

# UNIVERSITY SCIENCE AND ENGINEERING: PROMOTIONS, PROGRAMS AND PROGRESS IN SWEDEN, CANADA AND THE USA

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## ABSTRACT

Two factors have contributed to the continuing low number of women in faculty positions in physics, materials science and other technology and science areas. One is the low enrollment at the undergraduate and consequently graduate levels. The other factor is hiring and promotional practices, combined with the overall working conditions. During the past two years, significant changes in Sweden, Canada and the USA have occurred, resulting in an improvement to the academic route for women. In Sweden, changes to the promotional system allows those with sufficient merit to advance to associate or full professor. As well, during the past few years the continuance of partially sponsored positions for the under-represented gender by major Swedish funding agencies (such as NFR and TFR) at both junior and senior faculty levels have helped to improve gender equalization. In 1998, a major Canadian funding agency (NSERC) revived an earlier recruitment program for women in the form of University Faculty Awards (UFA). This program is designed to encourage Canadian universities to appoint very promising women researchers to their first faculty positions in science and engineering. To date, 19 women have received these awards with >15% returning from appointments abroad. In the USA, several recent reports have raised awareness of the remaining gender inequity and significant progress has been made. The first of these reports involves the federal government filing a suit against Stanford University early in 1999, for not doing enough to aid the progress of women. In the second, MIT, with prompting from tenured female faculty members in science, took stock of its situation and addressed outstanding issues. In the third report, the American Physical Society, in 1998, aided two researchers conducting a survey on the dual-career-couple problems. The replies point to both the progress and continuing barriers to women and couples in scientific careers. A review of the promotions, programs and progress in the past few years in these three countries can lead to more funding, greater happiness and a better understanding of the issues.

## INTRODUCTION

To discuss the initiatives and opportunities available to women in academia, one must first put their status into perspective. Fact: The number of women in academic positions does not reflect the available pool of Ph.D. graduates in the three countries being considered: Sweden, Canada and the USA. To illustrate this point, consider that 22% of the Ph.D.'s awarded in the natural and technical science and engineering areas in Sweden in 1994 were to women. The percentage of female faculty at the assistant professor level (fo ass), 2 years later was 18%. Similarly, the female graduates in 1990 were 20% and the associate professors (lektor), 6 years later was only 11%. The

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corollary to this fact is that the number of men in academic positions exceeds the available pool of Ph.D. graduates on a percentage-wise basis. Using the aforementioned example, 80% of the graduates in 1990 were men, however 89% of the associate professors in 1996 were male. Even at the most junior level (assistant professor), the available pool is exceeded by 4%. These trends are even more marked in some other countries, but it is not a worldwide phenomena (Table I).

**TABLE I. COMPARISON OF AVAILABLE FEMALE PH.D. GRADUATES TO FACULTY MEMBERS<sup>1</sup>**

Good Representation of Women in Science Faculty Positions (Pool of Graduates Available $\leq$ Female Faculty)	Poor Representation of Women in Science Faculty Positions (Pool of Graduates Available $\gg$ Female Faculty)
Hungary	USA
USSR	UK
Italy	Canada
France	Germany
Turkey	Sweden
Poland	Belgium

The implication is that there are inherent reasons for this inequity. The number of available qualified women cannot be used as the sole explanation. Fact: Studies have shown a bias in the evaluation of the work of females relative to males.<sup>2-4</sup> In a controlled test,<sup>2</sup> it was shown in 1968 that the evaluation of literature is more highly rated if associated with a male rather than female name. A similar study conducted years later,<sup>3</sup> asked department heads to consider candidates for faculty positions based on their C.V.'s. A clear trend of suggesting women for assistant professor and men for associate professor positions was found. In both studies, duplicates were included so that the names were assigned in both ways. Fact: Having quorum, a minimum number of women, matters,<sup>5</sup> as less than the minimum number does not encourage women to express and promote less traditional ideas, nor does it allow for a significantly changed atmosphere or working environment. The phrase, "its lonely at the top" has been applied frequently to the situation for senior female faculty members and with numbers well below 20% in all three countries this is not surprising. Other possible reasons for the low number of women academics are that better career opportunities are available to women elsewhere, e.g. in industry, or that they have chosen to take some time off or have abandoned their careers to raise families.

