 1996 • Denver, Colorado

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## **APPENDIX B**

### **WEPAN National Conference Program At-A-Glance**

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference





# PROGRAM AT-A-GLANCE

## SATURDAY, JUNE 1

8:00 a.m. - 3:00 p.m.	WEPAN Board Meeting (Wind River AB)
2:00 - 5:00 p.m.	Registration (Mesa Verde Foyer)
3:00 - 6:00 p.m.	WORKSHOP 1 (Mesa AB) Evaluation - Interactive Hands-On Planning
4:30 - 6:00 p.m.	WORKSHOP 2 (Highlands) Steps to Leadership Success
6:30 - 7:30 p.m.	New Member Reception (Wind River AB)

## SUNDAY, JUNE 2

8:00 a.m. - 5:00 p.m.	Registration (Grand Mesa Foyer)
9:00 - 9:30 a.m.	Conference Welcome & Introduction (Grand Mesa ABC)
9:30 - 10:30 a.m.	PLENARY 1 (Grand Mesa ABC) Classroom Climate Revisited Bernice R. Sandler, Ph.D.
10:45 - 11:45 a.m.	SESSION 1 A. Workshop - Teaching Professional Survival Skills to Women in Engineering Students (Mesa Verde ABC) B. Utilizing Resources Effectively: From the Library to the World Wide Web (Highlands) C. Bridging the Gender Gap in Engineering and Science: The Challenge of Institutional Transformation (Wind Star AB)
10:45 - 11:15 a.m.	D. Situation of Women Academics in the New Länder in Germany (Wind Star AB)
noon - 1:15 p.m.	Lunch (Atrium)
1:30 - 2:45 p.m.	SESSION 2 A. Workshop - Communication and Conflict Resolution Between Colleagues (Highlands) B. Helping Women Select Career Paths (Wind Star AB) C. Perspectives of Female Executive Scientists & Engineers - Panel Discussion (Mesa Verde ABC)
2:45 - 3:00 p.m.	Break
3:00 - 4:15 p.m.	SESSION 3 A. The Experience of Being a Woman Engineering Student: Perspectives and Coping (Highlands) B. Navigating Career and Family Paths: Personal Perspectives - Panel Discussion (Mesa Verde ABC) C. K-12 Programs: Innovative and Collaborative Approaches (Wind Star AB)
4:30 - 5:30 p.m.	WEPAN Action Group Meetings Admissions (Highlands) Faculty (Wind Star AB) International (Mesa Verde ABC) Research (Wind River AB)
6:00 - 7:15 p.m.	Dinner (Grand Mesa ABC)
7:15 - 8:30 p.m.	"Miz Wizard's Science Secrets" (Grand Mesa ABC)

## MONDAY, JUNE 3

7:45 a.m. - 5:00 p.m.	Registration (Grand Mesa Foyer)
7:45 - 8:45 a.m.	Continental Breakfast (Atrium)
9:00 - 10:15 a.m.	PLENARY 2 (Grand Mesa ABC) Women Engineers and the New Focus on International Education William E. Kirwan, Ph.D. F. Suzanne Jenniches

10:30 - 11:30 a.m.

### SESSION 4

- A. Facilitated Discussion - An Interactive Discussion of International Programs (Wind River AB)
- B. Workshop - Practical Advice for Women in Engineering Program Administrators: What To Do When An Allegation of Sexual Harassment Walks in Your Door (Mesa Verde ABC)
- C. Curriculum Reform (Wind Star AB)

11:45 a.m. - 1:00 p.m.

Lunch (Grand Mesa DE)

1:15 - 2:30 p.m.

### SESSION 5

- A. Workshop - Gender Communications: He Said...She Said... (Mesa Verde ABC)
- B. Campus Climate Issues (Wind River AB)
- C. Corporate Strategies for Increasing the Participation of Women: A Panel of Industry Representatives (Wind Star AB)

2:30 - 2:40 p.m.

Break

2:40 - 3:55 p.m.

