Advisory Council on Science and Technology
Conseil consultatif des sciences et de la technologie

SUPPORTING DOCUMENT 9
EXECUTIVE SUMMARY

A Study on Education and Training Capacity: Barriers and Incentives

Prepared for the Expert Panel on Skills
by Bill Ahamad, Ahamad Consultants Inc.

September 1999

Canada

Summary
A Study on Education and Training Capacity: Barriers and Incentives

Bill Ahamad, Ahamad Consultants Inc.

Purpose of Study

To provide a description of the ability of the education system to supply individuals with the critical skills needed in five knowledge-industrial sectors.

Highlights

Methodological limitations

The information currently available on graduates from the education system can only be used indirectly to analyze the supply of critical skills in the five knowledge sectors since products of education are tracked on the basis of fields of study rather than specific skills. An assessment of the system's ability to supply individuals with particular skills would require a full examination of institutions' curricula.

Data on graduates by field of study

Data on graduates by field of study show that while the overall number of graduates in all fields has increased over time, the number of bachelors in a number of engineering and science fields relevant to the five sectors has been at best stable during the 1990s. Masters and PhDs have grown more steadily, for the most part.

At the college level, despite an increase of over 50 percent in the total number of graduates between 1980 and 1995, there was no identifiable pattern in the number of graduations in fields relevant to the five sectors.

Projections of graduates:

The School Leavers Model of HRDC projects a total increase of about four percent in Bachelor's degrees, and 9 percent percent in Ph.Ds awarded, between 2000 and 2005, and a two percent decline in Master's degrees. Model assumes constant shares by fields of study, over time, so graduates from each field of study rise or fall by this rate.

Data on recent graduates with the same fields of study disperse into a wide variety of occupations. At the same time, the new graduates in the same occupation are often drawn from diverse fields of study. This suggests that many of the skills employers seek are not necessarily embodied in particular fields of study. It also suggests that the success of efforts to increase the supply of individuals in a particular occupation by increasing the number of graduates in a particular field, may be limited by 'leakage' to other occupations.

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Étude sur la capacité d'éducation et de formation : Obstacles et incitatifs

Préparé pour le Groupe d'experts sur les compétences
par Bill Ahamad, Ahamad Consultants Inc.

Septembre 1999

Canada

Étude sur la capacité d'éducation et de formation : Obstacles et encouragements
(A Study on Education and Training Capacity: Barriers and Incentives)
– Bill Ahamad, Ahamad Consultant
dans

Objet de l'étude

Décrire la capacité du secteur de l'éducation de fournir les compétences essentielles nécessaires dans cinq secteurs du savoir.

Faits saillants

Contraintes méthodologiques

- Les renseignements qui existent actuellement sur les diplômés du secteur de l'éducation ne peuvent être utilisés qu'indirectement pour analyser l'offre de compétences essentielles dans les cinq secteurs du savoir, puisque les produits d'éducation sont suivis en fonction des disciplines plutôt que des compétences particulières. Une évaluation de la capacité du système de produire des travailleurs possédant des compétences données exigerait un examen complet des programmes d'études des établissements.

Données sur les diplômés selon la discipline

- Les données sur les diplômés selon la discipline révèlent que, même si le nombre total de diplômés dans toutes les disciplines a augmenté avec le temps, le nombre de bacheliers dans certains programmes de génie et de sciences pertinents pour les cinq secteurs a été au mieux stable dans les années 90. En règle générale, les diplômés de maîtrise et du doctorat ont augmenté davantage.
- Au niveau collégial, malgré la hausse de plus de 50 percent du nombre total de diplômés entre 1980 et 1995, il n'y a pas de profil évident au sujet du nombre de diplômés dans les domaines pertinents pour les cinq secteurs.