In view of the issues raised above, the choices are simple, (1) we can accept the current situation and allow "things" to evolve naturally without intervention, or (2) measures can be taken to improve the situation. Ten percent of the 1978 Ph.D. graduates were women within Sweden, however two decades later, only 5% of the full professors were women. Time is not the solution to equity! The positive effect of the second option are improved utilization of human resources and education, and a betterment of the working environment for women in academia.

In an ideal world, the barriers would be removed and equity would eventually prevail. However, it is difficult to remove these barriers because they are cultural, historical, environmental and/or unidentified. The approach instead has largely been to slowly push, through incentives and special programs, for a greater percentage of women in academia. In turn, it is hoped that as the numbers change that perceptions will also change in both men and women, fostering a long-term equitable environment in academia.

## SWEDEN

Due to recent changes to the promotional system, it is expected that more women will be promoted to full professor. Previously a person with a background from another discipline could be held back from promotion to associate professor thereby blocking the route to full professor. As well, a full professor was also a division head (appointed by the government), necessitating either a wait for a vacancy at that level or the formation of a new division. Now individuals with sufficient merits can advance to associate or full professor. However these changes have mostly occurred in late 1999 or later and as such are not reflected in the statistics available today (Figure 1).

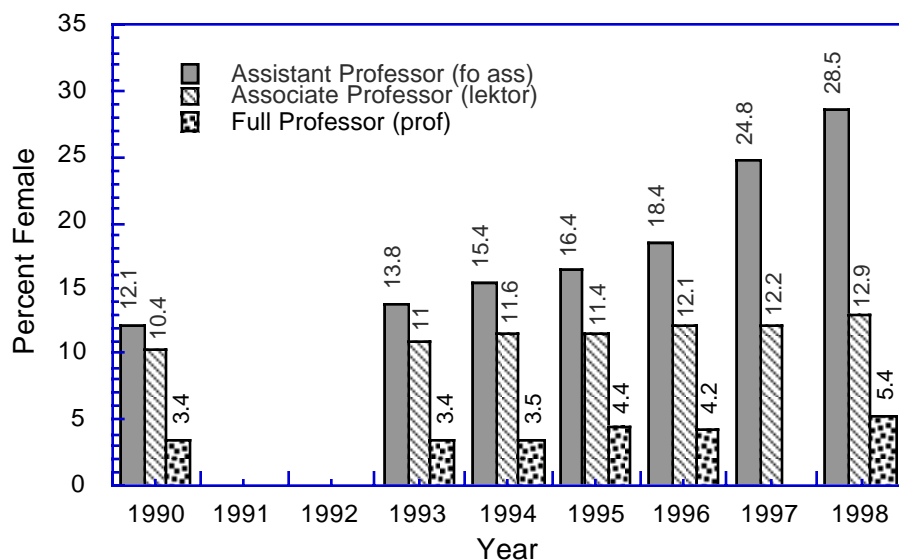


FIGURE 1. PERCENTAGE OF WOMEN FACULTY IN THE NATURAL SCIENCES (*NATURVETENSKAP*) AND TECHNICAL/ENGINEERING (*TEKNIK*) AREAS IN SWEDEN.<sup>6</sup>

Since 1995, major Swedish funding agencies, such as the Swedish Research Council for Engineering Sciences (TFR) and Swedish Natural Science Research Council (NFR), have provided partially-sponsored positions (for the under-represented gender) at both junior and senior faculty levels (Table 2). These efforts dictated by the Swedish government have aided in greater gender equalization. However, recent governmental changes mean no new positions will be created. It is a pity that these programs are stopping as they have resulted in more than a 50% increase in the number of women in junior and senior faculty positions. Other initiatives such as post-doctoral fellowships and guest professorships (for women visiting Sweden) continue, and help encourage women in academic routes. The presence of female guest professors in Sweden makes an impact with both students and faculty. The students have female role models, and faculty members become aware that there is not a lack of talented women to recruit. Visiting female professors are provided with largely unrestricted funding, up to 770,000 SEK (~\$140,000) for one year, and thereby given a unique opportunity to establish or bolster their international collaborations, specifically in Sweden.

