CANADIAN ENGINEERING MANPOWER

As a one-time physicist, I am very pleased to have been asked by the CAP to speak to you this morning on the engineering manpower picture. There are many common features as to how physicists and engineers are deployed within the labour force and so most of what can be said about engineers might also apply to the physics profession.

The profession of engineering has one major feature that distinguishes it from physics - in Canada an engineer is required by law to be registered in a provincial or territorial association. To qualify for registration, an engineer must have graduated from an accredited engineering program or pass a set of examinations proving he has an adequate academic background, and have accumulated two years of relevant engineering experience. In Ontario, we now require all applicants to write admissions exams on engineering law, and practice and ethics. It is estimated that 85% of all engineering graduates who qualify and work in Canada are registered.

During a study on Engineering Education that I conducted in Ontario about fourteen years ago, I discovered we knew very little about the engineering labour force in Ontario and in Canada. We had little idea about interprovincial flows, how engineers were utilized in the workplace, how their careers progressed and indeed little feedback to the educational system about the suitability of the product. We did not know if the system was producing the right type of engineer to match the requirements of the marketplace - and indeed today we still do not. At that time, in the late 1960s, there were schools of thought in some countries that it should be possible to plan just how many engineers of a certain type - civil, mechanical, electrical, chemical for instance - should be graduated each year to meet demand.

In Ontario, no such planning was contemplated, but it did seem important to know more about the stock and flow of engineers in our labour force than we did then. Moreover, because of the legal requirement to be registered, it seemed that we had a handle on the entire universe of engineers - working on the assumption that, formally, a person is an engineer if and only if he or she is registered with a provincial or territorial association, a convenient definition because it falls within the ambit of the law.

Within that setting, I proposed in the engineering education study referred to earlier, called Ring of Iron, that a Canadian Engineering Manpower Council be created, operated by the Canadian Council of Professional Engineers, a creature of the provincial licencing bodies. This proposal was adopted, and the CEMC was set up in 1972.

Manpower activities breakdown into three main categories:

1. Generation of Supply Data

CEMC picked up from the Engineering Institute of Canada probably one of the longest time series data bases of its kind in Canada - the undergraduate and graduate enrolment statistics which has been in existence since the early 1930s. In recent years, there has been an effort to survey the intention of engineering graduates and their success rate in finding employment. Also, CEMC is obtaining regular data of immigrating engineers from the Canadian Employment and Immigration Commission, and is trying to make some estimate of the number of Canadian engineering graduates outside of Canada.

The slides show the nature of supply data being gathered by CEMC.

2. Stock and Flow Data within the Engineering Labour Force

Following a study that was conducted in 1979, CEMC is establishing a Canadian Engineering Manpower Inventory - a computer-based data storage and retrieval system containing disaggregated data on persons who are registered or who have applied for registration in each participating constitutent association of CCPE. To date, Alberta, British Columbia, New Brunswick, Ontario and Quebec are taking part, representing over 80% of all licensed engineers in Canada. The purpose is to obtain quantitative data on the stock of engineers in Canada on an annual basis. The type of stock data includes:

a) Fixed data - e.g. name, age, sex, language, registration data, education

b) Variable data - e.g. address, employer data, employment status and field of employment, engineering specialization, work function and level of responsibility.

By taking annual "snapshots" of the profession, it will be possible to establish flows within the labour force - where engineers are moving, career progressions, those leaving engineering into other occupations, etc. When coupled with supply data, it will be possible to create a dynamic model of the profession as a whole. It will include the supply in through our university system and other methods of entry, through immigration and from related professions - such as physics. Flows out of the profession through deaths, retirements, emigration and movement into other occupations can be obtained from Inventory data. This model should be of assistance to educational and manpower planners, and help to improve the utilization of engineers.