### SESSION 6

- A. Workshop - Maximizing Your Resources: Working Effectively With Student Employees (Mesa Verde ABC)
- B. Retention Efforts - Programs That Work (Wind Star AB)
- C. K-12 Outreach Programs (Wind River AB)

3:55 - 4:00 p.m.

Break

4:00 - 5:30 p.m.

POSTER SESSIONS (Chasm Creek AB)

3:45 - 6:00 p.m.

Book Sale by Tattered Cover Bookstore (Chasm Creek Foyer)

5:30 - 6:30 p.m.

Reception (Atrium)

7:00 - 9:00 p.m.

Gender Equity Workshop for Middle and High School Teachers (Highlands)

## TUESDAY, JUNE 4


8:00 - 10:00 a.m.	Registration (Grand Mesa Foyer)
8:00 - 8:45 a.m.	Continental Breakfast (Atrium)
9:00 - 10:00 a.m.	PLENARY 3 (Grand Mesa ABC) Affirmative Action: Promise or Progress? What Lies Ahead? Yvonne Freeman, Ph.D.
10:15 - 11:15 a.m.	SESSION 7 A. Facilitated Discussion - An Interactive Discussion on Affirmative Action (Mesa Verde ABC) B. Programs at 2-Year and Community Colleges (Wind River AB) C. New Ways of Looking at Engineering Education: TQM (Wind Star AB)
11:30 a.m. - 12:30 p.m.	Lunch (Grand Mesa DE)
12:45 - 1:45 p.m.	SESSION 8 A. The Year of the Women: A Report on the First Year of Coeducation at Rose-Hulman Institute of Technology (Mesa Verde ABC) B. Curriculum Reform: Innovative Teaching Methods (Wind River AB) C. Campus Climate - Perspectives From Coalitions (Wind Star AB)
1:45 - 1:50 p.m.	* Break
1:50 - 2:45 p.m.	WEPAN Annual Meeting (Mesa Verde ABC)

**WOMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES**  
1996 WEPAN National Conference



## APPENDIX C

### **WEPAN National Conference Annual Business Meeting**

 OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



**WEPAN Annual Business Meeting**  
**Tuesday, 1:50 p.m. - 2:45 p.m.**  
**June 4, 1996**

The 1996 WEPAN Annual Business Meeting was called to order by President Suzanne Brainard. All new and returning WEPAN Board of Directors were introduced. The new Board members are as follows:

**At-Large:** George Brewster, Corning Incorporated  
**Western Region:** Mary E. S. Loomis, Ph.D., Hewlett-Packard Laboratories  
**Mid-Western Region:** Marcia R. Simpson, Mobil Corporation

Returning WEPAN Board members are:

**Mid-Western Region:** Judith W. McDonald, The Ohio State University  
**At-Large:** Carmen B. Cannon, Ed.D., Howard University  
Karan L. Watson, Ph.D., Texas A&M University  
Susan Wood, Ph.D., Westinghouse Savannah River Co.

John C. Vergelli announced his plan to step down from the WEPAN Board as a result of his impending retirement from the IBM Corporation. The Executive Committee thanked Mr. Vergelli for his commitment to the WEPAN organization and hoped he would continue his participation. In addition, Suzanne R. Nagel's Board appointment will end this year. Suzanne Brainard presented her with a plaque for her two-year appointment and thanked her for her commitment.

**TREASURER'S REPORT:** Karan Watson reported that because of a good Conference turnout, the WEPAN treasury will come out with a profit.

**AWARD'S COMMITTEE:** Jill Baylor announced the awardees of the Presidents, Research and Program awards for 1996.

**President's Award:** Suzanne Brainard, President, and Jane Daniels, Past President, were both selected. Jill described Suzanne's energy and determination to WEPAN as well as her fundraising efforts which brought in at least two million dollars in grant money for the organization as determining factors. Jane Daniels was the first president of the fledgling organization. Because of her experience and knowledge, WEPAN was able to grow and expand during her tenure. Jill mentioned that Jane has also been able to raise five hundred thousand dollars for WEPAN. Both Suzanne and Jane announced that they were going to donate the \$1,000 award money back to WEPAN to establish a Betty Vetter Scholarship Award. They hope to be able to raise more funding for this new scholarship.