TABLE 2. ADDITIONAL POSITIONS CREATED AS A RESULT OF A SWEDISH GOVERNMENT DIRECTIVE IN 1996.<sup>7,8</sup>

Year	Post-Doctoral Fellowship	Assistant Prof. ( <i>fo ass</i> )	Full Prof.	Visiting Professorship
1996	5 TFR	2 TFR	0 TFR	3 NFR
1997	5 NFR 6 TFR	12 NFR 14 TFR	8 NFR 2 TFR	3 NFR 18 TFR
1998	5 NFR 0 TFR	13 NFR 19 TFR	8 NFR 4 TFR	7 NFR
1999	9 TFR			16 TFR
Sub-totals	30	60	22	47

A private research agency, the Knut and Alice Wallenberg Foundation, also contributes by supporting women in the early period after receiving a doctorate.<sup>9</sup> Statistics have shown that a great drop in female researchers is between graduate school and the continuation towards a research position. One reason is that this may be the time when they decide to form a family. Once having left the academic world it may be difficult to return and find a research position. To help female researchers remain in the academic world during this time, the Foundation started this programme in order to give female researchers a greater possibility to remain at the university by providing extra funds for costs that arise. Generally the stipend is used for salary (since it often is difficult to find a position right after graduation),

childcare (since many women decide to have children after having graduated), or bringing the family along on a postdoctoral visit. Although there is no limitation to the use of the funds, they request that the recipients report to them the use of the funds in order to evaluate the needs of female researchers. The programme has now been running for four years. Each year about 50 of 250 applicants have been awarded a stipend.

In most cases, faculty are supported in Sweden with 'soft money' obtained through research grants. Without sufficient support, one can be forced out at the assistant professor level, or receive extra teaching loads at more senior levels. Therefore, the distribution of project grants is essential not only to sustain research activities, but also to advance or survive in academia. Although the data is presented in different ways for TFR and NFR project grants in Figures 2 and 3 respectively, the message is similar. It is only in the past 4 years for TFR and in the last year for NFR where equality between grants awarded to men and women has been achieved. (TFR claims that statistical significance between the genders for 1993-1998 is  $<95\%$ .<sup>10</sup>) NFR presents data showing the age distribution of primary investigators funded (Figure 4). The implication is that older academics receive more funding and hence women, justifiably, are allocated a smaller percentage than men. However, NFR offers no detailed analysis to support this theory. Other explanations are possible. Firstly, the promotion of young researchers might balance this age distribution. Secondly, it is possible that women write weaker grant proposals. Do they, and if so, why? Thirdly, it is possible that the evaluators are biased towards men or against women (see earlier comments in the introduction for the foundation to this statement). NFR asks for investigators to supply sex, marital status and number and age of children on their C.V.s. Unlike U.S. applications where sensitive information is held only by the funding agency, the Swedish system distributes this information with every application. It appears that this request is to accommodate the family-focussed years. However, NFR does not know how this information is perceived nor how it affects the ratings of the applications, e.g. parents could be seen by the evaluators as less-serious researchers. If NFR needs to collect such personal information, they also must maintain control and apply any adjustments in an even, consistent and open manner.

In closing, Sweden is making notable efforts to support women in academia, however unfortunately the best of these programs are being stopped. Refinements need to be made with the distribution of project proposals, namely it must be recognized that a bias can easily be introduced at the evaluation stage, either due to personal information supplied or prevalent attitudes. The fair allocation of resources reached in recent year/s, must be maintained.

