

The Professional Education of Women Engineers in Ontario and Quebec (1920-1999): Enrolment Patterns

Monique Frize

Dept. Of Systems and Computer Engineering
Carleton University
School of Information Technology and Engineering
University of Ottawa, Ottawa, Ontario, Canada

Ruby Heap

Dept. of History and Dir. Institute of Women's Studies,
University of Ottawa
Ottawa, Ontario, Canada

ABSTRACT

Entering into the engineering profession has always been and remains to this day a feat of 'mouldbreaking' by women. It is astonishing that this should still be so, whilst other male-dominated professions have achieved gender balance for at least a decade. It is important to study all aspects that govern this profession in order for women to take their rightful place in it and make contributions which are expected to enrich it greatly, as women have now done in law, medicine, and other previously male-dominated fields. Thus, one has to consider that faculties and Schools of engineering in Canadian universities are amongst the last to see progress in increased enrolments of women. Our project examines the evolution of the participation of women in engineering education at the undergraduate and graduate levels in Quebec and Ontario between 1920 and 1990. Its main objectives are to identify the size and nature of female participation in education programs and into the profession itself; study the connections between the structural and cultural dimensions of the education and the gendering of the profession; and complete the study with a focus on the lives and experiences of the female students. Preliminary data was gathered from six institutions: University of Toronto, Queen's University, Carleton University, University of Ottawa, Ecole Polytechnique, and McGill University. The first phase of the project consisted of collecting basic data on enrolment statistics by sex from six universities. These data are also compared for certain eras in Canada, Ontario, and Quebec. Future work will consist of collecting qualitative material (student newspapers, presidents' reports, yearbooks, annual reports from the Faculties and Schools, alumni/ae magazines, etc.) to depict the various "cultures" of engineering present in our designated universities. Finally, interviews will be conducted with different generations of graduates and with some of the pioneers of the early period.

This paper presents and discusses the results of the first phase of the project. To summarize, enrolment patterns of women and of men in Canadian engineering schools and faculties can be divided in 5 major periods: (i) The pioneering stage (1924-1938); (ii) World War II (1939-1945); (iii) The post-war era and the Cold War (1946-1970); (iv) Two decades of increased recruitment (1971-1989); (v) The post-Montreal massacre decade (1990-1999). This information will be complemented by a study of enrolments by discipline. Another set of data compares nation-wide patterns with those in Ontario and Quebec.

INTRODUCTION

Starting in the mid-nineteenth century, Canadian engineering leaders began taking various steps aimed at professionalizing their occupation along the lines of the traditional professions of medicine and law. In addition to securing licensing privileges which would protect the emerging profession's autonomy and jurisdiction, one of the most important features of this professionalization drive was the establishment of university-based education, in replacement of the apprenticeship method of training. Canadian universities gradually agreed to take on this

responsibility, starting with the University of Toronto, whose Faculty of Applied Science and Engineering was the most important in the country.

As demonstrated by recent feminist scholarship, the professionalization of occupations such as law and medicine was a male endeavour which led to a close articulation of the concept of "professional" with middle-class masculinity. Engineering was no exception. The few existing studies on Canadian engineering suggest that its leaders sought to define the "modern" engineer as a male professional armed with a specific body of knowledge which was essential in the building of Canada's industrial-military complex. Women, whose main social functions were to be wives and mothers in the private sphere, and whose feminine traits confined them to specific areas of activity in the public sphere, such as volunteerism and "women's occupations" such as teaching, nursing and clerical work, did not fit at all in this scheme. Hence their continuing under-representation in engineering, a trend which has only recently begun to change.

The preliminary data presented here clearly illustrates the results of this process of exclusion and/or marginalization of women in engineering. Along with professional associations and the engineering leadership, universities have played a leading role in the shaping and transmission of the professional culture of engineering. The university curricula and various restrictive and openly discriminatory academic and administrative policies and practices also acted as strong disincentives. On the other hand, the data indicates that since the beginning of the 20th century, a few women have been enrolling in engineering, and that there were periods where their numbers have increased. In addition, we know that the development of specialisms has divided the small female student body, with some areas, such as chemical, industrial and, more recently, environmental engineering, proving to be far more attractive to women than fields such as mechanical and electrical engineering.

METHODOLOGY

The preliminary data presented in this paper was collected by a student hired during the summer of 1998, mainly from university records, Statistics Canada, and the CCPE (Canadian Council of Professional Engineers). The enrolment patterns of women and of men in undergraduate engineering faculties in our selected Ontario and Quebec universities have therefore been recorded.

