

# ***Women into Engineering Project*** **Final Report**

*Electronic version available at <http://www.ospe.on.ca/weac.html>*

**2006**

***A Partners For Change Project with***  
**the Ontario Society of Professional Engineers/ Women in Engineering Advisory Committee,**  
**Natural Sciences and Engineering Research Council (NSERC)/ Hewlett Packard Chair for**  
**Women in Science and Engineering in Ontario,**  
**and the Ontario Women's Directorate**

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*The views expressed herein are those of the authors and do not necessarily reflect those of the Ontario Society of Professional Engineers (OSPE), the Ontario Women's Directorate, the Minister Responsible for Women's Issues or the Government of Ontario.*

# **Women Into Engineering, a Partners for Change project**

## **BACKGROUND / INTRODUCTION**

In 2000, a Partnership was formed to examine the entry rate and retention rate of Women into Engineering and the effect of communication and gender differences in the classroom upon those rates. This was an area of concern because it has been observed that instructors at all levels, both men and women, tend to treat male and female students differently. Studies have shown that women's self esteem and career aspirations drop significantly during their university years, despite strong academic performance.

Representatives of the partners - the Women in Engineering Advisory Committee (WEAC) of Professional Engineers Ontario (now of OSPE), the NSERC/Nortel Networks Joint Chair for Women in Science and Engineering in Ontario (to 2002), and the Ontario Women's Directorate (OWD) – provided direction as a Steering Committee to encourage and support Ontario universities in the removal of barriers for recruitment and retention and thereby to increase the number of full-time undergraduate women entering and staying in Engineering and Applied Science. The new NSERC/Hewlett Packard Chair for Women in Science and Engineering in Ontario joined the committee in 2003. In 2001 Professional Engineers of Ontario (PEO) divested itself of all non-regulatory activities, and in June 2003, WEAC was transferred to, and is active as a committee of the Ontario Society of Professional Engineers (OSPE). The responsibility for this Partnership Project was accepted by OSPE in December 2003.

In 2000, the Partnership engaged a consultant to summarize the current knowledge and understanding of the issues surrounding women in engineering faculties (both students and faculty members), and to recommend a framework for action to overcome the barriers preventing more women from engaging in engineering studies. The initial report *Where We Are And Where We Need To Go*, by Etta Wharton Consulting, 2001, is available for download from the OSPE website: <<http://www.ospe.on.ca/weac.html>>. It provides a literature review as well as some new research based on student and faculty interviews.

Drawing upon the Consultant's report and feedback, the Steering Committee developed a detailed *Next Steps Action Plan*. Several of the consultant's recommendations called for focused intervention by the members of the Partnership. In response, the Partnership proposed to work in four critical areas to develop and implement interventions to improve the climate for women in engineering studies. All the proposed actions could be undertaken independently or in conjunction with the other actions.

- A. *Forum/Working Session* to promote dialogue among key stakeholders and receive input regarding the content and design of the subsequent steps (held in October 2001).

- B. Development of a *Gender Issues Training Kit* to raise the awareness of engineering faculty members to gender issues (presented to Council of Ontario Deans of Engineering, CODE, in June 2003).
- C. Development of *Women in Engineering Associate Chairs* in at least three faculties in Ontario. These Associate Chairs will in turn develop and implement strategies to increase the proportion of women in undergraduate programs. (This project was transformed).
- D. *Improve Engineering Pedagogy* by making curricula more relevant in today's social context and appealing to a wider variety of learning styles, thereby more attractive to both women and men. (Short-term milestone met in 2003).

**Project A - the October 2001 Forum** was held concurrently with a meeting of the Council of Ontario Deans of Engineering (CODE) at the University of Western Ontario. The outcomes of the event were the launch of the Steering Committee's Action Plan; key stakeholders met and engaged in dialogue on the issue; Engineering deans and faculty members developed and began to co-ordinate project action plans. A longer-term outcome is that barriers for undergraduate women entering and remaining in faculties of engineering are removed.

The Action Plan was modified by the Steering Committee to reflect the views and knowledge of the Forum participants. The project plans were refined and an Advisory Committee of experts was created for each project. This final report details the activities of Projects B, C and D up to 2006.

## PROJECT UPDATES

### **Project B – Gender Issues Training Kit**

#### Project B - Kit Preparation:

Under the direction of the Project B Advisory Committee, Elza Seregelyi & Associates Inc. was engaged to develop and pilot a training kit on gender issues for faculties of engineering throughout Ontario. Work on this project began in June 2002, with a proposal for draft kit presented to the Committee in August 2002.

The training kit was designed to be delivered by a facilitator in a group setting. The workshop includes a combination of print, video and interactive activities, and was originally planned to be two hours in duration. The draft kit was piloted in the form of a two-hour workshop. With the help of the Advisory Committee members, two pilot workshops were held. The first pilot took place at McMaster University on November 14, 2002, co-ordinated by Bob Loree of the Advisory Committee. There were 21 registered participants, including one representative of the Steering Committee. The participants were mainly faculty who teach first year courses to engineering students, but also

included two teaching assistants and a student advisor. About one-third of the participants were female.

The second pilot took place at the University of Toronto on December 5, 2002, co-ordinated by Barbara McCann of the Advisory Committee. This group was slightly smaller than at McMaster, but still numbered about 17 people including four observers from the Steering Committee and the University.

The experiences and feedback from the two pilot workshops helped the Advisory Committee to make recommendations to fine-tune the workshop materials and process. In addition, it was decided to extend the recommended workshop duration to 2.5 hours to allow more time for group discussion and action planning.

