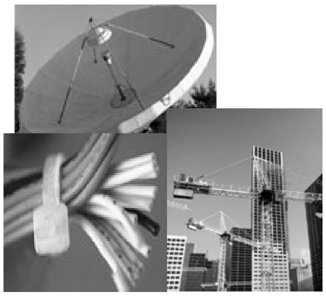

Engineering and Technology Labour Market Study

Engineers Canada
and
Canadian Council of Technicians and Technologists

The Engineering and Technology Labour Market: Final Report

March 2009

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The Engineering and Technology Labour Market: Final Report

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The Engineering and Technology Labour Market: Final Report

Executive Summary

The *Engineering and Technology Labour Market Study* produced ten studies. These include:

- a national survey of engineering and technology employers,
- a national survey of engineering and technology professionals,
- trends in licensure and certification,
- changing roles within the engineering team,
- trends in continuing professional development,
- a study of Canada's consulting sector in the international economy, and
- two studies of diversity challenges in the engineering and technology professions.

A *Labour Market Tracking System* was developed to support ongoing monitoring of labour market conditions by region and by technical field.

Over the last decade, employment in engineering and technology occupations grew almost twice as rapidly as employment in non-engineering and technology occupations. During this period, there were also significant changes in the engineering and technology labour market. Many of these changes pose important challenges for human resources planning.

Demographic trends will reduce the cohort from which the overwhelming majority of new admissions into post-secondary engineering and technology programs are recruited. These trends increase the urgency of addressing the acute gender imbalance in admissions to engineering and technology programs.

Immigration is re-shaping the profile of the engineering and technology labour force. A surge in immigration after 1993 led to serious imbalances between supply and demand in some regions, notably Ontario. In the 1990s, governments and the professions failed to anticipate the serious labour market integration challenges that international graduates in engineering and technology would face.

Over the last decade, philosophical support among employers and engineering and technology professionals for licensure and certification remained strong. However, among employers in some sectors, support for licensure and certification appeared to weaken. Changes in the roles of engineers and technicians/technologists raised new questions about how to approach the regulation of engineering and technology.

By 2008 certain imbalances in the engineering and technology labour market had become more evident. There were significant skills shortages in some regions and in a number of technical fields. These shortages were exacerbated by an apparent worsening of the gap between the skills that employers required and the skill profile of new entrants into the engineering and technology labour market. In some regions skills shortages co-existed with a more than adequate supply of formally qualified job-seekers.

Globalization also intensified during the period. Among the consequences of globalization is a restructuring of earnings. Globalization increases the premium on those engineering and technology skills that are in short supply internationally while, at the same time, generating downward pressure on standard or ‘commodity’ engineering and technology skills.

The recommendations arising from the analysis of these trends are grouped around four themes:

- Re-thinking Professional Formation
- Ensuring Supply by addressing the Gender Imbalance
- Strengthening Professionalism
- Ongoing Monitoring of the Engineering and Technology Labour Market

■ ■ ■

The Engineering and Technology Labour Market: Final Report

Introduction

The *Engineering and Technology Labour Market Study* was a joint undertaking of Engineers Canada and the Canadian Council of Technicians and Technologists (CCTT). The study was supported financially by Human Resources and Skills Development Canada (HRSDC).

The *Engineering and Technology Labour Market Study* arose from a key finding in an earlier study - *From Consideration to Integration* - which examined the challenges faced by international engineering graduates as they endeavour to integrate into the Canadian engineering and technology labour market.[1] Among the conclusions of that study was the need for significantly more detailed labour market information and a better understanding of the engineering and technology labour market. Other labour market issues, including the impact of globalization trends on the Canadian engineering and technology labour market, were identified in workshop hosted by HRSDC. The workshop brought together representatives from Engineers Canada, the Canadian Council of Technicians and Technologists, the post-secondary system, governments, and industry.

The *Engineering and Technology Labour Market Study* produced nine studies, in addition to this Final Report:

1. *2007 Engineering and Technology Employer Survey* presents the results of a survey of 701 engineering and technology intensive employers. The survey was conducted between July 2007 and January 2008.
2. *Survey of Engineers and Engineering Technicians and Technologists* reports the results of a survey of 15,585 persons who are engineers or engineering technicians and technologists or who are otherwise employed in engineering and technology. The survey was conducted from February to December 2008.
3. *Labour Market Tracking System* analyzes supply and demand trends by occupation, region, and technical field. The *Tracking System* identified supply and demand imbalances in the latter half of 2008 and provides a technical framework for ongoing monitoring of the engineering and technology labour market.