RESULTS

1. Enrolments in Engineering Undergraduate Programs

1.1. The early years (1924-1939): From Table I, it can be seen that in the first 14 years, female participation remained less than 1 percent and very little progress on that front was made. The average proportion of women in engineering programs at the national level was 0.15%. During this period, the enrolment of women at the University of Toronto varied between 1 and 6, with only 3 women actually obtaining a degree. The first to obtain a degree in engineering at the University of Toronto was Elsie Gregory McGill who graduated from Mechanical Engineering in 1927. Two other women obtained their degree in 1935 and 1937, respectively. These last results refer to two very important issues: that of the perseverance of women in engineering programs and of the factors leading to their departure, and secondly, that of their motives for enrolling in the first place. For men enrolled at the University of Toronto, their numbers nearly doubled in the 14 year period from 442 men enrolled in 1925 and 832 in 1938, with 1,788 of these obtaining a degree. Finally, it is interesting to observe that the Depression of the 1930's did not act as a deterrent to female enrolment, except between 1936 and 1938, and that the same can be said of male enrolment, a trend which deserves closer examination.

TABLE I: ENROLMENT IN ENGINEERING AND APPLIED SCIENCE (1924-1938)

Year	<u>UNIVERSITY of TORONTO</u>						<u>ECOLE POLYTECHNIQUE</u>						<u>CANADA</u>		
	Enrolment			Degrees			Enrolment			Degrees			Enrolment		
	M	F	F%	M	F	F%	M	F	F%	M	F	F%	M	F	F%
1924/25				123	0	0							1964	3	0.15
1925/26	442	3	0.67	89	0	0									
1926/27	483	4	0.80	102	1	0.10									
1927/28	546	4	0.70	82	0	0									
1928/29	583	3	0.51	88	0	0									
1929/30	697	4	0.57	97	0	0									
1930/31	846	4	0.47	123	0	0									
1931/32	879	5	0.57	115	0	0									
1932/33	903	5	0.55	124	0	0									
1933/34	877	6	0.68	172	0	0									
1934/35	791	6	0.75	191	1	0.52									
1935/36	763	4	0.52	159	0	0									
1936/37	786	3	0.38	129	1	0.77									
1937/38	832	1	0.12	164	0	0									
1938/39	918	6	0.65	153	0	0									

1.2. World War II period (1939-1945): Table 2 shows that the number of women enrolled doubled and tripled during the war period, going from 12 women enrolled in 1939 to 19 women in 1943. During these 7 years, five women obtained a degree, compared to only three in the previous 14 years. In 1939, only 3 men obtained a degree. In the seven year period, their enrolments climbed from 949 in 1939 to 1639 in 1945, with a total of 955 of them graduating. The numbers indicate that, similarly to women, more men graduated in these 7 years than in the previous 14 years. In sum, these statistics allude to the impact of World War II on enrolments in engineering programs, including female enrolments. We will explore the various factors which encouraged women to enroll during this period on international crisis, such as the need for qualified workers in specific areas, government propaganda, etc.

TABLE II: ENROLMENT IN ENGINEERING AND APPLIED SCIENCE (1939-1945)

<u>Year</u>	<u>UNIVERSITY of TORONTO</u>						<u>ECOLE POLYTECHNIQUE</u>						<u>CANADA</u>		
	<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>		
	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>
1939/40	949	12	1.25	3	0	0									
1940/41	975	10	1.02	168	0	0									
1941/42	1139	10	0.87	164	0	0									
1942/43	1373	15	1.08	201	2	0.99									
1943/44	1102	19	1.69	205	1	0.50									
1944/45	1166	18	1.52	214	0	0									
1945/46	1639	17	1.03	265	2	0.75									

1.3. The post-war era and the Cold War(1946-1970): Table 3 shows the enrolments for this era, although some data is missing for that period at the University of Toronto. We can observe, in the first place, that the end of the war led to a significant drop in both male and female enrolments. The return to peacetime thus had a negative impact on general enrolment, although we must look for gender-specific factors explaining the decline in the number of female students (such as government incentives to return women to the home or to their former "women's jobs". Secondly, the data on national enrolments indicates an important rise in both male and female enrolments starting in the mid-1950's, up to the end of the next decade. We will have to depict the reasons behind this increase; the Cold War, advances in technology and, as far as women are concerned, their increased level of participation in university education.