Research Award: Emily Wadsworth was selected for the Research Award due to her research on women in engineering and women in engineering programs in the United States. She developed, implemented and evaluated WIE Programs and published the materials for use by others doing similar research. She has also served as a mentor, role model and friend to many people around her.

Program Award: The University of Maryland was selected based on their numerous programs which help improve the atmosphere on campus for underrepresented undergraduate and graduate students.

**CONFERENCE COMMITTEE:** Miriam Maslanik was presented with a plaque and thanked for her work and dedication to the 1996 WEPAN Conference. Suzie Laurich-McIntyre, who served as Miriam's Co-Chair, was thanked and given a plaque as well. Suzie Laurich-McIntyre and Carmen Cannon will both serve as the Co-Chairs for the 1997 WEPAN Conference, which will be held in Washington, D.C. on March 8-11.

**STANDING COMMITTEES:** The Standing Committees were announced and each gave a brief synopsis of their activities.

Ethics & Standard Practices Committee: This committee was formed to assist WEPAN with procedures to follow when members represent WEPAN to outside organizations. The Committee Co-Chairs, Susan Wood and Indira Nair, asked for volunteers to help them with the program.

New Members Committee: Connie Stein was thanked for her work with the New Members Reception which was held for the first time at the 1996 Conference.

Metrics & Milestones Committee: Kathleen Buechel explained that the Metrics & Milestones Committee is dedicated to publishing a report which chronicles the developments and achievements of WEPAN during its brief history. She mentioned that this report should help WEPAN move forward toward the future.

Speaker's Bureau: Jane Daniels will be working to delineate the objectives of this committee.

Membership Committee: Jill Baylor announced that she will be sending out letters to prospective corporations to attempt to recruit more corporate membership in WEPAN.

The other Committees are: the Nominating Committee, Chaired by Jane Daniels and the Review & Publications Committee, Chaired by Cinda Sue Davis.

**NEW INITIATIVES:** Susan Metz announced three new Products and Services for WEPAN members. They are:

(1) A book entitled, *Increasing Access for Women in Engineering*. The sponsor for publishing this book is FIPSE (Department of Education) and WEPAN. An order form will be mailed out to the WEPAN membership. The publication will be available in August 1996.

(2) Mentoring Training Manuals, funded by NSF and FIPSE, will be available in 1998. The project is being test-piloted at several institutions during Summer 1996.

(3) The 1996 Regional Training Seminars will be funded by a grant from the Philip Morris Company. They will be held primarily for community colleges and universities that participate in bridge programs which help students in transferring from two-year colleges to four-year universities. This year, they will be held at the following locations: University of Colorado-Boulder on September 8-10, 1996; the University of Illinois-Chicago on November 3-5, 1996; and at the Thomas Nelson Community College in Hampton, Virginia, on December 1-3, 1996. The regular Training Seminars, which are held for Women in Engineering Program representatives, will return in 1997 and will be funded by the Sloan Foundation.

**ACTION GROUPS:** Pat Glassner announced the new and returning Chairs for the four Action Group committees:

AGRED: Sylvia Middleton will be the new Chair and Dorie McCubbrey will be the Vice Chair. Pat told WEPAN members that the Evaluation Workshop held at the Conference was a success.

Admissions Action Group: Lisa Oliveira will be the new Chair and Yvonne Romero will be the Vice Chair. She would like to do a workshop at next year's Conference. She will send out a survey to WEPAN members to solicit ideas.

Faculty Action Group: The new Chair will be Carolyn Heising and the Vice Chair will be Eileen Ashworth. Their plans are to help establish an ementoring network.

International Action Group: Barbara Lazarus is the returning Chair and Gertrud Humily is the returning Vice Chair. Their goals are to establish an email mentoring list.

Pat Glassner asked all WEPAN members to join an Action Group that they would be interested in.