Projections des diplômés

- Le Modèle sur les sortants de DRHC prévoit une hausse totale d'environ quatre percent des baccalauréats et de neuf percent des doctorats entre 2000 et 2005, ainsi qu'une baisse de deux percent des maîtrises. Le modèle suppose des parts constantes selon les domaines d'étude, dans le temps, de sorte que les diplômés de chaque domaine d'étude augmentent ou diminuent dans les mêmes proportions.
- Les données sur les diplômés récents dans les mêmes domaines d'étude se dispersent dans une foule de métiers. Par ailleurs, les nouveaux diplômés de la même profession proviennent souvent de diverses disciplines. Il semble donc qu'un grand nombre des compétences que recherchent les employeurs ne se trouvent pas dans des disciplines particulières. Il semble aussi que le succès des efforts visant à accroître l'offre de travailleurs dans certaines professions en augmentant le nombre de diplômés dans une discipline en particulier pourrait être limité par les « fuites » vers d'autres professions.

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Summary

Introduction

This paper provides a summary of the results of a study on the "Education and Training: Capacity, Barriers and Incentives", carried out for the Expert Panel on Skills.

The broad objective of the study was to provide a description of the ability of the education system to supply individuals with the critical skills needed in five strategic sectors (aerospace, automotive, biotechnology, environment and information and telecommunications). This cannot be done directly since information on the supply of critical skills *per se*, including that from the education system, is not currently available. However, information on the *fields of study* of graduates from universities and community colleges, and the *occupations* of recent graduates, is currently available from Statistics Canada. This study explores the use of such information to describe the supply of critical skills in the five strategic sectors.

The Identification of Critical Skills

To start, the study required an identification of the critical skills in the five strategic sectors, as well as a knowledgeable assessment of the university and community college fields of study most likely to be associated with them. Such an assessment had been undertaken in a separate report carried out for the Expert Panel on Skills (see Margaret Roberts: **Monitoring Critical Skills**). This information, in turn, had drawn on sector profiles of each sector which had been prepared for the Panel using existing literature and company interviews in the five sectors.

It is significant that from the above sources, a very high proportion of the 'critical skills' identified in these five sectors were expressed in *occupational* terms. These sources thus identified a combination of *critical skills* and *demand occupations*, for which relevant *fields of study* could be derived. This list of critical skills, occupations, and associated fields of study was used as the basis for the analysis in this report.

Occupations and Skills

It is important to note that fields of study can only provide crude indicators of the *supply* of critical skills, and that occupations will provide similarly crude indicators of their *use*.

Individuals develop skills in the public educational system; but they also develop them through work experience, on-the-job training, the private education system, and a range of informal education programs (such as interest courses, private study, etc.). In addition, while it is possible to identify university and community college programs which are broadly relevant to occupations and/or sectors, it is not possible without a detailed curriculum review, to determine whether those programs impart specific skills or skill sets. Thus estimates of the number of graduates from public educational institutions can only provide very rough estimates of the supply of these critical skills.

Similarly, workers need these critical skills to perform the functions required in different occupations. But it may be possible for workers with other skills to quickly develop these critical skills in the workplace; for example, it may be possible for graduates with mathematical skills to quickly develop programming skills. Thus there may be some room for skill substitution in the production process.

It follows that the numbers of graduates in different fields of study provide only an approximate indicator of the availability of the critical skills to the five sectors. And the occupations in these sectors in which graduates from different fields of study find jobs provide only a rough indicator of the demand for these skills.

Trends in the Number of Graduates in the Specified Fields of Study

The data in Table 1 show that the number of university graduates in all fields and all levels increased considerably over the period 1980-95. Bachelor's graduates increased from 98,600 to 150,800 (an increase of about 50%), Master's graduates from 14,100 to 23,500 (an increase of 67%), and Doctorate graduates from 1,700 to 3,700 in 1995 (an increase of over 100%).

The data also show that the number of university graduates in the fields associated with critical skills/occupations in the five sectors was relatively small except for Commerce, Management, Business Administration, etc.

At the same time, the rate of increase in the number of graduates in the individual fields and levels has varied considerably.

Among Bachelor's degrees, the number of graduates in many sciences has in many cases remained stable, and in some cases declined, since 1990. There has been similar stability in several major engineering fields (electrical, industrial, and mechanical). Despite increases in chemical and civil engineering and computer science, the number of graduates in 1995 was still at or below levels reached in the 1980s. The number of commerce/business graduates has risen consistently since 1980.

At the Master's level, there has been an increase in graduates in all the engineering and computer science specialties, as well as commerce/business, during the 1990s. The pattern for sciences has been less regular.