The finalized kit consists of the following materials:

Facilitator Materials	Participant Materials
<ul style="list-style-type: none"> <li>• Facilitator’s Guide</li> <li>• Introductory slides with notes (PowerPoint)</li> <li>• Quiz answers with documentation</li> <li>• Purdue videotape</li> <li>• University of California videotape</li> </ul>	<ul style="list-style-type: none"> <li>• Agenda handout</li> <li>• Gender Equity Quiz</li> <li>• Quiz answers with documentation</li> <li>• Worksheet for Purdue video</li> <li>• Action planning worksheet</li> <li>• Evaluation form (may be modified by the facilitator at each campus)</li> <li>• Reference material, including annotated bibliography</li> </ul>

Project B - Kit Implementation:

Sixteen kits were assembled by PEO for distribution to all engineering schools in Ontario. One kit was kept on file by PEO for reference.

The Women into Engineering Partnership Steering Committee made a short presentation to the Council of Ontario Deans of Engineering during their CODE meeting at PEO on June 20, 2003, and the kits were distributed at that time. Twelve kits were delivered in person, and three were forwarded to Deans not in attendance.

The Project B - Gender Issues Training Kit is also available for download from the OSPE website <<http://www.ospe.on.ca/weac.html>>. Interested parties can print out all of the written material but will have to order the videotapes separately. Instructions to order the videotapes are included in the kit.

In order to assist the universities in preparing to present the workshops within their own faculties, a ‘Train the Trainer’ Session was held, facilitated by the Project B Consultant.

The 'Train the Trainer' Session was held on October 27, 2003, and was attended by representatives from seven engineering schools (Guelph, Carleton, Royal Military College, Western, Ryerson, Lakehead and Queen's).

Project B – Evaluation:

Follow-up on the Gender Issues Training Kit took place throughout 2005.

Letters to each Dean were issued February 7, 2005, reminding them that the project evaluation will be taking place in 2005. Additional feedback forms were included for their use.

Feedback forms were to be completed by Deans/universities and sent to the Women Into Engineering Partnership c/o OSPE. Feedback was to include date and instructor of training session, attendance numbers, and summary of post-workshop evaluation forms.

Although no written feedback has been received, the project status was discussed at the Ontario Network of Women in Engineering (ONWIE) Meeting held at McMaster University on December 12, 2005.

- Carleton University – ONWIE rep for Carleton noted that Workshops had been held at Carleton, but that they were not well attended (7-9 people in each), held during July, and were presented by the Equity Office.
- McMaster University – ONWIE rep from McMaster noted that Workshops had taken place during 2003 but were not well attended and did not go over well with audience.
- Queen's University – The ONWIE rep from Queen's noted that she was not aware of the Kit.
- Royal Military College (RMC) – ONWIE rep from RMC noted that they had run the Workshop three times, 3 hours each, with 10 participants in each session. Workshops were held during May and at the end of the summer, and the majority of the attendees were new professors. The Workshop Facilitator had developed her own presentation slides (20 slides) and attendees found it to be extremely valuable, with no negative feedback. The Workshops were advertised through the Dean's Office administration and it was marketed as "how to get the best results out of your students". The ONWIE rep was the Faculty member who presented, and she recommended that the Facilitator engage the participants in discussion, not just present to the group.
- Ryerson University – The ONWIE rep from Ryerson noted that workshops had not taken place.

- University of Ontario Institute of Technology (UOIT) – The ONWIE rep from UOIT noted that workshops had not taken place.
- University of Waterloo – The ONWIE rep from Waterloo was not aware if workshops had or had not taken place.
- University of Western Ontario – The ONWIE rep from Western noted that workshops had not taken place.

Further discussion took place, and the following recommendations were made:

1. Presenter/Facilitator should not be a female faculty member from Engineering.
2. Workshops may be better attended if advertised to each Department individually rather than through the Dean’s Office.
3. WEAC has a small amount of funding available to present a few more workshops. NSERC WSE Chair for Ontario will investigate where to hold additional Workshops.

Project B – Consolidation:

The learning from the first pilot sessions, the advice and experience of ONWIE members, and the desire of the WIE project Steering Committee to include the topic of professional identity, informed the revision of the original kit contents. Ann Holmes, a consultant in education and social issues, worked with Valerie Davidson, the Ontario NSERC CWSE, to revise and co-facilitate two sessions in the spring of 2006. Detailed information can be found in **Report on 2006 Workshop Sessions** at <http://www.ospe.on.ca/weac.html>

The title of the workshop was changed from *Communication and Gender Differences in the Classroom* to *Communication and Gender in the Engineering Faculty*.

The goals were revised to add, “*Discuss ways to support students' development of "professional identity" and to emphasize a faculty-wide approach “Develop a "do-able" action plan for the faculty that will benefit your students.”*

The original workshop contents were revised to introduce material to support the revised goals. A detailed agenda was developed to guide the facilitators.

The revised sessions utilized these resources.

Facilitator Materials	Participant Materials
<ul style="list-style-type: none"> <li>• Detailed agenda Guide</li> <li>• Revised PowerPoint slides with notes</li> <li>• Quiz answers with documentation</li> <li>• Purdue videotape, first section</li> </ul>	<ul style="list-style-type: none"> <li>• Participants’ Agenda</li> <li>• Revised Myths &amp; Facts Quiz</li> <li>• Quiz answers with documentation</li> <li>• Worksheet for Purdue video</li> <li>• Modified evaluation form</li> <li>• Updated annotated bibliography</li> </ul>

## Project B - Results:

Facilitators interacted with 65 participants in two sessions at McMaster University on Feb 21 and Queen's University, Feb 24, 2006.

Feedback from 2/3 of the participants answered the question "To what extent did this workshop help you to increase your understanding of gender differences as they apply to learning situations?" as 3.5 – 4, i.e. more than somewhat.

Each session resulted in small groups creating action plans for the faculty to move forward on the issues.

The key issues appear to be

- Work and family issues
- Increasing women's participation
- How other universities deal with macho culture
- Specific examples, need for input / advice on what is acceptable
- How can professors influence student culture?