[1] Copies of the reports arising from the *From Consideration to Integration* project are available at:http://fc2i.engineerscanada.ca/e/index.cfm

4. *Changing Roles in Engineering and Technology* examines the factors that are changing the boundaries between 'engineering work' and 'technology work' and the possible implications of these changes for engineering and technology professionals.
5. *Trends in Continuing Professional Development* examines trends in the engineering and technology professions and compares these to other professions.
6. *Trends in Licensure and Certification* examines recent survey evidence and data on professional regulation of engineers and engineering technicians and technologists.
7. *Achieving Diversity: Strategies that Work* profiles ten examples of interventions intended to change the profile of the engineering and technology professions. The report describes initiatives to encourage more women and more aboriginal Canadians to enter the engineering profession as well as programs to accelerate the integration of internationally educated professionals into the engineering and technology labour market.
8. *Right For Me?* reports on a study of young women in high school and examines the factors that shape their attitudes to mathematics and science and to careers in engineering and technology.
9. *Canada's Consulting Engineering Sector in the International Economy* examines trends in the export of engineering services and the factors that underpin Canada's competitiveness. Canada is among the world's leading exporters of engineering services.
10. *The Results So Far: An Interim Report* is a November 2008 report on work-in-progress. The report also presents a statistical profile of the engineering and technology labour market, based on 2006 Census data.

The *Engineering and Technology Labour Market Stud*y was supported by a 32-person Steering Committee drawn from professional associations, universities and colleges, industry, and organizations that assist in the integration of internationally educated engineering and technology professionals.

Reports from the *Engineering and Technology Labour Market Stud*y are published on the study website: www.engineerscanada.ca/etlms

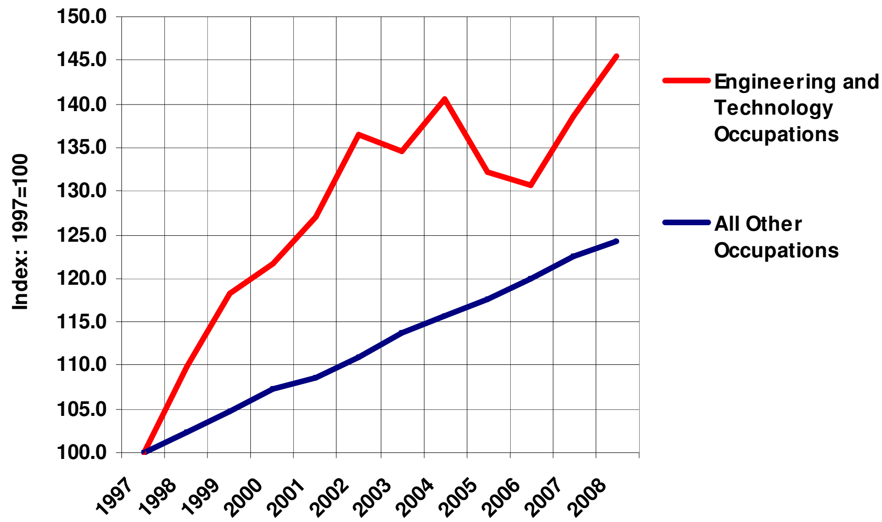
Research work for the *Engineering and Technology Labour Market Stud*y was undertaken by Prism Economics and Analysis.

■ ■ ■

Growth and Change

Over the past decade, economic growth in Canada has favoured engineering and technology occupations
Between 1997 and 2008, employment in these occupations increased by 45%, compared to 24% growth in all other occupations.[2]

Figure No. 1
Employment in Engineering and Technology Occupations compared to All Other Occupations
Index: 1997=100
Statistics Canada, CANSIM; ETT Labour Market Tracking System



The driver behind this employment growth for engineering and technology occupations was a surge in capital investment. Prior to 2001, information and communications technology dominated the increase in capital spending. After the downturn in IT in 2001, resource development and construction were the primary drivers of the increase in capital spending. In 1997, investment in fixed capital formation was 19.5% of GDP. By 2008, the investment share of GDP had increased to 23.8%. In real terms (*i.e.*, netting out inflation), investment in fixed assets increased by 70% between 1997 and 2008. Engineering and technology occupations accounted for approximately 2.8% of overall employment in 1997. By 2008, that proportion had increased to 3.3%.