**RAFFLE:** The Business Meeting concluded with a drawing for Hewlett-Packard calculators and other gifts. The winners of the two **H-P calculators** were: Marjorie Leavene and Jan Rinehart. The winner of the **Multimeter** was Deidre Hirschfeld. The **Deskset** was won by Deborah Walter. Winners of **T-shirts** were: Karan Watson, Carmen Cannon, Bernadette Soltero and Michele Fish. **Mouse pad** winners were: Mary Pavone, Normandie Zagorski and Wyona Turner. **Towel** winners: Jean Cathcart and Cheryl Morris. **Hats:** Suzie Laurich-McIntyre, Jonne Brown, Pam McGrew-Kesselring, Pat Glassner, Sue Scheff and Susan Metz. **Golf club cover:** Susan Smith.

The WEPAN Business Meeting concluded at 2:40 p.m.

Respectfully submitted:

Claire M. LeBlanc  
Assistant to the President, WEPAN



## APPENDIX D

### WEPAN National Conference Action Group Meetings



## WEPAN FACULTY ACTION GROUP MEETING MINUTES

Submitted by:  
Carolyn Heising  
Iowa State University

### In Attendance:

Prof. Mary Anderson,  
Arizona State

Prof. Mary C. Verstraete  
Univ. of Akron

Prof. Carolyn Heising  
Iowa State

Prof. Karan Watson  
Texas A&M

Prof. Elizabeth Ervin  
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Prof. Eileen Ashworth  
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Suzie Laurich-McIntyre,  
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Prof. Laura Steinberg  
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Deborah Waltar, PhD  
Penn State

Prof. Harriet Black Nembhard  
Auburn U.

Sarah Whitlock  
Stanford University

Prof. Caroline Carvill  
Rose-Hulman

We discussed issues related to developing a network of ties across the US and Canada, and possibly elsewhere, including Australia, etc. of women engineering faculty. We would plan to do this initially

through the INTERNET (e-mail) and also through various available professional engineering societies professional women's organizations. We also discussed tying in with the women in academia committee of SWE (which Carolyn Heising attended in June at the SWE Portland meeting). We discussed new leadership, and Carolyn Heising became the new chair of the meeting after volunteering to relieve Dean Mary Anderson, who has tirelessly worked for WEPAN (and SWE) for so many years in her multiple roles. We discussed a position paper that was being spearheaded by Mary Anderson and Karan Watson.

We discussed future efforts to be made at WEPAN at the next conference in the Washington, DC area principally focusing on a panel that would address women in academia concerns. Several of the members present agreed to participate as panelists. Issues such as tenure and promotion were discussed, and availability of faculty slots as several attendees were PhD students interested in future careers in academia. Ties were made with the women faculty and the students in this regard. Issues of obstacles that women faculty face in engineering colleges were also discussed, and individuals made personal observations based on their relevant experience. The backlash against women in academia in general was discussed, as well as the backlash against affirmative action programs and how this impacts faculty women in particular. A discussion was held of the issue of women faculty teaching evaluations by both male and female students; these evaluations were discussed in a paper by Bernice Resnick Sandler and this issue was also touched upon by Dr. Sandler in her keynote address to the WEPAN conference. It was determined that the WEPAN faculty action group would develop a position paper related to this issue of teaching evaluations and how such evaluations are used in academic decision-making, particularly with respect to promotion and tenure issues. It was agreed that the work done by Dr. Sandler's center would form a central part of this position paper. It was also suggested that the WEPAN women faculty action group develop such a position statement jointly with the SWE women in academia committee. The new chair of the action group, Dr. Heising, agreed to serve as liaison between WEPAN and SWE in this regard. It was agreed that such a position paper would be circulated to all Deans of Engineering so that the issue of teaching evaluations in women engineering faculty promotion and tenure cases be taken seriously.

## ACTION GROUP MEETINGS: INTERNATIONAL MINUTES

Submitted and chaired by:  
Barbara B. Lazarus, Ph.D.  
Chair, WEPAN International Action Group

Members of the International Action Group have a variety of interests and concerns including: American graduate study opportunities for Canadian Students, helping international women students acclimate to engineering study in the U.S., finding work, study abroad opportunities, finding employees for the global economy, finding support systems for women in science and engineering worldwide, and examining the cultural factors which have encouraged retention and success of able young women in other countries.