3. Demand Studies

A third category of manpower activity relates to the forecasting of demand. This area is frought with hazards because of the difficulties associated with any economic prediction. In general, increases in the demand for engineers flows from capital expenditures which, in turn seem to be a function of prevailing interest rates. The problem then becomes one of forecasting interest rates which is well beyond the domain and competency of any wise engineer. CEMC has not been in the demand study business except for an early effort to look at engineering PhDs, the results of which did not go over well with the academic community.

I thought it might be of interest to this conference looking at the challenge ahead for technical training to provide you with the current manpower picture of the engineering profession - it is not a pretty sight !

Today, as a percentage there are more engineers out of work than at any other time in recorded history. I ~~only~~ have data for Ontario which represents about 45% of the total Canadian picture. At December 31, 1982 there were approximately 3600 engineers unemployed, 2630 of which were active UIC claimants. This represents about 7% of all registrants in Ontario.

Hardest hit has been the consulting sector where in all of Canada some 3500 engineers had been laid off in 1982. The big danger is that some very good engineering teams are being disbanded at a time when recovery is occurring in the U.S. We could lose some excellent people from an industry where Canada has a world reputation for excellence and which is always is the forerunner of major equipment export sales.

Fortunately today there are some rays of light beginning to appear. The Technical Service Council claims that professional vacancies have risen 13% in the first quarter of 1983 after 21 dismal months. Employers are now much more optimistic about the economy.

I might add at this point that the same labour force survey data I used for information on engineers showed that as of December 31, 1982, there were 1400 physical scientists out of work in Ontario, 1159 of which were on the active UIC roles.

The real tragedy of the current job situation, however, is what is happening to the class of 1982 and 1983. In round figures, 25% of the engineering class of '82 and 75% of the class of '83 are without jobs of any description. This represents an entire graduating year which, in Ontario, is approximately 2800 graduates. Many of the graduates contacted by CEMC have given up in despair and are not even seeking engineering jobs.

In this connection, the Association of Professional Engineers of Ontario and the Technical Service Council are about to mount a campaign to assist these recent graduates in career counselling and job seeking through seminars and other means across the province. As recovery gains momentum, the demand for engineering graduates should expand to absorb them. By 1984 and beyond, the Ontario graduating classes will be over 3000 in number, but if you believe in the cyclical nature of demand as I do, then we should see shortages of engineers develop again before the present decade is over.

Just to confirm the cyclical nature of the play between supply and demand, this year there is a 12% reduction in the number of Ontario graduating high-school students selecting engineering as their first choice in curriculum. This early indication could result in a decline in engineering enrolments next fall which would be the first such decrease in over a decade as shown on the next slide. The four-year lead time of an engineering undergraduate program seems to put supply and demand close to being 180 degrees out of phase.

Another phenomenon is occurring which could work to our advantage. The current depression in the labour market is driving more Canadian baccalaureates into the graduate schools as shown on the slide. This has two beneficial effects.

The first relates to the need for an increase in the supply of engineering faculty. The recent boom in capital projects before the current recession coupled with a serious under-funding of universities across the board over the past decade have resulted in a serious depletion of engineering faculty right across Canada, and particularly in Ontario. While I would advocate that greater use should be made of practicing engineers both as adjunct professors and temporary full-time staff on loan from industry, the solid core of all university faculty, particularly those that perform research, these days are drawn from the graduate schools. An increase in the supply of Ph.D/s from the system will help to relieve the depleted ranks of academe.

A second beneficial effect of increased graduate enrolments relates to a structural change taking place in engineering employment. The past decade has seen in Canada a spectacular rise in the so-called high-technology industrial sector based, in large measure, on the technologies related to the chip and microprocessors. These industries are unlike the more traditional Canadian companies in that they actually want Ph.Ds and engineers with advanced degrees! The structural change, in my view, is that an advanced degree will result in a net positive present value - and thus ultimately lead more students into masters and doctoral programs than in the past.