## Project B - Key Lessons Learned/ Recommendations:

The subtle problems need work rather than the overt ones in the video. Challenge is how to give subtle examples that can be easily understood. E.g., the daily behavioural adjustments required of female students in how they present themselves so as to integrate into engineering culture, and the need to create an impression that they are willing and uncritical adaptors to this culture.<sup>1</sup>

There is a general perception that, in Canada, obvious gender discrimination has been eliminated. Participants may be more familiar with obvious examples of bias related to diversity, rather than the aforementioned more subtle examples of gender bias. The session must focus specifically on making obvious the subtle issues re gender.

Revisions tried to link professional identity with out of the classroom issues. It would be more palatable for faculty to focus on how students develop professional identity.

Even with this package, it is unlikely that an in-house person is going to have success in implementing action on gender. Workshop needs to be tailored to the specific faculty with local statistics and sensitivity to internal issues.

Each faculty has to take ownership and develop the session from their perspective. Addressing equity issues is an expectation of professional faculty and the law requires it.

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<sup>1</sup> **Dryburgh, Heather.** "Work Hard, Play Hard: Women and Professionalization in Engineering—Adapting to the Culture", Gender & Society, Vol. 13, No. 5, 664-682 (1999) © 1999 Sociologists for Women in Society

## **Project C – originally entitled **Development of Women in Engineering Associate Chairs****

### Project C - Desired outcomes/Intent:

- Create at least three extended positions (networks, associate chairs, or other) for women in engineering in Ontario
- Focus of extended positions – develop and implement strategies to increase the proportion of women in undergraduate programs by coordinating efforts with the NSERC Chair for Women in Science and Engineering (CWSE) in Ontario

### Project C - Method:

- Work with various stakeholders (NSERC, CWSE Chair, Deans, and others) to determine the most likely way to create funded positions in other engineering faculties to support and extend the activities of the NSERC CWSE. Although the NSERC CWSE's mandate covers all of Ontario, there is added value in local presence, and our original research showed that adding new, part-time positions at other universities would help create and implement local activities.
- Nurture and support the suggested course of action as a stakeholder.

### Project C - Status:

A conference call was held in September 2003 with Leah Braithwaite (NSERC Program Officer for CWSE program), Sarah Shortreed (representative of WIE Steering Committee) and Valerie Davidson (NSERC CWSE for Ontario) to discuss potential NSERC funding sources. It was clear that funding was not available for a new Associate Chairs program and that we needed to work within the boundaries of existing NSERC programs. Based on the consensus of this group, the course of action agreed upon was to develop a proposal for the Research Networks Program. A national network would support the original intent of this Project by providing resources for projects at a number of universities which would bring together local clusters of faculty and staff with interests in increasing the participation of women in science and engineering.

Two workshops have been held at the University of Guelph to discuss a national research network that supports and expands the activities of the NSERC CWSEs. After the first workshop (July 2004), a notification of intent to submit a Research Network application was sent to NSERC. This resulted in a series of discussions with NSERC and SSHRC (Social Sciences and Humanities Research Council) staff about appropriate funding programs for this research. As a starting point, a proposal was submitted to the Research Development Initiatives (RDI, SSHRC) and it was awarded funding (\$40,000 for 2 years) in July 2005.

The RDI funding is supporting two initiatives. The first initiative is a foundation study investigating the complex factors that relate to the under-representation of women graduate students in the sciences and engineering (S&E). Data will be collected via an

online survey (September 2006) regarding the impact of four sets of predictor variables: 1) gender ratios, 2) culture, 3) gender-related stressors experienced, and 4) perceived supports, and the moderating effect of contextual factors (e.g., type of degree, discipline, demographics) on a number of outcome variables, including: math and science self-efficacy, stress, institutional and career commitment, satisfaction, and intention to quit or to continue in S&E. The second initiative involves the development of an interdisciplinary, cross-national cluster of researchers who will work to: 1) generate a more extensive program of research on this issue and 2) create a larger alliance of researchers, practitioners, and other stakeholders with research interest in increasing the numbers of women in S&E. A second workshop was held in November 2005 to develop the graduate survey and to discuss the larger research initiative.

A Letter of Intent was submitted to the SSHRC Community University Research Alliance (CURA) program in May 2006 by a team of researchers from the humanities, social sciences, sciences and engineering (including all of the current NSERC CWSEs). If the letter of intent is successful, the team will be invited to submit a full proposal for a 5-year program of research activities. NSERC has made a commitment to provide additional financial support for the research program.

Three key objectives and anticipated outcomes were identified in the Letter of Intent:

1. Building of a strong research program with a multidisciplinary approach, to investigate social and organizational processes that impede participation of women in post-secondary programs and careers related to sciences and engineering: The program will generate knowledge on learning and employment environments for women in science and engineering departments at Canadian universities. Scholars and practitioners from humanities, social sciences, S&E will work together on research activities, interventions and evaluation. The knowledge that is developed will inform decision-making and policy development for academic institutions, for university funders at provincial and federal levels and for organizations committed to increasing the participation rates at all levels of science and engineering.

2. Identification of conditions necessary for social change in order to enhance learning and employment environments in Universities and subsequently other Canadian workplaces at many levels: The program will focus on universities to increase the capacity of institutions to recruit and retain women as students and as employees in areas related to sciences and engineering. One goal is to provide departments and institutions with opportunities to learn more about gendered environments and work to develop useful tools, resources and training programs. Based on critical analysis of existing policies and knowledge gained from research activities, concrete recommendations for policy changes will be made as well as realistic measures of progress.

3. Establishment of an on-going alliance that serves the creation, dissemination and uptake of new knowledge to enhance women's participation in science and engineering: This alliance will be created through participation in research as well as broader networking and outreach activities. The alliance will increase the research capacity of women in science and engineering and their advocates as well as the capacity of social

science researchers to construct research agendas that are well grounded in realities of Canadian institutions. It will serve as a key point of collaboration between international networks and Canadian programs in related areas and will provide critical paths for dissemination and delivery of new knowledge as strategies for change, thereby increasing the capacity of institutions across the country to meet the goals of recruiting and retaining women in S&E.