At the Doctorate level, the increase in the number of graduates has applied across virtually all the listed specialties, albeit in varying degrees.

Table 1: Number of University Graduates in fields associated with critical skills/occupations in five strategic sectors

Field of study associated with critical skills/ occupations in the five strategic sectors	Bachelor's				Master's				Doctorate			
	1980	1985	1990	1995	1980	1985	1990	1995	1980	1985	1990	1995
Commerce, Management, Business Administration, etc.	10850	16519	19888	21099	2437	3110	3504	4236	16	31	49	70
Geology and Related	474	988	388	362	146	226	188	180	42	53	57	71
Aerospace Sciences	0	9	18	12	2	3	8	17	1	7	3	6
Biophysics	7	12	10	7	1	7	8	3	1	0	7	9
Other Physics	417	577	652	633	142	171	231	209	60	89	107	129
Pharmacology	0	14	26	96	32	40	44	84	18	19	29	45
Chemistry	782	848	1010	1009	152	147	199	231	145	138	184	212
Soil Science	51	52	37	21	16	30	33	26	4	7	9	19
Genetics	38	46	122	115	2	7	9	2	0	0	4	3
Microbiology	189	190	258	263	21	16	36	34	10	13	18	36
Chemical Engineering	628	835	631	786	93	182	142	193	26	27	64	73
Civil Engineering	1653	1259	960	1464	250	360	260	377	31	49	73	108
Electrical Engineering	1514	2104	1953	1873	212	340	411	536	62	77	107	193
Industrial Engineering	217	261	313	293	31	28	48	98	3	2	9	10
Mechanical Engineering	1493	2002	1859	2041	137	261	208	318	22	46	54	130
Aeronautical and Aerospace Engineering	16	32	23	95	21	26	27	43	1	5	5	6
Other Engineering	481	788	790	1361	122	178	171	308	11	18	16	55
Computer Science	1244	3523	2752	3510	153	255	374	404	25	33	45	88
All fields of study	98648	113940	130629	150803	14053	16811	19491	23547	1738	2001	2672	3716

Source: Based on data provided by the Applied Research Branch, HRDC

The data in Table 2 show that the total number of College graduates increased from 46,600 in 1980 to 72,500 in 1995 (an increase of 56%), despite a slight reduction in the 1985-90 period. In addition, the number in the individual fields associated with the critical skills in the five sectors was relatively small. There was no consistent growth pattern across fields, however. In some fields, such as Avionics Technology and wildlife conservation, the number of graduates increased at a higher rate than the number in all fields. In others, such as aircraft mechanics, machinists, and biological sciences, an increase in the 1990-95 period tended to offset a decline in 1985-90. In yet others, such as Electrical Engineering Technology and Biochemical Technologies, the number declined over the period.

Table 2: College graduates in fields associated with critical skills/occupations in five strategic sectors

Field of study associated with critical skills/occupations in the five strategic sectors	1980	1985	1990	1995
Avionics Technology	39	75	95	131
Aircraft Mechanics	321	329	229	328
Manufacturing Technology	5	0	0	8
Electrical Engineering Technology	812	557	681	698
Other Mechanical Engineering Technologies	499	819	817	1114
Industrial Design/Operations Technologies	112	100	58	87
Machinist	45	251	120	164
Manufacturing Management/Administration	33	134	165	209
Biological Sciences/Technologies	172	101	77	103
Biochemical Technologies	134	107	108	34
Environmental Control/Protection Technologies	233	243	237	467
Land Resources Technologies	41	36	18	11
Wildlife and Forest Conservation Technologies	136	172	184	235
Water Science Technologies	43	107	103	187
Air Purification Technologies	3	10	0	0
Other Environmental and Conservation Tech. NEC	85	95	110	294
All fields of study	**46561**	**60777**	**57255**	**72532**

Source: Based on data provided by the Applied Research Branch, HRDC

To summarise, data for the period 1980-95 show that the number of graduates in the fields associated with the critical skills in the five sectors is relatively small. In addition, the rate of increase in the number of graduates has varied considerably from one period to the next. While the number of Master's and Doctorate degrees awarded has increased for the great majority of fields associated with the strategic sectors, there have been much more uneven patterns at the Bachelor's and College levels. With the possible exception of aerospace-related fields, most of which have shown an increase, there has been no identifiable pattern in fields related to specific strategic sectors.