Mechanisms which help the IAG members stay in touch include: the GE3 student exchange, a DLIST among members, and the annual conference. Next year we hope to sponsor a panel on issues for women from countries in science and engineering, a session on model support programs offered for our international students, and a plenary session with a major address by an international leader in women in science and engineering.



ACTION GROUP ON RESEARCH, EVALUATION, AND DISSEMINATION  
MINUTES

Submitted by Dorie McCubbrey, AGRED Co-Chair

Chaired by Silvia Middleton  
University of North Carolina, Charlotte, North Carolina

1. The meeting began at 4:35 p.m. Present were 27 WEPAN members.
2. Emily Wadsworth, chair of the AGRED Executive Committee for the 1994 and 1995 academic years, began the meeting by "passing the baton" to Silvia Middleton, who was elected to lead the AGRED Executive Committee as chairperson for a two-year term. Emy also "passed the baton" to Dorie McCubbrey, who was elected as co-chair. Emy thanked the group for their support, and also thanked the WEPAN board for their support of AGRED.
3. Silvia Middleton introduced herself, and stated that her goal as chair of AGRED was to continue the excellence set forth under Emy's direction. Silvia referred to the change in leadership of AGRED as the "changing of the guardians" of AGRED. Silvia, wearing a guardian angel pin, presented Emy with a guardian angel pin and thanked her for her contributions. Silvia also gave guardian angel pins to Michele Fish and Dorie McCubbrey as the co-chair guardians.
4. Dorie McCubbrey introduced herself, and indicated that she and Silvia wanted the AGRED membership to become actively involved in planning AGRED's future directions.
5. Silvia asked each of the meeting attendees to introduce themselves, and to share what they were hoping to get out of their involvement with AGRED.
6. The Evaluation Workshop held at the 1996 Conference was discussed. Beverly Marshall-Goodell indicated that there was a great deal of information presented in a short period of time, and that she came away with what she needed. Miriam Maslanik stated that she learned that her institution was indeed engaged in aspects of program evaluation although prior to the workshop she had not realized this. Lisa Frehill indicated that consultations were held in addition to the workshop because it was

recognized that the workshop could not address each participant's specific needs. Geneva Blake shared that she obtained a good overview of evaluation which was very helpful. Emy Wadsworth thanked Dorie McCubbrey for chairing the committee which planned the workshop.

7. Group directions were discussed. Silvia stated that she would like to see more guidelines formulated for research, so that it is possible to compare "apples to apples" rather than "apples to oranges". Dorie stated that she would like to see AGRED develop future goals for all of the categories: research, dissemination, and evaluation. Participants shared their needs and concerns with the group. Silvia stated that a "shared vision" was necessary for the group to effectively move forward. She asked all meeting participants to answer three questions on a sheet of paper: first, needs from AGRED; second, short-term goals for AGRED; third, long-term goals for AGRED. The papers were collected at the conclusion of the meeting for review and detailed planning of future directions.

8. Ideas for the 1997 WEPAN Conference were discussed. Some ideas included: a workshop on proposal writing, a workshop on the development of web pages for the World Wide Web, a workshop on dissemination including where to publish results of research.

9. Three sub-committees were established: first, a Strategic Planning Sub-Committee with Silvia Middleton as leader and Beverly Marshall Goodell as co-leader; second, a 1997 Conference Sub-Committee with Jorga Kimball as leader; third, an Internet Sub-Committee with Irene Mikawoz as leader and Deidre Hirschfeld as co-leader.

10. Silvia concluded the meeting by thanking the attendees for their participation, and by giving each attendee a gold star to symbolize that AGRED is "reaching for the stars!" The meeting was adjourned at 5:45 p.m.