### **Project D - Improving Engineering Pedagogy**

Since the project started in 2000, the Partnership has found there is a dearth of research into Engineering Pedagogy in Ontario, and internationally.

#### Project D - Desired Outcomes:

- Research undertaken and curricula developed which are pedagogically and socially relevant, and which attract more women into engineering;
- Dissemination of the research results through the Academic engineering community in Ontario and at large.
- Curricula implemented in the engineering and education academic communities.
- Increases are evident in women's enrolment and retention in engineering faculties.

#### Project D - Method:

The Steering Committee made a competitive Call for Proposals in September 2002 and provided \$5000 seed money in 2003 to each of three groups of academics to support the preparation of Major Grant Applications in the field of engineering pedagogy. Topics of investigation to be supported were:

- Research into gender related aspects of current engineering teaching practices (understanding the status quo);
- Assessment of teaching methodologies that acknowledge a broader range of learning styles than currently assumed (pedagogy); and
- Course content enhancements that capture the inter-relationship between current societal issues and engineering (curriculum development).

The proposals were to include measurement techniques for future evaluation. Multi-disciplinary projects were encouraged in education, engineering, women's studies, social sciences and other domains.

#### Project D - Intent:

This developmental funding was meant to encourage and enable proposal submissions for full funding from federal agencies such as the Social Sciences and Humanities Research Council (SSHRC) and the Natural Sciences and Engineering Research Council (NSERC). Support was provided by the Steering Committee to three teams to enhance their Grant proposals, which were reviewed before submission to the Granting Agencies.

### Project D - Status:

- Three research teams were funded and developed their research proposals in summer/fall 2003. (See appendix for summaries of their work.)
- Some difficulty was encountered in identifying appropriate categories for funding such research within the current criteria of the federal granting agencies: Engineering pedagogy falls between the traditional domains of interest for NSERC and SSHRC (NSERC funds scientific and engineering research while SSHRC funds sociological and educational research).
- Discussions between the Steering Committee and Agency representatives, and constructive interpretation of categories, have lead to successful resolutions.
- The Davidson and Stiver project will continue under the auspices of the NSERC/HP Chair for Women in Science and Engineering for Ontario (Davidson) and the NSERC Chair in Environmental Design Engineering (Stiver); papers are being prepared for publication.
- The Heap, et al, Project was awarded SSHRC funding in March 2004. The research program is underway, the literature survey is up to date, the questionnaires have been developed, ethical approval for the interviewing program is being acquired university by university, a web site is being developed, and various papers are being prepared for presentation and publication;
- The Wood Project was submitted for consideration in September 2004, but not funded. The researcher has recently presented several papers and won awards for her earlier work on Doctoral women engineers, and continues her research in the field of engineering pedagogy both for women and immigrants.

### Project D - Comparison with Desired Outcomes

Multi-disciplinary projects were developed in education, engineering, women's studies, social sciences and other domains. Due to the Partnership's support, research will continue to flourish after the closure of this project in the following areas:

- Research into gender related aspects of current engineering teaching practices (understanding the status quo);
- Assessment of teaching methodologies that acknowledge a broader range of learning styles than currently assumed (pedagogy);
- Course content enhancements that capture the inter-relationship between current societal issues and engineering (curriculum development);
- Measurement techniques; and

- Dissemination of findings, both in academic conferences and journals, and in the classrooms of Ontario Engineering Faculties (particularly via the outcomes of Projects B and C, above).

Due to its embedment within the culture of engineering, we have found the field of engineering pedagogy to be rather intractable and our proposed timeline for changing curricula was too optimistic. However, Project D has successfully sown the seeds for considerable research into the complex relationship between engineering pedagogy and the presence of women in the profession.

### **Outcome of the WIE Partnership**

Over the past five years the Women Into Engineering Partnership has examined the entry and retention rates of women in Ontario Faculties of Engineering, and the effect of communication and gender differences in the classroom. This final report presents the progress and findings of the program supported by WEAC/PEO/OSPE, NSERC/Nortel Networks and /Hewlett Packard Chairs for Women in Science and Engineering in Ontario, and funded by the Ontario Women's Directorate.

We have reported on the successful completion of four Projects, namely:

- Forum/Working Session, concurrent with the Council of Ontario Deans of Engineering meeting, to develop the structure of the project;
- Development and dissemination of a Training Kit: "Communication and Gender in the Engineering Faculty";
- Leadership in the development of a national *research* network for women in engineering and science, funded by SSHRC, and involving the five NSERC funded Chairs for Women in Science and Engineering across Canada.
- Seeding and mentoring of the preliminary development of three research projects in engineering pedagogy in Ontario, one of which achieved major funding for a five-year research program, and all of which have been disseminated into the international academic literature.

The Partnership has consisted of the following volunteer members at various times: Ann Holmes, Consultant; Sarah Shortreed, P.Eng., Project Executive, IBM Canada Limited; Lisa Anderson, P.Eng., Supervisor, Facilities Engineering, Ryerson University; Jean Surry, P.Eng. Adjunct Professor, University of Western Ontario; Monique Frize, P.Eng., past NSERC/Nortel Networks CWSE; and Val Davidson, P.Eng., NSERC/Hewlett Packard CWSE. The Partnership wish to thank all those who have participated in the project: the consultants Etta Wharton and Elza Seregelyi; the researchers in Project D; all those listed as advisors to various committees; past and present Deans of all Ontario Faculties of Engineering, and various staff members in the sponsoring agencies.

## PROJECT COMMITTEE LISTS

### **Project B Advisory Committee**

Lisa Anderson  
Co-ordinator, Women in Engineering  
Ryerson University

Miriam Capretz  
Assistant Professor, Dept of Electrical and Computer Engineering  
The University of Western Ontario

Sherry Draisey  
President, Good Vibrations Engineering Ltd.