Projections of the Number of Graduates in Different Fields of Study

Projections of enrolments and graduations are developed in the COPS (Canadian Occupational Projections System) School Leavers Model (CSLM), which has been developed by the Applied Research Branch in Human Resources Development Canada (HRDC). The projections are based on changes in the demographic structure of the population, and they take account of the effects of labour market conditions (such as unemployment rates) on enrolments and graduates at different levels of education.

The projections in the CSLM are based on fields of study defined for use by COPS. In some cases, these fields are the same as the detailed fields used above, but in many cases they are aggregations of the detailed fields. Thus projections for all of the detailed fields in Table 1 are not available from the model.

Table 3: Projections of the number of university graduates, in selected fields of study 2000 and 2005

	Bachelor's		Master's		Doctorate	
Field of study	**2000**	**2005**	**2000**	**2005**	**2000**	**2005**
Commerce	13894	14370	3956	3872	76	83
Biology	274	283	429	420	180	198
Chemical Engineering	5937	6140	170	167	101	111
Civil Engineering	1345	1391	375	367	103	114
Electrical Engineering	1798	1860	488	477	204	225
Mechanical Engineering	1803	1865	311	305	127	140
Computer Science	2247	2324	381	372	83	92
Chemistry	429	444	221	216	251	277
All fields	**122657**	**126862**	**20770**	**20330**	**4290**	**4730**

Source: Projections based on the CSLM developed by Applied Research Branch, HRDC.

The data in Table 3 show projections from the CSLM for university graduates in selected COPS fields of study for the period 2000 and 2005. The data suggest that the number of Bachelor's graduates will grow by about 4% over the period 2000-2005. By contrast, the number of Master's graduates is likely to decrease slightly over the period; and the number of Doctorate graduates is projected to increase by about 9% over the period 2000-2005.

The Occupations of Recent Graduates in the Selected Fields of Study

Data on the occupations of recent graduates in different fields of study are available from the National Graduates Surveys (NGS) conducted for several years by Statistics Canada/HRDC. These data show the fields of study of graduates at the time of graduation and their occupations two years after graduation.

The surveys are based on a sample of about 20% of graduates with different levels of education (except for Doctorate graduates who are all included). The data are subject to sampling variation; fields with an estimated number of under 100 graduates are not therefore included in the discussion below.

The data in Table 4 show the occupations in 1997 of university graduates in the calendar year 1995 in the fields of study included in Table 1 (except those with fewer than 100 graduates). Column 2 lists the main occupations (of those associated with the critical skills in the five sectors), in which graduates in the given field found jobs.

Two columns of data are included for each level of education. The first column shows the percentage of graduates in the given field who were working in the specified occupation; and the second column shows the percentage of graduates working in the given occupation who had specialised in the given field. For example, the data in the first row show that 3.4% of Bachelor's graduates in Commerce, Management, Business Administration, etc. found jobs as Sales, Marketing and Advertising Managers. At the same time, 32.5% of Bachelor's graduates working as Sales, Marketing and Advertising Managers had specialized in Commerce, Management, Business Administration, etc.

The data show, for example, that only a relatively small proportion of university graduates from the fields seen as most relevant to the critical skills/occupations in the five strategic sectors actually found jobs in these critical occupations. Similarly, only a relatively small proportion of graduates working in the critical occupations were qualified in the fields seen as most relevant to those occupations.

There are of course exceptions to this. One exception occurs for Mechanical Engineering: 86% of Bachelor's graduates in this field found jobs as Mechanical Engineers. A second occurs for Chemical Engineers; 83% of new Chemical Engineers had graduated from Chemical Engineering.

Significantly, only 30% of the Computer Science Graduates were working as computer systems analysts. Conversely, only 39% of graduates working as computer systems analysts had graduated from Computer Science.

There are several possible explanations for these findings. For example:

- Employers may prefer to employ new graduates with a variety of skills rather than to focus on those with the critical skills.
- New graduates may be expected to develop the critical skills on the job.
- Graduates may develop the critical skills outside the formal education system.