TABLE III: ENGINEERING AND APPLIED SCIENCE (1946-1970)

<u>Year</u>	<u>UNIVERSITY of TORONTO</u>						<u>ECOLE POLYTECHNIQUE</u>						<u>CANADA</u>		
	<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>		
	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>	<u>M</u>	<u>F</u>	<u>F%</u>
1946/47	4238	24	0.56	258	3	1.15									
1947/48	4495	14	0.31	467	5	1.06									
1948/49	3785	9	2.40	1045	1	0.10									
1949/50	2892	7	0.24	1149	2	0.17									
1950/51	2010	7	0.35	731	2	0.27							8348	19	0.23
1951/52	1584	10	0.63	491	2	0.41									
1952/53	1600	7	0.44	332	2	0.60									

1953/54	1622	8	0.49	296	0	0									
1954/55	1797	7	0.39	291	0	0									
1955/56				376	2	0.53							11222	34	0.30
1956/57				394	1	0.25									
1957/58				427	3	0.70									
1958/59				482	2	0.41									
1959/60				454	2	0.44		1							
1960/61				437	1	0.26					1		14587	45	0.31
1961/62				406	2	0.49					1				
1962/63				337	1	0.30					1				
1963/64				308	3	0.96					1		15148	128	0.84
1964/65				263	1	0.38					1				
1965/66				309	1	0.32					4				
1966/67				346	1	0.29					2				
1967/68				338	3	0.88					5				
1968/69				332	7	2.06					3				
1969/70				440	5	1.12					6				

1.4. Two decades of increased recruitment (1971-1989): Both sets of data presented here illustrate the great progress made by women in university engineering programs. The impact of the women's movement, changing attitudes towards working women, and more specifically, towards women working in "non-traditional" masculine fields such as science and engineering, a positive policy climate resulting in the adoption of various laws and rulings aimed at ending discrimination and at achieving equity between women and men, and the continuing rise in female enrolments at universities are some of the major factors which help account for these impressive figures. WE should note, at the same time, the decline in male enrolments in the mid-1980's, a trend which may help also explain why women were encouraged to enroll.

TABLE IV: ENGINEERING AND APPLIED SCIENCE (1970-1989)

	<i>UNIVERSITY of TORONTO</i>						<i>ECOLE POLYTECHNIQUE</i>						<i>CANADA</i>		
<u>Year</u>	<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>			<u>Degrees</u>			<u>Enrolment</u>		
	M	F	F%	M	F	F%	M	F	F%	M	F	F%	M	F	F%
1970/71				479	4	0.83					10		25232	474	1.84
1971/72				500	7	1.38					15				

1972/73				419	6	1.41					19				
1973/74				465	3	0.64					8				
1974/75				469	14	2.90					10				
1975/76				434	12	2.69					7		22745	849	3.60
1976/77				465	27	5.49					11		23878	1099	4.40
1977/78				434	36	7.66					19		25409	1423	5.30
1978/79				480	33	6.43					27		26061	1685	6.07
1979/80				500	40	7.41					30		27279	1963	6.71
1980/81	2318	251	9.77	463	47	9.22	2076	179	7.94		23		27692	2388	7.94
1981/82	2480	292	10.53	528	57	9.74	2175	220	9.19		30		29555	2715	8.41
1982/83	2376	306	11.41	554	54	8.88	2574	272	9.56		46		30744	3236	9.52
1983/84	2342	322	12.09				2432	319	11.60		33		30264	3440	10.21
1984/85	2273	320	12.34				2826	382	11.91		52		30679	3458	10.13
1985/86	2178	323	12.91				3034	451	12.94		68		30175	3660	10.82
1986/87	2125	315	12.91				2905	499	14.66		62		29453	3771	11.35
1987/88	2214	333	13.07	530	71	11.81	2662	528	16.55	558	99	15.07	29130	3805	11.55
1988/89	2273	370	14.00	465	79	14.52	2787	580	17.23	533	102	16.06	28766	4023	12.27

1.5. Post-Montreal massacre (1989-1999): Finally, the striking advances made by female students both at the University of Toronto and at the national level during the last ten years are an illustration of many factors, which we will have to weigh carefully: the impact of the Montreal Massacre, which rapidly led to increased public discussion on the place and role of women in science and engineering, and to multiple initiatives to promote their entry into the profession by governments, universities, the private sector and women's organizations, the aims and motives of the young women enrolling in engineering, immigration trends, and the boom in the high-technology sector. In any case, the data clearly identifies the 1990's as a crucial period in the history of women's engineering education in Canada. Comparisons with trends in other countries such as the United States and Great Britain will help assess the specific features of this trend.

TABLE V: ENGINEERING AND APPLIED SCIENCE (1989-1999)

Year	<i>UNIVERSITY of TORONTO</i>						<i>ECOLE POLYTECHNIQUE</i>						<i>CANADA</i>		
	Enrolment			Degrees			Enrolment			Degrees			Enrolment		
	M	F	F%	M	F	F%	M	F	F%	M	F	F%	M	F	F%
1989/90	2275	386	14.51	452	76	14.39	2683	575	17.65	517	98	15.93	28541	4276	13.03
1990/91	2415	429	15.08	419	83	16.53	2746	660	19.38	521	102	19.5	30859	5013	13.97