This is a very different situation than existed a decade ago. Then, studies by David Dodge at Queen's University showed that the present value of a masters' program was approximately zero, and for a doctoral program definitely negative. The major single factor in these calculations was foregone earnings that were never really regained over a lifetime of employment. The growth of part-time programs and the premiums now developing for advanced degrees I believe will result in a net positive rate of return.

A final aspect I would like to touch upon is the other end of the engineering employment spectrum - the impact of the paraprofessional. In Ontario and indeed across Canada, there is an expanding stock of engineering technologists and technicians pouring out of the community colleges. This cadre of highly-skilled technical people is beginning to displace graduate engineers at the junior level, and are quite capable of performing engineering tasks which in the past have been reserved exclusively for licenced engineers. Indeed our new Professional Engineers Act reflects this reality by permitting any person to perform engineering work just so long as a professional engineer takes responsibility for such work, the old Act allowed no such exemption. There now is even provision for limited licensure to permit the Association to licence persons other than engineers to take professional responsibility for limited areas of activity to cover cases where a perfectly competent technologist can take on the legal mantle of an engineer where it is not practical or possible for an engineer to do so.

The paraprofessional surge in the labour force will have the effect of improving the utilization of the engineer who perhaps may be driven into positions of responsibility earlier in his or her career than in the past. It may also reduce the demand for engineers in the long run.

I should wind up by remarking that there is a welcome increase in the number of women entering the profession. They comprise a surprising 9.4% of the undergraduate engineers in the present academic year, up from 8.2% last year.

I hope these comments on engineering manpower have been of some use, and in part apply to physicists in Canada. I believe there is much in common in how we view ourselves relative to the Canadian economy, and the contributions we each can make to research, teaching and industrial development.

Philip A. Lapp

Table 1
TOTAL GRADUATE ENROLMENT: CANADA

YEAR	TOTAL ENROLMENT	INCREASE (DECREASE) FROM PREVIOUS YEAR	% INCREASE (DECREASE)
1970-71	4488	216	5.1
1971-72	4268	(220)	(4.9)
1972-73	3867	(401)	(9.4)
1973-74	3914	47	1.2
1974-75	4539	625	16.0
1975-76	5194	655	14.4
1976-77	5189	(5)	(0.1)
1977-78	5159	(30)	(0.6)
1978-79	5038	(121)	(2.4)
1979-80	4930	(108)	(2.2)
1980-81	5084	154	3.1
1981-82	5486	402	7.9
1982-83	6267	781	14.2

Table 2
TOTAL UNDERGRADUATE ENROLMENT: CANADA

YEAR	TOTAL ENROLMENT	INCREASE (DECREASE) FROM PREVIOUS YEAR	% INCREASE (DECREASE)
1970-71	23552	263	1.1
1971-72	22645	(907)	(3.9)
1972-73	22103	(542)	(2.4)
1973-74	21176	(927)	(4.2)
1974-75	22418	1242	5.9
1975-76	24842	2424	10.8
1976-77	26501	1659	6.7
1977-78	28501	2000	7.5
1978-79	29446	945	3.3
1979-80	30758	1312	4.5
1980-81	32179	1412	4.6
1981-82	34155	1976	6.1
1982-83	35869	1714	5.0

Table 3
GRADUATE ENROLMENT: REGION

	1982-83	% TOTAL (CANADA)	1981-82	% TOTAL (CANADA)
Atlantic	411	6.6	325	5.9
Quebec	1771	28.3	1697	30.9
Ontario	2789	44.5	2466	45.0
West	1296	20.6	998	18.2
Canada	6267	100.0	5486	100.0

Table 4
GRADUATE ENROLMENT: DISCIPLINE

	1982-83	% Total	1981-82	% TOTAL
Civil	1486	23.7	1297	23.6
Electrical	1649	26.0	1297	23.6
Mechanical	913	14.5	779	14.2
Chemical	735	11.7	666	12.1
Metallurgy	285	4.5	262	4.8
Computers	139	2.2	138	2.5
Industrial	102	1.6	102	2.0
Other	1058	16.8	945	17.2
Total	6267	100.0	5486	100.0