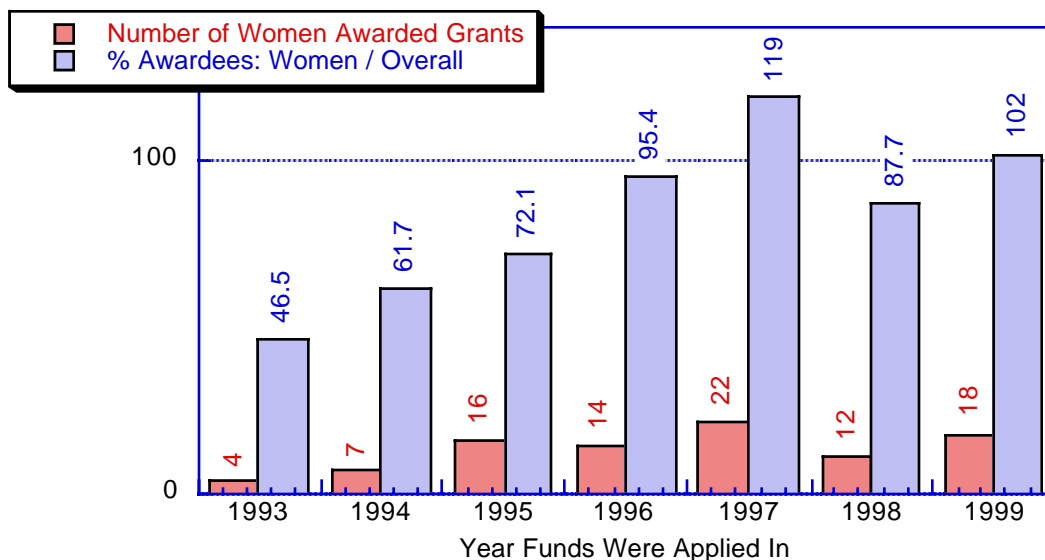


FIGURE 2. PERCENTAGE OF WOMEN RECEIVING TFR FUNDS RELATIVE TO THE NORM (100) AND THE NUMBER OF SUCCESSFUL APPLICATIONS FROM WOMEN AT TFR FOR THE YEARS 1993 THROUGH 1999.<sup>7</sup>