During this period of rapid employment growth, the ground also shifted. Changes that had begun a decade earlier became more evident.

[2] Appendix A lists the occupations that make up the engineering and technology labour market and shows key labour market measures for each occupation, based on the 2006 Census.

- Demographic trends are reducing in absolute numbers, the pool from which the overwhelming majority of new admissions into post-secondary engineering and technology programs are recruited. *In the absence of measures to change the acute and persistent gender imbalance in admissions, demographic trends will make it difficult to ensure the long-term supply of engineering and technology graduates*.
- In many regions and in many technical fields, there is evidence of *a widening gap between the skill depth and skill breadth that employers require and the skill profile of new entrants into the labour market*.
- Employer support for licensure and certification remains strong at the philosophical level, but there is evidence that *practical support among engineering and technology employers for licensure and certification may be weakening.*
- Census data suggest that *30% of the persons in engineering occupations in 2006 did not have a university degree in engineering*. About a third of these were persons with college qualifications in technology. Census data also show that *a large number of persons with university degrees in engineering were working in occupations which, for the most part, did not fall under the ambit of statutory regulation*.
- Industry does not consistently use the terms 'technician' and 'technologist' to connote the same differences in technical competence and responsibility levels as do colleges (in some jurisdictions) and certifying bodies. In some provinces, this asymmetry weakens efforts to promote the adoption of competency standards.
- Immigration is re-shaping the profile of the engineering and technology work force. *The challenge of integrating internationally educated professionals into the Canadian labour market was seriously under-estimated*.
- Globalization is growing more significant in the engineering and technology market. *Globalization increases the premium on those engineering and technology skills that are in short supply internationally while, at the same time, generating downward pressure on standard or 'commodity' engineering and technology skills*.
- *The engineering and technology professions in Canada appear to lag the majority of regulated professions in this country in adopting continuing professional development standards* and also lag trends that are emerging for engineering and technology professionals in the United States, the United Kingdom and Japan.

The next section of this report describes these trends in more detail by drawing on research reports published as part of the *Engineering and Technology Labour Market Study*. The section after that discusses the potential implications of these changes and sets out a number of recommendations. The recommendations are grouped around four themes:

- Re-thinking Professional Formation
- Ensuring Supply by addressing the Gender Imbalance
- Strengthening Professionalism
- Ongoing Monitoring of the Engineering and Technology Labour Market

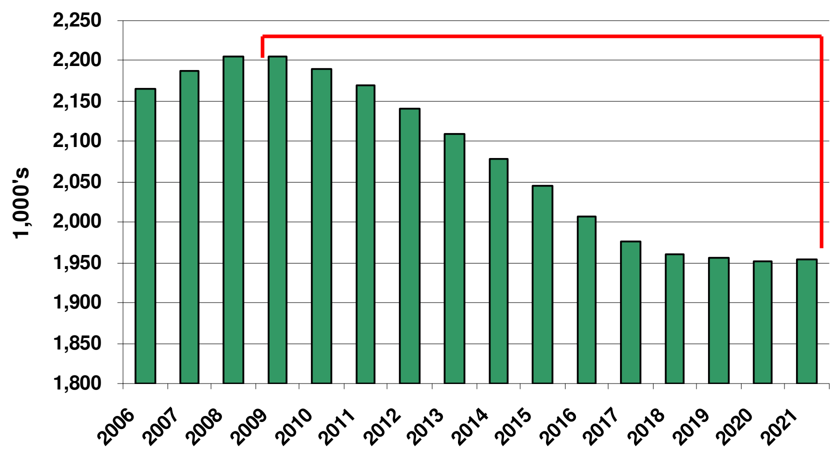
This report does not reproduce the recommendations from the other reports that are part of the *Engineering and Technology Labour Market Study*. That does not diminish the importance of those recommendations. Rather, those recommendations are best read in tandem with the research that supports them. This report focuses on a smaller number of over-arching recommendations.