Table 5
GRADUATE ENROLMENT: DEGREE LEVEL

	1982-83	% TOTAL	1981-82	% TOTAL
M. Eng.	1878	30.0	1745	31.8
M. A. Sc.	2985	47.6	2517	45.9
Ph. D.	1404	22.4	1224	22.3
Total	6267	100.0	5486	100.0

Table 6
GRADUATE ENROLMENT: FULL-TIME

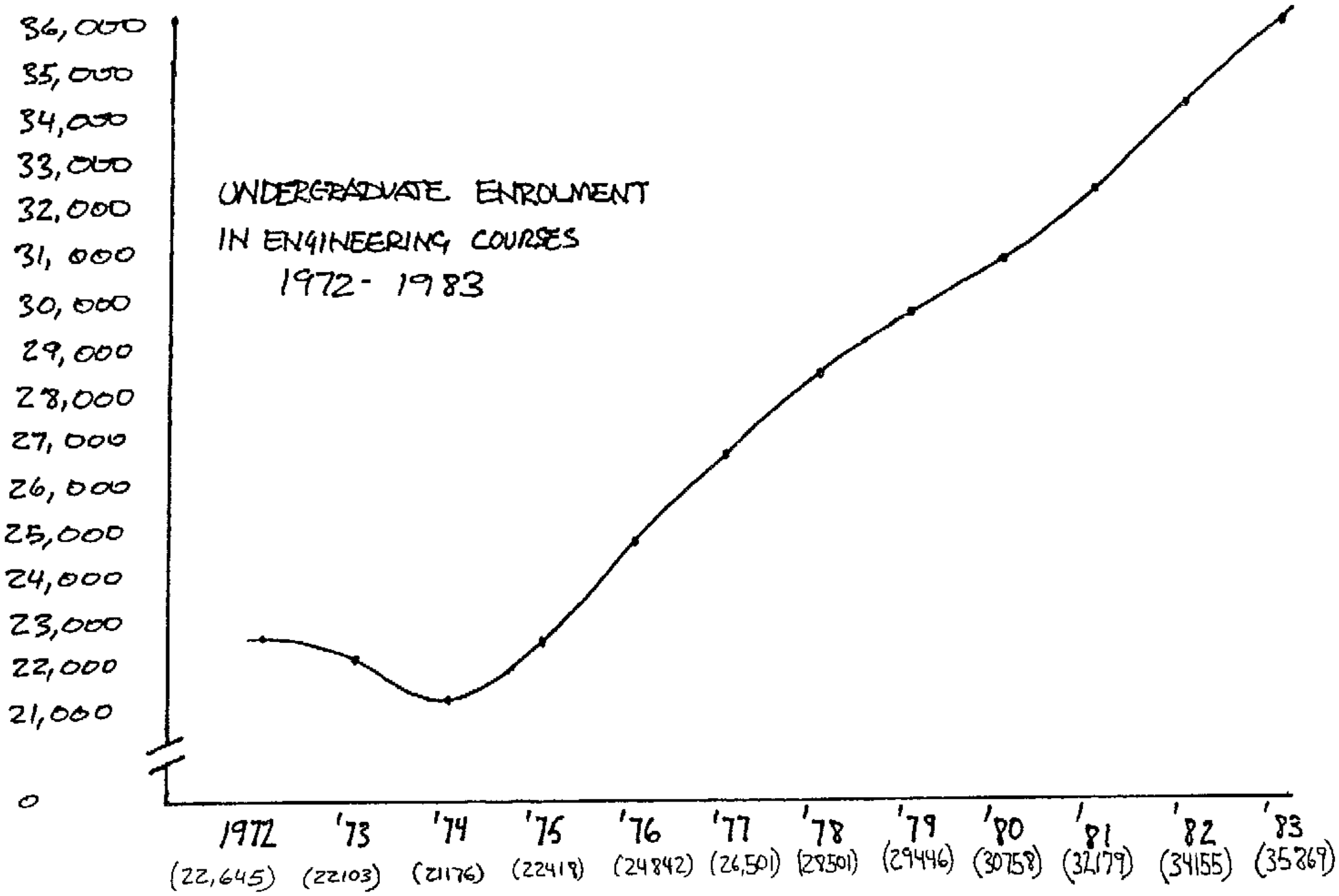
	1982-83	% TOTAL (DEGREE LEVEL)	1981-82	% TOTAL (DEGREE LEVEL)
M. Eng.	784	41.7	631	36.2
M. A. Sc.	2258	76.0	1732	68.8
Ph. D.	1132	81.0	950	77.6
Total	4174	66.6	3313	60.4