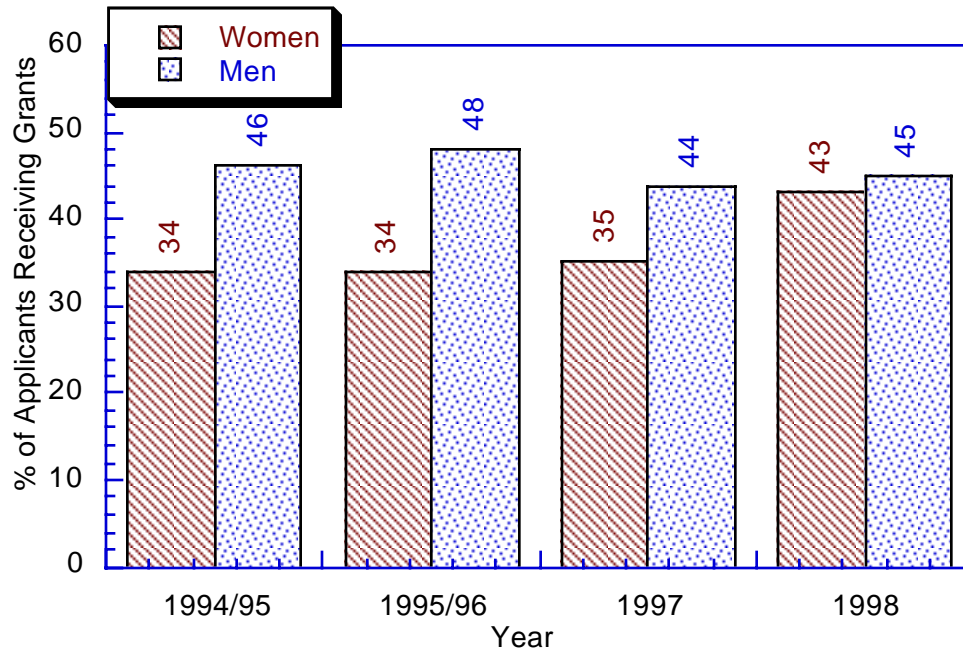


FIGURE 3. PERCENTAGE OF WOMEN AND MEN RECEIVING NFR FUNDS FOR THE YEARS 1994 THROUGH 1998.<sup>8</sup>

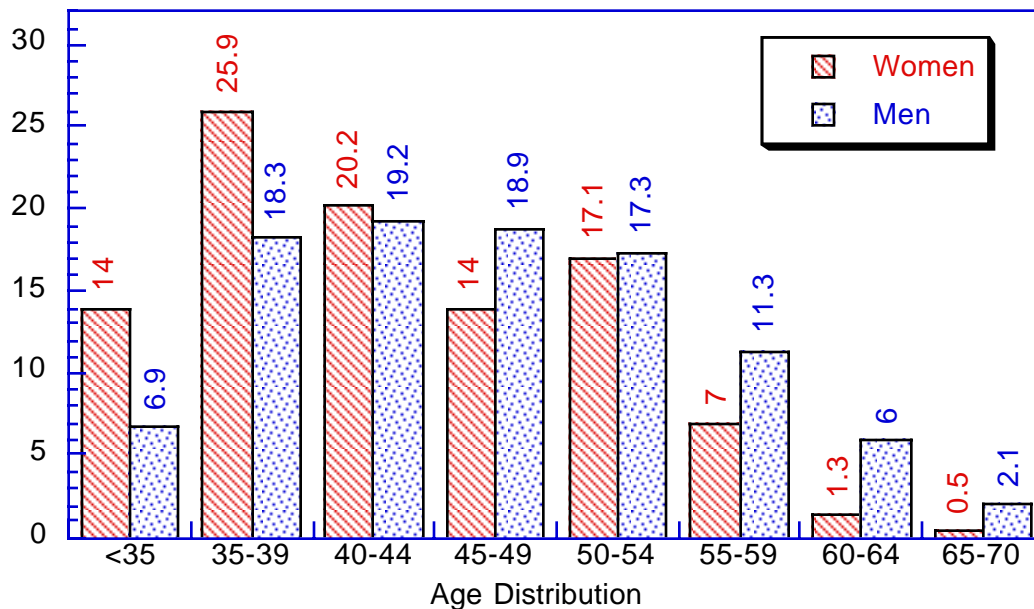


FIGURE 4. AGE DISTRIBUTION IN % FOR 228 WOMEN AND 1696 MEN WHO RECEIVED NFR GRANTS IN THE PERIODS: 1995/96, 1997 AND 1998. DATA FROM NFR'S YEAR REPORT FOR 1998.<sup>8</sup>

### CANADA

In 1998 within Canada, the Natural Sciences and Engineering Research Council of Canada (NSERC) revived its earlier recruitment program for women in the form of University Faculty Awards (UFA).<sup>11</sup> This program is designed to encourage Canadian universities to appoint very promising women researchers to their first faculty positions (tenure-track or tenured) in science and engineering (S&E) in Canada. The awards are tenable for 5 years with NSERC contributing \$40,000 per year toward the award holder's salary and guaranteeing a minimum research

grant for each year of the award. To date, 19 women have received these awards with >15% returning from appointments abroad. Some universities, e.g. University of British Columbia and Queen's University, have taken an aggressive approach to capitalizing on this opportunity through direct advertisements. It is permissible to offer positions contingent on the outcome of the faculty awards. Although this represents just one directed effort, it is significant and the creation of up to 25 partially-endowed positions per year is likely to gradually change the situation in Canadian academia.