Trends affecting the Engineering and Technology Labour Market

Demographic Trends:

Recent high school graduates are by far the largest source of admissions into full-time engineering and technology programs in Canada's universities and colleges. Figure No. 2 shows the projected decline in the age-15-19 cohort, based on Statistics Canada's medium growth scenario.

Figure No. 2
Projected Population of Age 15-19 Cohort, Canada 2006-2021 (Medium Growth Scenario)
Statistics Canada, CANSIM

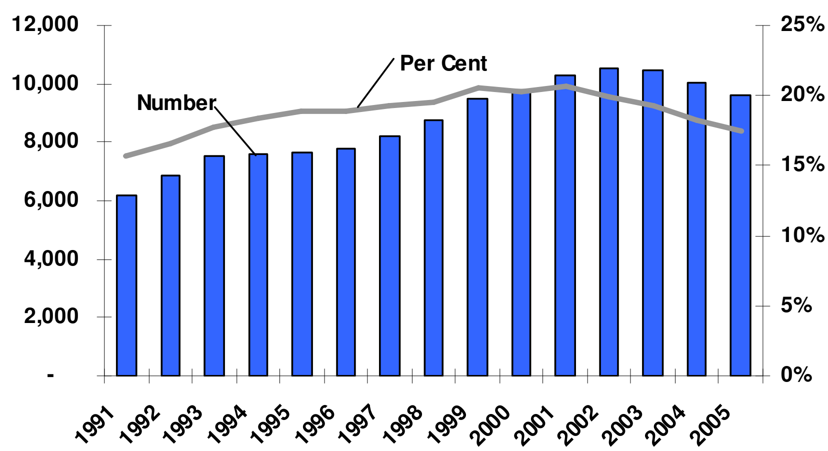


Based on Statistics Canada's projections, *the age 15-19 cohort will peak in 2009 and decline thereafter*.

Demographic trends are not the only determinant of enrolment trends. Nevertheless, the decline in the age 15-19 cohort could have significant implications for university engineering faculties and college technology programs. Universities and colleges can either accept declining enrolments as an inexorable consequence of demographic trends or they can strive to maintain (or even increase) enrolments. Given demographic trends, maintaining (or increasing) enrolments will be difficult. It is possible, of course, that future efforts to promote engineering and technology studies will be more successful, though it must be borne in mind that the competition for qualified admission candidates will increase each year. Universities and college could also maintain enrolment levels by increasing the number of foreign students whom they admit or by reducing admission standards. Admitting more foreign students, however, would contribute only indirectly (through subsequent immigration) to maintaining Canada's skill base. *Reducing admission standards would undermine the reputation of Canadian engineering and technology professionals and, in the long run, undermine Canadian competitiveness. It is essential to avoid this*.

By far the most attractive strategy maintain the skill base, without compromising standards, is to increase the number of young women who enter engineering and technology programs. Despite many efforts to improve the female share of admissions, that share has resisted any sustained increase. Figure No. 3 shows the trend from 1991 to 2005 in female undergraduate admissions to university programs in engineering. The female share of admissions peaked at 20.7% in 2001 and declined thereafter to levels that prevailed in the early 1990s.

Figure No. 3
Female Share in Undergraduate Enrolments
in Engineering Programs in Canadian Universities, 1991-2005
Engineers Canada



A strategy that successfully tackles the gender imbalance in admissions would be one of the most important contributions that could be made for ensuring the long-run supply of engineering and technology professionals.

Skills Shortages:

The *2007 Survey of Engineering and Technology Employers* showed many employers were experiencing or anticipating a skills shortage. At the same time, the 2006 Census showed that there was significant under-employment among both domestic and international engineering graduates.[3]

All professions require well-developed institutions and traditions to bridge the gap between the core skills that are acquired through post-secondary training and the additional technical and non-technical skills that employers require. The co-existence of a skills shortage with under-employment suggests that for engineering and technology occupations these institutions and traditions have weakened. Among the most unsettling trends is a decline in the number of 'junior engineers' or 'junior technologists' that provided opportunities for recent graduates and immigrant professionals to acquire practical experience and additional skills. Small and mid-sized firms, in particular, appear to be cutting back on their hiring of entry-level engineers and technologists. Offshoring of basic engineering and technology tasks will exacerbate this situation.