Table 7
GRADUATE ENROLMENT: PART-TIME

	1982-83	% TOTAL (DEGREE LEVEL)	1981-82	% TOTAL (DEGREE LEVEL)
M. Eng.	1094	58.3	1114	63.8
M. A. Sc.	727	24.4	785	31.2
Ph. D.	272	19.4	274	22.4
Total	2093	33.4	2173	39.6

Table 8
WOMEN STUDENTS: REGION

	1982-83	% TOTAL (REGION)	1981-82	% TOTAL (REGION)
Atlantic	36	8.8	22	6.8
Quebec	146	8.2	117	6.9
Ontario	210	7.5	178	7.2
West	66	5.1	51	5.1
Canada	458	7.3	368	6.7



SOURCE: ENGINEERING MANPOWER NEWS NO. 52
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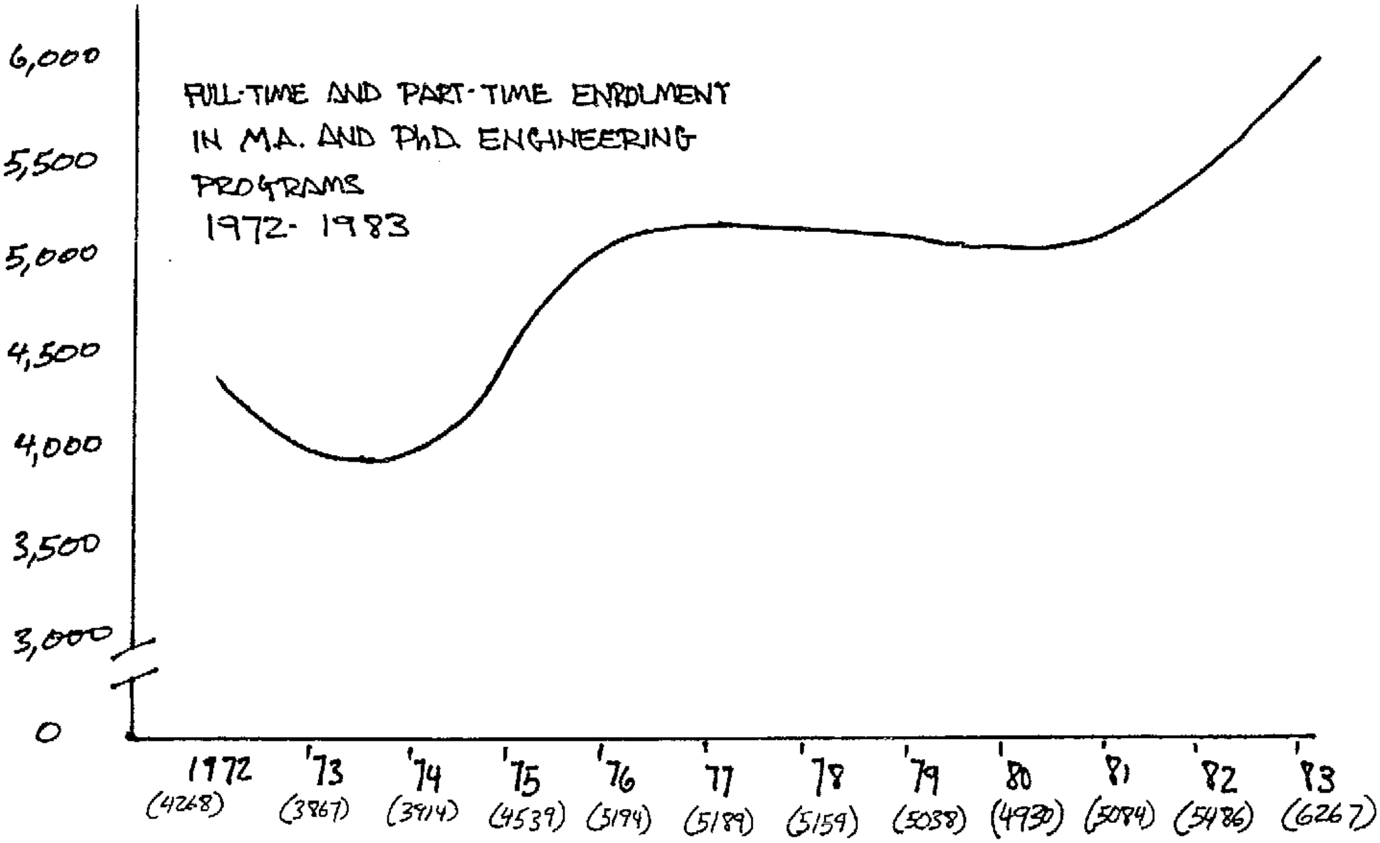