Bob Loree  
formerly Director Engineering 1, Faculty of Engineering  
McMaster University

Barbara McCann  
Faculty Registrar, Faculty of Applied Science and Engineering  
University of Toronto

### **Project B Consultants**

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Owner and president of a small consulting company providing facilitation, project management, communication, research and evaluation services. The company specializes in multi-stakeholder programs, especially collaborative initiatives between industry, government and education.

Ann Holmes  
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## **Project C Advisory Committee**

Barbara Gough  
formerly Senior Policy Advisor, Ministry of Training, Colleges and Universities

Barbara McCann  
Faculty Registrar, Faculty of Applied Science and Engineering, University of Toronto

Leah Braithwaite  
formerly at Natural Sciences and Engineering Research Council

Bonnie Schmidt  
Director, Let's Talk Science

Daniela Iliescu  
CEO, Colt Engineering

Julie Shang  
Professor, University of Western Ontario

Karen Martinson  
formerly at Canadian Council of Professional Engineers

Karen Webb  
Vice President, Rogers Wireless

Linda Weaver  
Vice-Chair Member Services, IEEE Regional Activities Board

Marta Ecsedi  
Director, Alumni Relations, Applied Science and Engineering  
University of Toronto

Peter Hiscocks  
Professor, Ryerson University (retired)

Tom Harris  
Dean, Applied Science, Queen's University

Trevor Dickinson  
Professor Emeritus, University of Guelph

## **Project D - Original Advisory Committee**

The creation of the Call for Proposals, review and evaluation of submissions were informed by input from an Advisory Committee:

Leslie Dolman, P.Eng.  
Faculty of Applied Science and Engineering, U of T

Colleen Ennett, Engineering graduate

A representative of ESSCO,  
Engineering Student Societies Council of Ontario.

Jennifer Flanagan, CEO, Actua

Ann Holmes, formerly Partnership Development Specialist  
Ontario Women's Directorate, Ministry of Citizenship and Immigration

Moyra McDill, Professor  
Mechanical and Aerospace Engineering, Carleton University

Deb Messina  
Computer Engineering graduate

Pat Rogers, Dean,  
Faculty of Education, University of Windsor

Vera Straka, Professor  
Department of Architecture, Ryerson University

Stacey Sukerman  
Engineering student

Jean Surry, Adjunct Professor  
Faculty of Engineering, University of Western Ontario

## Appendix of funded project summaries – Project D

### Report to WIE Partnership Steering Committee

#### Improving Engineering Pedagogy: Programming and Computer-based Design Tools

February 2004 (Updated May 2006)

Val Davidson and Warren Stiver  
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Abstract:<sup>2</sup>

Pedagogical changes were implemented to aid learning a challenging computer-aided engineering software package and to promote collaborative work approaches in “*Engineering and Design II*”. Qualitative and quantitative assessments have been conducted.

The instructional learning aids developed were helpful to a fraction of the students. However, the aids were not completely successful in preparing teaching assistants at a consistent and strong level. Teaching assistants were not seen by the students as the best source for help in the details of the project.

The collaborative strategies appear to have been successful. Informal collaboration was the most common strategy students employed to overcome challenges in this course. The general attitude seems to be that everyone is in the same situation and eager to help one another.

The results indicated a number of similarities and differences based on student gender. Female students did as well or better on all components of the course as measured by grades. Females appeared to respond more favourably to the ‘helping atmosphere’ created in the course. No gender difference was evident in student self-efficacy related to abstract engineering skills, design skills, or team skills. Females were less confident initially in oral presentations and in hands-on work. Female students gained confidence in oral presentations through the course more than their male counterparts to reach parity by the end of the course. The gap in confidence in hands on skills was not overcome over the period of this single course.

The Davidson and Stiver project will continue under the auspices of the NSERC/HP Chair for Women in Science and Engineering for Ontario (Davidson) and the NSERC Chair in Environmental Design Engineering (Stiver). An abstract has been submitted to GASAT 12 (Brighton, UK September 2006) and a manuscript is in preparation for submission to a refereed journal on engineering education (V. J. Davidson, W. H. Stiver, J. Newberry, M. Hayward, M. Rohatynskj and L. Yuval 2006 “Computer-based design tools in engineering”)

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<sup>2</sup> Steering Committee Note: A more detailed report is available upon request.

## Appendix of funded project summaries – Project D

### **Report on activities performed with the support of \$5000 grant awarded by the Women Into Engineering project (PIWE)**

Ottawa, March 28 2004

by Ruby Heap, Department of History, University of Ottawa. [rheap@uottawa.ca](mailto:rheap@uottawa.ca)

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Thanks to this financial support, a multidisciplinary team of researchers from the University of Ottawa was able to submit in October 2003 a grant proposal to SSHRC, based on the proposal submitted earlier to PIWE. (See Abstract below.) The title of the proposal is: "Society centered educational practices and the retention of women in engineering". The success of this proposal was announced by SSHRC in March 2004.

The team is composed of the following professors: Ruby Heap, History (PI); Ann B. Denis, Sociology (CI); Monique Frize, Engineering (CI); Janice Ahola-Sidaway, Education (CI) and Donatille Mujawamariya, Education (CI).

The grant was used more specifically for the following items:

1. An experienced research assistant (Shaunda Wood) was hired to conduct an exhaustive literature review<sup>3</sup> and to assist the team in writing and reviewing the SSHRC proposal.
  2. Primary and secondary documentary sources (reports, books and articles) was purchased and photocopied. As a result, large corpus of material has been collected, which will be useful for future research projects undertaken by team members.
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### **“Society Centered Educational Practices and the Retention of Women in Engineering”**

#### **Abstract**

Despite concerted efforts by governments, industries, funding agencies, professional associations and universities to increase the number of women engineers, their under-representation in the profession remains a critical issue of national and international concern. Recent Canadian statistics report that only 20% of undergraduate engineering degrees are awarded to women. Scholars have targeted the attrition of women in undergraduate engineering education and proposed various explanations for the failure to retain women at this critical period in their career. Recent studies on this “leaky pipeline” point to a restrictive curriculum and pedagogy, as well as an engineering education culture, that disregard the links between engineering and society. These explanations have, in turn, led to calls, and attempts, to make engineering education more *socially relevant* by emphasizing engineering's social contribution and by encouraging women to develop a sense of community both inside and outside of the classroom. However, the extent to which policies and practices aimed at transforming engineering

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<sup>3</sup> Literature review available on request to Dr. Heap.