Table 4: The occupations in 1997, of 1995 university graduates in fields associated with the critical skills in the five sectors

Fields of study associated with critical skills in the five strategic sectors	Relatively large occupation(s) associated with critical skills in the five strategic sectors and given field	Bachelor's		Master's		Doctorate	
		% of field's graduates working in occupation	% of graduates in occupation who came from field	% of field's graduates working in occupation	% of graduates in occupation who came from field	% of field's graduates working in occupation	% of graduates in occupation who came from field
Commerce, Management, Business Administration, etc.	1. Sales, marketing and advertising managers	3.4	32.5	7.9	78.2	-	-
	2. Computer systems analysts	2.3	13.0	4.4	29.9	4.8	3.7
Geology and Related	Geologists, geochemists and geophysicists	28.7	41.7	-	-	-	-
Other Physics	Geologists, geochemists and geophysicists	5.8	12.8	-	-	-	-
Chemistry	Chemists	13.9	37.4	12.0	-	28.3	49.1
Microbiology	Biologists and related scientists	8.7	4.5	-	-	16.7	4.7
Chemical Engineering	Chemical engineers	21.7	83.2	17.5	-	2.9	-
Civil Engineering	Civil engineers	35.3	49.1	40.0	44.3	24.1	-
Electrical Engineering	1. Electrical and electronics engineers	28.4	55.3	36.4	56.9	38.3	58.9
	2. Computer systems analysts	12.8	30.8	12.0	8.2	11.9	18.5
Industrial Engineering	Industrial and manufacturing engineers	27.5	13.6	-	-	-	-
Mechanical Engineering	1. Mechanical engineers	86.0	28.2	31.1	49.2	10.4	-
	2. Industrial and manufacturing engineers	13.2	39.4	13.3	-	3.0	-
Aeronautical and Aerospace Engineering	Aerospace engineers	30.3	16.6	-	-	-	-
Other Engineering	Computer engineers	6.8	10.3	0.8	1.5	0.0	-
Computer Science	Computer systems analysts	30.1	39.0	39.8	21.8	38.9	25.9

Notes: The symbol – is used in cells with fewer than 100 graduates. The data are derived from the 1995 NGS, and were obtained form the Applied Research Branch, HRDC

Similar data are shown in Table 5 for college graduates in the fields included in Table 2. These data show that the findings for college graduates are similar to those for university graduates.

Taken together, the university and college graduate results from Tables 4 and 5 show that graduates from particular fields spread widely into many occupations -- well beyond the occupations which one would expect them to enter, based on their field of study. Similarly, among the graduates in particular occupations, often only a minority come from the fields which appear most relevant to those occupations. These data suggest that the field-to-occupation link is relatively weak and unpredictable.

Table 5: The occupations in 1997, of 1995 college graduates in fields associated with critical skills in the selected sectors

Field of study associated with critical skills in the selected sectors	Relatively large occupation(s) associated with critical skills in selected sectors and given field	% of field's graduates working in occupation	% of graduates in occupation who came from field
Aircraft Mechanics	Aircraft mechanics and aircraft inspectors	39.4	62.2
Electrical Engineering Technology	Industrial electricians	41.9	5.3
Other Mechanical Engineering Technologies	Machinists and machining and tooling inspectors	5.9	55.0
Industrial Design/Operations Technologies	Machinists and machining and tooling inspectors	9.6	10.0
Machinist	Machinists and machining and tooling inspectors	11.7	8.0
Biological Sciences/Technologies	Biological technologists and technicians	26.0	20.4
Land Resources Technologies	Biological technologists and technicians	6.0	18.1
Water Science Technologies	Biological technologists and technicians	15.3	14.2
Air Purification Technologies	Geological and mineral technologists and technicians	8.4	10.9

Notes: The data are derived from the 1995 NGS, and were obtained form the Applied Research Branch, HRDC

Key factors affecting the capacity of the supply channels for critical skills

During the 1990s, full-time enrolments in post-secondary education grew consistently even though public funding for post-secondary education and research was declining. The impact of declining budgets has been felt, in particular, in salaries and staff and physical infrastructure.