1991/92	2092	485	18.82	467	81	14.78	2558	697	21.41	484	125	20.50	33812	6276	15.66
1992/93	2020	491	19.55	436	96	18.05	2507	690	21.58	469	141	23.11	34924	6923	16.54
1993/94	1929	491	20.29	425	103	19.51	2437	664	21.41	505	136	21.22	35163	7597	17.77
1994/95	2078	563	21.32	468	102	17.89	2202	566	20.45	496	109	18.02	34185	7654	18.29
1995/96	2072	570	21.57	486	132	21.36	2053	509	19.87	457	136	22.93	33208	7718	18.86
1996/97	2096	574	21.50	493	116	19.05	2056	463	18.38	452	108	19.29	33837	7909	18.95
1997/98	2148	634	22.79	430	125	22.52	2058	457	18.17	445	118	20.96	34668	8252	19.23
1998/99	2241	759	25.30	418	115	21.58	2269	572	20.13	403	96	19.24	36085	8739	19.50

2. Distribution of Enrolments in Ontario and Quebec

2.1. The early years (1924-1939): Table 5 compares the proportion of women and men enrolled in engineering undergraduate programs in Ontario and in Quebec. In the 40 year span, the proportion of women enrolled in engineering undergraduate programs in Ontario increased from zero to 28, representing an increase of just 0.6 women per year, whereas for men, this was an increase of 111 men per year, or a 15 percent annual rise. It is really in 1950 that women started to enrol in every year of the program for both provinces. In Quebec, during this same period, women increased from none in 1924, to 78 in 1964, an average rise of 2 women per year. For Quebec men, the increase was 91 men per year or 17 percent per year.

2.2. The middle years (1965-1985): In Ontario, women increased by 281 percent per year, or in absolute numbers, by 79 women per year if averaged over the 20 year period. For Ontario men, the rise was of 431 per year or 8 percent per year. In Quebec, the increase was 55 women per year or a rise of 71 percent per year, and men's participation rose by 253 men per year, or 6 percent per year. The overall pattern in Table 5 shows that, because the number of men rose faster in Ontario than in Quebec, the proportion of women's was similar for both provinces; in absolute numbers, Ontario women increased more rapidly than Quebec women. However the percentage of women in Quebec though was 1 percent higher than in Ontario at the end of the period.

2.3. The recent years (1986-1999): This is where the pattern changes and when Quebec female enrolments increase at a faster rate than Ontario women. We will have to examine closely this pattern and try to verify if they are any socio-economic and cultural factors explaining these statistics.

TABLE VII: Enrolments in Engineering (1989-1999)

<u>Year</u>	<u>ONTARIO</u>				<u>QUEBEC</u>			
	Enrolment				Enrolment			
	M	F	F %	Total	M	F	F %	Total
1924/25	746	3	0.40	749	536	0	0	536
1929/30				1305	494	0	0	494
1933/34				1494	598	0	0	598
1950/51	2997	9	0.30	3006	1730	4	0.23	1734
1955/56	3528	17	0.48	3545	2606	5	0.19	2611
1960/61	4328	10	0.23	4338	4013	21	0.52	4034
1964/65	5193	28	0.54	5221	4193	78	1.83	4271
1970/71	10513	194	1.81	10707	5879	194	3.19	6073
1975/76	14355	885	5.81	15240	6421	425	6.21	6846
1979/80	15791	1668	9.55	17459	8335	847	9.22	9182
1984/85	13811	1603	10.40	15414	9264	1184	11.33	10448
1989/90	12257	1770	12.62	14027	9260	1821	16.43	11081
1990/91	12636	2033	13.86	14669	9561	2103	18.03	11664
1991/92	13218	2315	14.88	15553	9642	2202	18.59	11844
1992/93	13451	2605	16.22	16056	9870	2250	18.56	12120
1993/94	13870	2991	17.74	16861	9963	2328	18.94	12291
1994/95	14127	3199	18.46	17326	8811	2003	18.52	10814
1995/96	13732	3287	19.31	17019	8459	1861	18.03	10320
1996/97	13894	3390	19.61	17284	8618	1780	17.12	10398
1997/98	13961	3555	20.30	17516	9209	1794	16.30	11003
1998/99	14759	4020	21.41	18779	9590	1961	16.98	11551

DISCUSSION

As discussed, the preliminary data collected so far indicates that the evolution of women's participation in engineering education in Canada can be divided in specific periods. The historical context linked to each of these periods must be examined carefully if we want to understand and explain the trends observed. Comparing the data collected at our selected universities will enable us also to depict variations which we will have to explain. Do these variations illustrate the existence of different "cultures of professional engineering", which have evolved not only over time in Canadian universities, but also according to specific socio-economic and cultural contexts? Statistics don't tell the whole story. If we want to maintain the gains made over the last decade and keep narrowing the engineering gender gap, we must understand how the cultural world of Canadian faculties and schools of engineering has evolved to make sure that we bring those changes that will close that gap definitively.

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