#### AGRED Executive Committee, 1996-1997

Chair: Silvia Middleton, University of North Carolina, Charlotte (sgm@uncc.edu)

Co-Chair: Dorie McCubbrey, The University of Akron (dmccubbrey@uakron.edu)

#### Strategic Planning Sub-Committee:

Silvia Middleton, University of North Carolina, Charlotte (sgm@uncc.edu)

Beverly Marshall-Goodell, The University of Iowa (bev-mgoodell@uiowa.edu)

#### 1997 Conference Sub-Committee:

Jorga Kimball, Texas A&M University (j-kimball@tamuk.edu)



## **APPENDIX E**

### **WEPAN National Conference Indexes**

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference



## AUTHOR INDEX

- |                                       |                                |
|---------------------------------------|--------------------------------|
| Algert, Nancy E., 45                  | Grimes, Charlena H., 341       |
| Athreya, Krishna S., 331              | Hellman, Nancy Bottone, 125    |
| Anderson-Rowland, Mary, 317, 337, 365 | Herbener, Kathy Weismehl, 119  |
| Bayer, Alan E., 323                   | Hirschfeld, Diedre, 323, 349   |
| Begolly, Joan A., 277                 | Hummel, Mary, 219              |
| Bigio, David, 163                     | James, S., 369                 |
| Binkley, Laura, 243                   | James, Susan P., 353           |
| Blake, Geneva, 193, 333               | Jenniches, F. Suzanne, 141     |
| Blaisdell, Stephanie, 337, 365        | Kimball, Jorja, 317            |
| Bott, Kathleen, 203                   | Kirwan, William E., 135        |
| Brainard, Suzanne, 83                 | Laughlin, Patricia, 157        |
| Brodie, Lynette, 67                   | Lazarus, Barbara, 33, 147,     |
| Brockhoff, Tracie L., 277             | Lewis, Sue, 305, 311           |
| Buie, Wendy, 271                      | LoFaro, Marsha, 213            |
| Carlin, Linda, 83                     | Mack, Karin, 201               |
| Carson, Sharon, 119                   | Manning, Colleen F., 4         |
| Carvill, Caroline, 285                | Margle, Janice M., 357         |
| Cassagnau, Christine, 193             | Marshall-Goodell, Beverly, 239 |
| Cavin, Susan, 185                     | Maslanik, Miriam K., 149       |
| Cooper, Sandra C., 213, 341           | McCarney, Gary, 171            |
| Collins, Deborah, 323                 | McConica, Carol, 105           |
| Cunningham, Christine M., 289         | McCubrey, Dorie, 361           |
| Curtin, Jean M., 193                  | McKinney, Jerri Gail, 171      |
| Daniels, Jane Z., 345                 | Mead, Patricia F., 163         |
| Davis, Cinda-Sue, 219                 | Metz, Susan Staffin, 101       |
| Dabipi, I.K., 297                     | Middleton, Angela, 337, 365    |
| DeLong, Mary J., 61                   | Mikawoz, Irene R., 243         |
| Doberenz, Ingrid, 41                  | Muller, Carol, 289             |
| Evans, Mary Ann, 179                  | Nair, Indira, 33               |
| Fish, Michele D., 75                  | Ocif, Jennifer, 239            |
| Fisher, Marlene, 179                  | O'Connell, Mary K., 353        |
| Frair, Karen, 317                     | Onaral, Banu, 233              |
| Freeman, Yvonne B., 251               | Pavone, Mary L., 289           |
| Frehill, Lisa M., 3, 5                | Perkins, Judy A., 297          |
| Goldberg, Julie L., 225               | Purushothaman, Sangeetha, 53   |
| Goodman, Irene F., 4                  | Reklaitis, Janine K., 345      |
| Gregg, Michael H., 349                | Remsberg, Judy P., 271         |