Salaries comprise almost two-thirds of university expenditures so that it is understandable that the recent fiscal constraints would have led to adjustments in salaries and staff. According to a recent report[1] by the Association of Universities and Colleges of Canada (AUCC), universities

[1] *AUCC: Trends: The Canadian University in Profile (May, 1999)*

reacted by cutting academic salaries and benefits by more than $350 million between 1993 and 1997. Academic salaries have been frozen in some provinces, and analysis by Statistics Canada shows that real salaries have declined in the late 1990's. The total size of university faculty has been reduced by 11% since 1992, and this has been accompanied by an increase in teaching time of as much as 25%.

The reduction in faculty has been eased by early retirement, but the AUCC report notes that only a few retiring faculty were replaced by new entrants so that the average age of faculty has continued to rise. However, faculty in Biological Sciences, Engineering, Health Professions, Commerce and Computer Science still tend to be relatively young because of the extent of hiring in these fields in the early 1990's.

Reductions in federal support for university-based research combined with increasing teaching workloads have forced some faculty to look abroad. A 1997 AUCC survey[2] found that most of the faculty leaving Canada do so at the peak of their careers; they are attracted not only by higher salaries but also by richer research funding and reduced teaching time.

The report of Ontario's Advisory Panel on Future Directions for Postsecondary Education[3] (published in December of 1996) attempted to address the problems of faculty development and retention. During the Advisory Panel's consultations, Ontario universities repeatedly voiced concerns about declining competitiveness in attracting and retaining the strongest teachers and researchers. The Advisory Panel recognised that some institutions need to be more active in the labour market for international scholars and recommended the establishment of matching trust funds for faculty renewal. The Advisory Panel also recognised that much of the responsibility rests with the universities: internal processes and collective agreements must recognise and encourage performance in teaching, research and the provision of service. However, there was no mention in the report about the effects of salaries in the private sector and in other countries in establishing competitive compensation for disciplines in shortage.

The report of the Advisory Panel also provides important insights on physical infrastructure. The post-secondary institutions participating in the consultations of the Ontario Task Force were confident that, given proper funding, the construction of new colleges and universities would not be necessary to meet the anticipated levels of demand for post-secondary education. The report describes a number of ways to increase capacity with existing physical infrastructure. These include:

- Co-operation and partnerships within and beyond the post-secondary education system;
- Measures that allow students to transfer easily from one institution to another, and the development of joint college-university programs;
- Approaches to learning based on the exploitation of new technologies; and
- Prior learning assessment using challenge exams or portfolio assessment.

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[2] *From documents provided by the AUCC*

[3] ***Ontario Ministry of Education and Training, Excellence, Accessibility, Responsibility: Report of the Advisory Council on Future Directions for Postsecondary Education, December 1996,***

Conclusions and Areas for Further Investigation

Several conclusions emerge from this Study:

- The information currently available on graduates from the education system can only be used indirectly to analyse the supply of critical skills in the five strategic sectors of primary interest to the Expert Panel on Skills. This is because the data are gathered and presented in terms of fields of study and occupations, rather than in terms of skills per se.

- Data on the fields of study associated with the critical skills required in the five sectors show that the number of Bachelor's graduates in many related science and engineering fields has remained fairly flat through the early 1990s, while the number of Master's and Doctorates, in most relevant fields, has continued to increase.

- Data on the occupations of recent graduates show that graduates from particular fields spread widely into many occupations -- well beyond the occupations which one would expect them to enter, based on their field of study. Similarly, among the graduates in particular occupations, often only a minority come from the fields which appear most relevant to those occupations. This suggests that there is considerable flexibility in the occupations in which many graduates may find employment.

- A more detailed analysis of the capacity of the education system to supply *specific critical skills* should be undertaken. This would explore the business, personal, and other skills imparted through post-secondary education. It should be based on in-depth interviews with knowledgeable experts, including the heads of departments/study in the fields of study associated with the critical skills in question. When combined with quantitative data on education supply such as data on the number of graduates and their occupations, such qualitative information would provide a much better understanding of the demand and supply of critical skills, and hence a valuable tool for policy development.