## Appendix of funded project summaries – Project D

education are having their desired effect remains largely unknown. This project addresses this gap by scrutinizing the meaning of social relevance, from the perspectives of institutions and their participants, and by investigating the scope and impact of reforms aimed at establishing connections between engineering education and the needs of society. An in-depth case study analysis of engineering programs in three central Canadian universities will be conducted; it will focus on selected sub-disciplines considered to be the *most* attractive to women (such as chemical and environmental engineering), and the *least* attractive to them (such as mechanical and electrical engineering). This rigorous approach will help uncover how the concept of social relevance is variously defined and perceived by female and male students, faculty, and administrators, and how these definitions and perceptions are and are not reflected in institutional policies and practices. It will also link the ways and extent to which socially relevant policies and practices influence students' experiences and perspectives, including their identification with specific engineering sub-disciplines, and their decision to remain or withdraw from their program.

This study is timely in view of the various initiatives carried out to make engineering education more attractive to women once they have enrolled in a program. It will clarify how the issue of retention can be understood as one related to gender, in conjunction with other indicators of difference, and how factors specific to engineering sub-disciplines may influence women students' decision to persist in their program. Our findings will thus provide an important basis for informing future initiatives and for allocating resources to improve the retention of female students in undergraduate engineering programs.

**PI: Ruby Heap, Department of History  
University of Ottawa**

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### **Engineering Pedagogy: Challenges and Transformations PEO SEED Grant**

March 12, 2004 (Updated May 31<sup>st</sup> 2006)  
Shaunda Wood

#### *Progress Report:*

After conducting the preliminary research and analyzing the findings of the survey, a more qualitative research methodology will be used in subsequent grant applications [see abstract below].

#### *Brief summary of survey findings:*

Engineering professors are not a homogeneous group by any means, and survey data did not allow for the emergence of individual perspectives on teaching nor their own unique suggestions. Ages, gender, degrees, areas, tenure, etc, were very different. There were no clear patterns. Although the survey had a small space for comments after each section, this did not allow enough room for the participants to fully explicate their knowledge and opinion related to transforming engineering education. What did ‘speak’ loudly was that younger engineering professors have made attempts “not to teach like my engineering professors”. The older part-time professors, who in many cases did not have PhDs but who certainly had abundant industry experience, were very adamant that engineering education is as it should be. They did, however, see the need for international students to be taught differently. Unfortunately, as already mentioned, this was not explained, as there was not enough room. Furthermore, the professors indicated they were not interested in being interviewed because they were too busy. In the future, I would develop a more open-ended questionnaire that allowed for fully developed answers and the professors’ busy schedules. Their short comments, along with the survey data will guide me in this process.

Due to my defense being delayed, I was not able to apply in September 2003 for the SSHRC grant as lead researcher under SSHRC guidelines. The SSHRC application, below, was used in September 2004, but did not gain funding. A summary of the preliminary study is also given below.

#### *SSHRC application abstract for September 2004:*

### **Deconstructing the Leaky Pipeline: Engineering Students’ Perspectives on Challenges and Transformations of Science/Engineering Education**

©Shaunda L. Wood

The purpose of this research is to understand how sociocultural influences affect women’s choices to participate and remain in engineering and how pedagogical

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transformations can add relevance and meaning to engineering education. Recruitment and retention programs for women in Canada and abroad, have attempted to address these disparities at all program levels (Cukier, 1993; Emerson, Williams, & Kieley, 2002; Ennett, 2002; Frize, 2002; Gibney, 1998; Jovanovic, Zinatelli, & Dube, 2002; Male, Lawrance, & Dias, 2002; Martinson & Smandych, 2002; Rinehart & Watson, 2002).

Employing a predominantly qualitative methodology along with a poststructuralist analysis, this study will attempt to bring a new perspective to research concerning women and engineering. There are currently virtually no published Canadian studies investigating women engineering students' experiences in the classroom setting and how the social processes of collaborative group work impact on their learning.

In sum, women face many obstacles in their academic careers. Moreover, there is a gap in the research with regards to their perceptions of science and engineering education and how non/participation in the culture of science/engineering affects women's identities and learning. The findings of this research will give voice to this unique population and help inform educational practices of students in public schools, as well as faculties of engineering and other institutions of higher learning.

The following papers were presented by the author:

Wood, S. L. (2003). *Engineering pedagogy: Doctoral women engineers' perspectives of learning and participation*. [9 pp]. Re-searching Research Agendas: Women, Research, and Publication in Higher Education, Curtin University of Technology, Perth, Western Australia, June 25-27. <http://lsn.curtin.edu.au/leadership/atn-resconf/abstracts/54woo.html>

Wood, S. L. (2005). *Becoming an engineer: Doctoral women's perspectives on learning and identity in faculties of engineering* [11pp]. American Educational Research Association's [AERA] Annual Conference, Montreal, Canada, April 2005.

Wood, S. L. (2005). *Doctoral women's learning and identity in the culture of engineering: Stories as situated retellings* [15 pp.]. mit4: the work of stories, Massachusetts Institute of Technology, Cambridge, May 6-8, 2005.

Wood, S. L. (2005). *The culture of engineering and its impact on learning and identity: Canadian doctoral women engineer's perspectives* [12 pp.]. The 13th International Conference of Women Engineers and Scientists (ICWES-13), August 2005, Seoul, Korea.