Rinehart, Jan, 317  
Rosenfeld, Elizabeth, 163  
Sandler, Bernice R., 17  
Schadler, Linda, 233  
Schloss, Kristy A., 263  
Silverstein, JoAnn, 111  
Simmons, Linda F., 297  
Siskind, Amy, 185  
Smith, Susan L., 285  
Sullivan, Laura L., 369  
Teasdale, Jean A., 373  
Tietjen, Jill S., 9, 263  
Tonso, Karen L., 93  
VanLeuvan, Patricia, 357  
Verstraete, Mary C., 361  
Vest, Jennifer L., 225  
Wadsworth, Emily M., 3, 6  
Watford, Beville, 349  
Watson, Karan, 317  
Wheatley, Margaret A., 233  
Withey, Edith, 377  
Zanish, Tanya L., 27



OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
1996 WEPAN National Conference

# ORGANIZATION INDEX

- American Institute of Physics
  - Cassagnau, Christine, 193
  - Blake, Geneva, 193, 329, 333
  - Curtin, Jean M., 177, 193
- Arizona State University
  - Anderson-Rowland, Mary, 317, 337, 365
  - Blaisdell, Stephanie, 329, 337, 365
  - Middleton, Angela, 329, 337, 365
- Carnegie Mellon University
  - Lazarus, Barbara B., ix, 33, 145, 147, 413
  - Laughlin, Patricia, 155, 157
  - Nair, Indira, 33
- Clark Atlanta University
  - Freeman, Yvonne B., 249, 251
- Colorado State University
  - James, Susan P., 329, 353
  - McConica, Carol, 99, 105
  - O'Connell, Mary K., 353
- Cornell University
  - Fish, Michele D., 73, 75
  - Cunningham, Christine M., 283, 289
- Corning Incorporated
  - Brewster, George, 199
- Dartmouth College
  - Muller, Carol, B., 99, 289
  - Pavone, Mary L., 289
- Denver, City and County of
  - Mejia, James, 261
- Drexel University
  - Onaral, Banu, 233
  - Schadler, Linda, 233
  - Wheatley, Margaret A., 231, 233, 329
- The DOW Chemical Company
  - Fowler, Deborah, 199
- Emory University
  - DeLong, Mary J., 51, 61
- The GEM Consortium
  - Fortenberry, Norman L., 177
- GMI Engineering & Management Institute
  - Sullivan, Laura, 369
  - James, S., 369
  - Withey, Edith, 329, 377
- Goodman Research Group
  - Goodman, Irene F., 1, 4
  - Manning, Colleen F., 1, 4
- Hewlett-Packard
  - Herbener, Kathy W., 117, 119, 329
  - McCarney, Gary, 171
  - McKinney, Jerri, 171
- Horace Mann School
  - Oliveira, Lisa J., 25, 231, 329
- Howard University
  - Cannon, Carmen B., 81
- The IBM Corporation
  - Vergelli, John, 199, 269

- Iowa State University  
 Athreya, Krishna S., 329, 331  
 Evans, Mary Ann, 177, 179  
 Fisher, Marlene, 179  
 Heising, Carolyn, 411  
 Zanish, Tanya L., 25, 27, 329
- Lucent Technologies  
 Nagel, Suzanne R., 199
- M.A. Mortenson Company  
 Halverson, Steven T., 261
- Mittweida University of Technology and Business  
 Doberenz, Ingrid, 41
- Montana State University  
 Brodowy, Jeralyn M., 329
- National Association for Women in Education  
 Sandler, Bernice R., 15, 17
- National Action Council for Minorities in Engineering  
 Purushothaman, Sangeetha, 51, 53
- New Mexico State University  
 Frehill, Lisa, 1, 3, 5, 295
- New Jersey Institute of Technology  
 Cavin, Susan, 177, 185  
 Siskind, Amy, 185
- Northrop Grumman  
 Jenniches, F. Suzanne, 133, 141
- The Ohio State University  
 McDonald, Judith W., 155
- Pennsylvania State University  
 Begolly, Joan A., 269, 277  
 Brockhoff, Tracie L., 277  
 Carpenter, C. Jan, 81, 329  
 Margle, Janice M., 329, 357  
 VanLeuvan, Patricia, 357  
 Walter, Deborah J., 281
- Purdue University  
 Daniels, Jane Z., 211, 329, 345  
 Deno, Cathy, ix  
 Floyd, Tamu, ix  
 Gentry, Alyn, ix  
 Reklaitis, Janine K., 345  
 Wadsworth, Emily M., 1, 3, 6
- Rensselaer Polytechnic Institute  
 Gerhardt, Lester A., 145
- Rose-Hulman Institute of Technology  
 Carvill, Caroline, 283, 285  
 Smith, Susan L., 283, 285
- Schloss Engineered Equipment, Inc.  
 Schloss, Kristy, 261, 263
- Southern University  
 Dabipi, I.K., 297  
 Simmons, Linda F., 295, 297
- Stevens Institute of Technology  
 Bott, Kathleen, ix, 203  
 Kornacki, Alison, ix  
 Metz, Susan Staffin, ix, 99, 101
- Stone & Webster Management Consultants. Inc.  
 Tietjen, Jill S., 9, 261, 263
- Swinburne University of Technology  
 Lewis, Sue, 295, 305, 311, 329
- Texas A&M University  
 Algert, Nancy E., 45  
 Kimball, Jorja, 317  
 Rinehart, Jan, 317  
 Watson, Karan, ix, 25, 315, 317
- Texas Instruments  
 Cathcart, Jean, 117, 329
- Thomas Nelson Community College  
 Buie, Wendy, 271  
 Remsberg, Judy P., 269, 271, 329