## USA

The National Science Foundation (NSF) has a mandate to ensure the vitality of the nation's scientific and engineering enterprise requiring a focus on the quality, distribution, and effectiveness of the human resource base in science and engineering, including full utilization of all potentially interested and qualified citizens. In 1997 women submitted 18.0% of the proposals to NSF and received 19.9% of NSF awards.<sup>12</sup> These numbers demonstrate a slightly higher success rate for women.

However, because women are underrepresented in the S&E workforce, NSF supports efforts aimed at increasing the number of women as full participants in the science and engineering mainstream of the nation's workplace through a special program: Professional Opportunities for Women in Research and Education (POWRE).<sup>13</sup> POWRE is a Foundation-wide program with activities designed to increase women's prominence in science and engineering and to enhance their professional advancement by providing women with funding opportunities of \$75,000 to \$150,000 for one year, not ordinarily available through regular research and education grants. Various former programs have been integrated and incorporated into the POWRE program. NSF asks for a personal/career relevance statement and is particularly interested in increasing the participation of minority women, women with disabilities, and women whose careers have been interrupted. These applications otherwise undergo the usual competitive procedures and 20-27% were funded (in 1997-99).

In the USA, several recent reports have raised awareness of remaining gender inequities and significant progress has been made. The first of these involves the federal government filing a suit against Stanford University early in 1999, for not doing enough to aid the progress of women. Secondly, MIT, with prompting from its tenured female faculty members in science, took stock of its situation and addressed outstanding issues.<sup>14</sup> Consequently more progress was made in one year at MIT than was accomplished in the previous decade. The percent of women science faculty members at MIT now exceeds 10%, for the first time. Thirdly, in 1998 the American Physical Society aided two researchers in conducting a survey on the dual-career-couple problem.<sup>15</sup> The more-than-600 replies point to both progress and barriers to women and couples in scientific careers.

The sustained, low numbers of women in S&E faculty positions demonstrates that dedicated efforts will be required to improve the situation. New initiatives to increase these numbers may be helped by a recent meeting sponsored by the American Society for Cell Biology. Some of their recommendations included the establishment of an information clearinghouse on the "best approaches for increasing access, retention, and advancement of women in science, engineering, and math careers" and the development of national mentoring and networking programs.<sup>16</sup> It is also argued that improving the lives of current female faculty members (e.g., via child-care funding) will improve the perceptions of academia for women for future generations.<sup>17</sup>

## SUMMARY

It is difficult to acquire numbers in terms of enrolment/degrees and faculty that can be directly compared between the countries — an attempt has been made in Table 3. Engineering lags S&E at all levels. The percentage of women are low in all cases apart the bachelor degrees in S&E in the USA. There is an overall trend for the percentage of female faculty to be lower than the percentage of female students emerging from the programs.

TABLE 3. COMPARISON OF COUNTRIES IN TERMS OF ENROLMENT AND FACULTY. NUMBERS INDICATE % FEMALE.

Level	Engineering			Science and Engineering		
	USA <sup>a</sup>	Sweden <sup>b</sup>	Canada <sup>c</sup>	USA <sup>a</sup>	Sweden <sup>b</sup>	Canada <sup>c</sup>
Undergraduate	17.3	—	19.5	46.5	21	—
Doctoral Degrees	12.3	—	15.4	32.8	21	—
Asst. Prof. ( <i>fo ass</i> )	—	24.6	14.2	31.6	28.5	—
Associate Prof. ( <i>lektor</i> )	} 4	9.8	8.1	19.8	12.9	—
Full Prof.	—	4.6	2.6	10.0	5.4	—
All levels of profs.	—	10.6	7.0	18.4	13.6	—

<sup>a</sup>1995 bachelor degrees,<sup>18</sup> 1997 doctorates,<sup>19</sup> faculty (engineering)<sup>20</sup>; 1996 faculty (science and engineering)<sup>18</sup>

<sup>b</sup>1996 enrolment,<sup>6</sup> 1998 faculty<sup>6</sup>

<sup>c</sup>1998 enrolment,<sup>21</sup> 1998 faculty<sup>21</sup>

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