Wood, S. L. (Sept., 2005). *Transitions in learning and identity in faculties of engineering: Doctoral women engineers' perspectives* [13 pp.]. In S. LeMay-Sheffield, C. O'Neil, K. L. Taylor, and D. Nevo, (Eds.), Atlantic Universities Teaching Showcase 2004: Proceedings, IX. Halifax, NS: Dalhousie University.

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SUMMARY FOR WEAC/PEO  
**Engineering Pedagogy: Challenges and Transformations**  
**Dr. Shaunda Wood**  
[swood@stu.ca](mailto:swood@stu.ca)

May 2006

Many thanks for the in-kind support provided by the Women in Engineering Committee [WEAC] of the Professional Engineers of Ontario [PEO] for this investigation.

### *Brief Review of Literature*

The purpose of this research and the mandate of WEAC SEED grants are to understand gender/sex related aspects of current engineering pedagogy including methodologies, practices, and curriculum. My interest has developed as a result of my doctoral research entitled *Becoming An Engineer: Doctoral Women's Perspectives On Identity and Learning in the Culture of Engineering* (Wood, 2004). In addition another study examining the perspectives of women electrical engineers at the Masters level (Wood, 2002) also informed the current investigation. In these studies, group work- whether organized or casual, was reported by women graduate engineers to be an important part of learning in the undergraduate program. In fact, the preference and importance for group work when learning new science concepts are supported by many researchers (Barab & Hay, 2001; Driver, 1995; Guzzetti & Williams, 1996; Hodson, 2001; McIlwee & Robinson, 1992; Wood, 2001, 2002a).

More specifically, girls and women are placed in inferior positions in discussion with males in the classroom. The later seldom give females a chance to talk, regard what they say as important, or consider women as equal participants in the discussion (Bell, 1989; Brickhouse & Potter, 2001; Guzzetti & Williams, 1996; Leroux, 1997). In this way researchers posit that there are hidden rules that govern discourse, establishing who can speak, when, and with what authority (Cherryholmes, 1988; Foucault, 2000; Lewis, 1990). It is not necessarily what is being said, but who is doing the talking that reflects the 'power' in a relationship (Guzzetti & Williams, 1996; Remlinger, 1995).

In addition, 'belonging' and 'participation' in relation to social and cultural groups became significant factors when examining learning in engineering (Wood, 2002a, 2002b). The experiences of women engineers (Heidenbrecht et. al., 1999; Morgan, 1995; Tonso, 1997; Wharton, 2001) and "scientists begin and end with the consequences of social exclusion in an activity that necessitates, perhaps demands, community" (Etzkowitz, Kemelgor, & Uzzi; 2000, p.16). Can acceptance and inclusion be mandated as proposed by institutions? Does it help or hinder change? According to my participants, they do not think that mandatory inclusion is possible. Yet they call for changes in engineering education—it appears more difficult for some people of difference; sex being just one factor.

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Another area of concern in my previous studies (Wood, 2002a, 2003, 2004) was professors who were overwhelmingly labeled as poor teachers. Participants felt they were not trained in pedagogical skills and lacked a basic understanding of principles of teaching. They were also criticized for their unavailability and inconsistent guidance or feedback similar to their interacting styles. Some participants also perceived the poor teaching to be related to professors' lack of effort as well as dissimilarity between learning objectives and teaching strategies (Trigwell & Prosser, 1996; Trigwell, Prosser, & Taylor, 1994), and academics' beliefs (Samuelowicz & Bain, 2001; Saroyan & Snell, 1997). The perception that professors did not value teaching, and that they 'teach as they were taught' was noted by Ney, Ross, and Stempel (2001).

### *Participants*

This study examined both male and female engineering professors' notions of teaching and learning, as they are ultimately the agents of curricular reform and active participants in the 'culture of engineering'. Based on the preliminary literature review and my previous experiences with graduate [MA and PhD] engineering participants (Wood, 2001, 2002a, 2002b, 2003, 2004), I designed a questionnaire that employed 41 attitudinal questions with a Likert scale, four sections for short written comments, and a page for demographic information.

The four main categories of the questionnaire addressed 34 professors' views on their a) teaching challenges, b) how they would like to see teaching and learning transformed, c) what assistance they would like, how that should be accomplished, and d) their own learning experiences as engineering students. These preliminary findings can be considered the catalyst for illuminating the multiple lens of difference within one faculty of engineering, at a medium size university in Ontario.

### *Hypotheses.*

The hypotheses that guided the construction and analysis in the questionnaire will be presented; in addition, similarities and differences will also be addressed.

- 1) The older-generation of engineering professors teach in a traditional manner and have traditional views of teaching, such as the lecture only method, and the 'cream will rise to the top' analogy.
- 2) Gender will affect the manner of teaching and the professors' views about teaching.
- 3) Disciplines of engineering will affect the manner of teaching and views held about teaching, that is, the more mathematically abstract, the more traditional the teaching methods.
- 4) Having a Bachelor of Engineering will affect attitudes toward teaching engineering curricula, that is, not being a "real" engineer may allow professors to view teaching engineering differently.

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### Findings

In relation to hypothesis one, there were no clear patterns related to the older generation of professors only teaching in more traditional ways. While their age was not asked, the year of PhD completion was, and this ranged from 1956- 2002. Fifty per cent of the professors completed their PhD before 1990, and only three professors completed their studies before 1970. Of course, this can be misleading as not all professors have PhDs. Conversely, a professor who completed their PhD in the 70s, stated, “I would say that if anything, the style I was taught by influenced me to try and do it differently when I taught”. In addition, one of the ‘older’ professors has won a teaching award; indicating the time of PhD completion [age] does not appear to negatively affect professors’ attitude toward teaching.

With regard to hypothesis two, there was no indication that gender directly affected women professors’ attitudes toward teaching. Perhaps like the ‘older-generation’ professor in hypothesis one-- related to negative experiences, professors set out to be very ‘different’ in their behaviour compared to their advisors and professors. More precisely, the two participants who strongly reported not having a good relationship with their doctoral advisors were women. Out of the sample of 34 professors, seven were women. And the majority of men strongly reported having a good relationship with their advisors.