**W**OMEN IN ENGINEERING CONFERENCE: CAPITALIZING ON TODAY'S CHALLENGES  
 1996 WEPAN National Conference

United States Department of Energy  
Joseph, Antionette G., 73  
Langenfeld, Cherri J., 74  
Hartline, Beverly, K., 74  
Cain, Linda C., 74

University of Akron  
McCubbrey, Dorie, 1, 329, 361, 415  
Verstraete, Mary C., 361

University of Alabama  
Frair, Karen, 317

University of California, Davis  
Mack, Karin L., 199, 201

University of Colorado, Boulder  
Glassner, Patricia B., 283  
Maslanik, Miriam K., 149  
Sandekian, Robyn E., ix, 117  
Silverstein, JoAnn, 99, 111  
Tonso, Karen L., 81, 93

University of Idaho  
Teasdale, Jean A., 329, 373

University of Iowa  
Marshall-Goodell, Beverly, 239  
Ocif, Jennifer, 231, 239

University of Kentucky  
Scheff, Susan, 315

University of Maryland, College Park  
Berman, Marilyn R., ix, 145  
Bigio, David, 163  
Goldberg, Julie, 225  
Kirwan, William E., 133, 135  
Mead, Patricia F., 155, 163, 329  
Rosenfeld, Elizabeth, 163  
Vest, Jennifer L., 211, 225

University of Manitoba  
Mikawoz, Irene R., 51, 231, 243, 329  
Binkley, Laura, 243

University of Massachusetts  
Hellman, Nancy B., 117, 125

University of Michigan  
Davis, Cinda-Sue, ix, 211, 219  
Hummel, Mary, 219

University of Missouri  
Leavene, Marjorie A., 281

University of New Orleans  
Perkins, Judy A., 297

University of Southern Queensland  
Brodie, Lynette, 51, 67

University of Washington  
Brainard, Suzanne, 83  
Carlin, Linda, ix, 81, 83  
Harkus, Deborah, ix  
Laurich-McIntyre, Suzie, ix  
LeBlanc, Claire, ix, 405

University of Wisconsin, Madison  
Chapman, Thomas, 145

Vanderbilt University  
Williams, Carolyn Ruth A., 329

Virginia Polytechnic Institute & State  
University  
Bayer, Alan E., 323  
Collins, Deborah, 323  
Gregg, Michael H., 349  
Hirschfeld, Deidre, 315, 323, 329, 349  
Watford, Beville, 349

Washington State University  
Cooper, Sandra C., 213, 329, 341  
Grimes, Charlena H., 341  
LoFaro, Marsha, 211, 213

Weld County School District 6  
Carson, Sharon, 119