SOURCE: ENGINEERING MANPOWER NEWS NO. 33
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1981-82	34155	1976	6.1
1982-83	35869	1714	5.0

Table 2
UNDERGRADUATE ENROLMENT: REGION

	1982-83	% TOTAL (CANADA)	1981-82	% TOTAL (CANADA)
Atlantic	3974	11.1	3549	10.4
Quebec	9316	25.9	8506	24.9
Ontario	14438	40.3	14434	42.3
West	8141	22.7	7666	22.4
Canada	35869	100.0	34155	100.0

Table 3
ENROLMENT BY DISCIPLINE: CANADA

	1982-83	% TOTAL (CANADA)	1981-82	% TOTAL (CANADA)
General	7911	22.0	8249	24.2
Electrical	7016	19.6	6675	19.6
Civil	4637	12.9	4546	13.3
Mechanical	6949	19.4	6364	18.6
Chemical	2986	8.3	2877	8.4
All Others	6370	17.8	5444	15.9
Canada	35869	100.0	34155	100.0

Table 4
YEAR 1 ENROLMENT: REGION

	1982-83	% TOTAL (CANADA)	1981-82	% TOTAL (CANADA)
Atlantic	1454	12.7	1151	10.4
Quebec	3459	30.2	3016	27.2
Ontario	4109	35.8	4490	40.6
West	2441	21.3	2415	21.8
Canada	11463	100.0	11072	100.0

Table 5
WOMEN UNDERGRADUATES: REGION

	1982-83	% TOTAL (REGION)	1981-82	% TOTAL (REGION)
Atlantic	340	8.6	262	7.4
Quebec	931	9.9	733	8.6
Ontario	1427	9.9	1288	8.9
West	679	8.3	533	7.0
Canada	3377	9.4	2816	8.2

Table 6
GRADUATES TO 1986 : REGION

	ACTUAL	PROJECTED			
	1982	1983	1984	1985	1986
Atlantic	528	1145	1159	1220	1420
Quebec	1642	1832	1843	1946	2029
Ontario	2605	2787	2995	3130	3013
West	1376	1513	1646	1714	1738
Canada	6151	7277	7643	8010	8200