With hypothesis three, the disciplines of engineering affecting professors’ attitudes toward teaching could not be examined. Most of the participants did not report their discipline of engineering. They left the space blank.

Hypothesis four was very interesting; ‘having a Bachelor of Engineering will affect professors’ attitudes toward teaching engineering curricula’ was not clearly answered. It appeared that many participants checked off BSc. not B.Eng. since different universities grant a BSc. or BA in engineering, while others grant B.Eng. To add further confusion, some B.Eng. and BSc. professors qualified for Professional Engineering certification but not all B.Eng. professors qualified or perhaps applied. Clearly, it would have been useful to provide a space for each participant to explain as they saw fit, their degrees and certifications. Interestingly, the notion of being a “real” engineer was expressed in relation to professional engineering certification and the body that regulates it membership. One professor stated

I am somewhat contemptuous of the CEAB. They appear to be more interested in engineering indoctrination than in education of engineers. A colleague of mine won the Alumni-teaching award for teaching both engineers and Arts and Science students, but CEAB downgraded her teaching because she is not a P. Eng. Check out how many Applied Science professors have alumni teaching awards. My department has two, which I believe is the same number awarded to all B.Sc. (Eng.) professors at [*this university*]. Neither of the two in my department has a B.Sc. in Engineering.

The notion of being a ‘true’ engineer was a constraint for professors at this university as well as those women coming to the doctoral program from other disciplines of science in my previous studies (Wood, 2002a, 2003, 2004). They were reminded through direct

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statements and behaviours that they had not passed the ‘competence testing’ of the undergraduate program and professional engineering associations, and therefore could not call themselves engineers. These participants stated with hesitation, “I am not really an engineer”—a description of how they viewed themselves in the culture of engineering.

### Additional Findings

Two main teaching challenges emerged in the written section. The questionnaire data indicated that professors predominately used lectures as the main components of teaching, usually related to classroom size and the content. One professor commented

Large classes are problematic not merely because of the in-class size with respect to lecturing, but because you have to spend so much more time being contacted by students, dealing with logistics [midterms, scheduling, office hours] because it becomes harder and harder to accommodate all of the students.

Another engineering professor justified using lectures since “many classrooms are not conducive to interaction with students”. Another ‘seasoned’ professor addressed this by adding; “students perceive lectures as less important with the availability of scanned and web-posted lecture notes”. One professor proposed a solution to improving the use of lectures in engineering by adding

some kind of shared access to teaching materials such as lecture notes, would be good especially for second and third year courses that are very similar at most institutions. Most instructors reinvent the wheel when preparing lecture notes for the first time.

While half of the professors reported planning student discussion of concepts into their classes, it was mostly done in the form of group work. While it is not clear how integrated and useful group work was to the purpose of their lessons, some professors strongly agreed it was beneficial. Not all participants viewed group work as positive. One professor stated

There are too many group projects now. There should be a mix of individual and group efforts. Knowing how to frame and research an engineering question and solution on one’s own is critical.

While most professors indicated that they would like to implement new methods of teaching into their classes, many were not sure how to go about the change and who would help them with it. One professor affirmed, “ I would attend training programs but they have generally been trivial and reasonably useless. They would have helped when I was starting out”. One size fits all workshops do not meet the needs of all engineering professors. Furthermore, one adjunct professor with industry experience stated he would only “be involved in ‘training’ if the training was presented by a highly successful classroom teacher giving practical suggestions. I would not be interested in having an educational theorist talking generalities. I don’t want to hear about multiple intelligences”. Again, it is necessary to include the perceived needs of the learners, engineering professors in this case. It appeared the department of education at this

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university had given lectures on broad educational theories not practical methods in planning and teaching engineering classes. One professor questioned, “What is an educational specialist? Certainly not faculty of education professors”. Another professor suggested an “engineering education specialist would be best” to assist with developing new methods of teaching in engineering.

One professor stated that there is not time available for pedagogy training, “since as a professor we are not given time for anything”. Conversely, another participant explicated

Such training [pedagogy training] is readily available at the IDC [instructional development center], and there is nothing stopping us from doing it. I attend many of their offerings. As with all of our duties, it is up to us to balance them. So it is not so much whether departments grant the time, but whether the Administration gives appropriate credit for those who partake.

With the differing perspectives of how to address teaching and additional training, it is no wonder that teaching practices have remained relatively unchanged. One engineering professor affirmed

My undergraduate education in engineering focused on ‘stuff’, the example I use is we were ‘taught’ the myriad of ways water volume/flow can be measured in rivers and canals. To me it seemed silly. Also, with the focus on ‘stuff’, there was this attitude that whoever didn’t crumble under the weight of their workload, got their degree. Some of that attitude still exists.

Based on the professors’ questionnaire data and comments, attitudes toward teaching are slowly changing—it is not necessary to ‘throw the baby out with the bathwater’ just yet. Engineering professors are not a homogeneous group by any means, and questionnaire data did not allow for the emergence of individual perspectives on teaching nor their own unique suggestions. Ages, gender, degrees, areas, tenure, etc, were very different. There were few clear patterns. Although the survey had a small space for comments after each section, this did not allow enough room for the participants to fully explicate their knowledge and opinion related to transforming engineering education.

What did ‘speak’ loudly was that younger engineering professors have especially made attempts “not to teach like my engineering professors”. The older part-time professors, who in many cases did not have PhDs but who certainly had abundant industry experience, were very adamant that engineering education is as it should be. They did, however, see the need for international students to be taught differently. Unfortunately, as already mentioned, this was not explained, as there was not enough room. Furthermore, the professors indicated they were not interested in being interviewed because they were too busy. In the future, I will develop a more open-ended questionnaire that allows for fully developed answers and the professors’ busy schedules. Their short comments, along with the questionnaire data will guide me in this process.

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