In the absence regulatory or institutional pressures, the labour market gravitates towards a high-training or a low-training equilibrium. In a high-training equilibrium, most employers hire entry-level job seekers and invest in training these staff. When a critical mass of employers change their policy, a perverse dynamic takes over. Employers who invest in training face a risk that their recently trained staff will be 'poached' by competitors. The poaching risk becomes a powerful disincentive to train. The labour market then slides further into a low-training equilibrium. Skill shortages grow worse, while at the same time, many graduates are forced into under-employment. The loss of entry-level positions also makes it more difficult for individuals to meet the experience requirements that professional associations establish for licensure or certification.

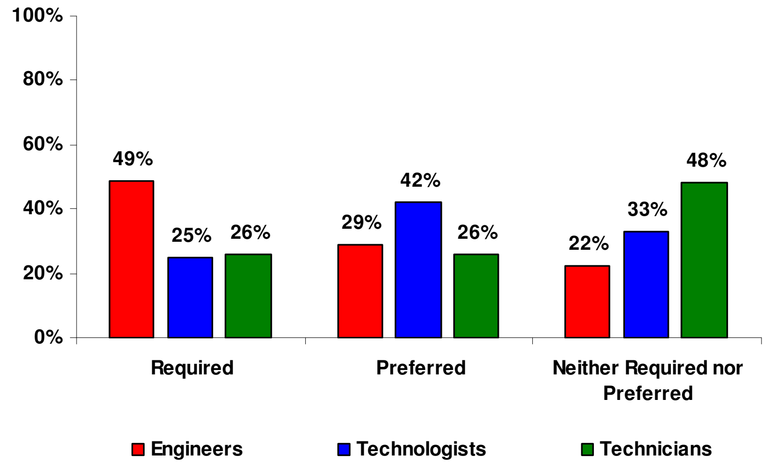
Support for Licensure and Certification:

Survey evidence shows that the ethic and culture of professionalism is the main source of both employer and individual support for licensure and certification. At the same time, survey data and other data suggest that there are weaknesses emerging in support for the system of professional regulation.

The *Survey of Engineers and Engineering Technicians and Technologist*s found that only 49% of employers require an engineer to be licensed, while just a quarter of employers require their technicians and technologists to be certified.

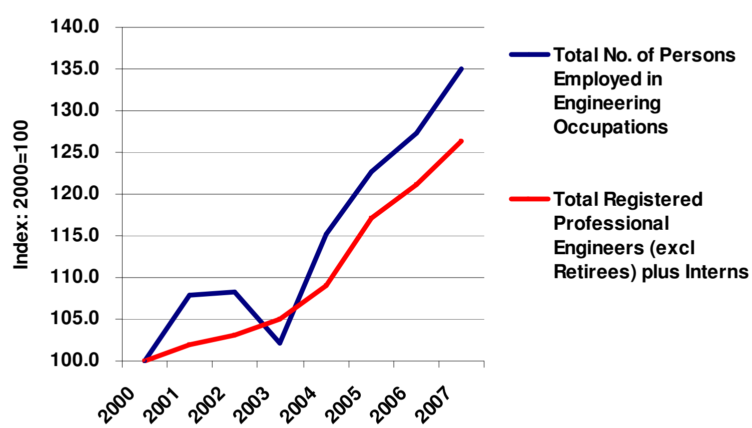
[3] Around 11% of persons with a Canadian engineering degree, and 18% of persons with a non-Canadian engineering degree, were employed in occupations for which they were *over*-qualified. Roughly 10% of persons employed as technologists or technicians were engineering graduates. For a more detailed discussion, see T*he Results So Far: An Interim Report*, published as part of the *Engineering and Technology Labour Market Study*.

Figure No. 4
Percent of Engineers and Engineering Technicians and Technologists describing their Employers' Policy on Licensure and Certification as Required, Preferred or Neither
Survey of Engineers and Engineering Technicians and Technologists



A comparison of licensure trends and employment also suggests that there may be some weakening of support. Between 2000 and 2007, the number of persons employed in engineering occupations increased by 35.1%. Over this same period, the total number of registered professional engineers (excluding retirees, but including interns) increased by 26.4%. The gap between the employment trend and the registration trend is not large. However, it has widened.

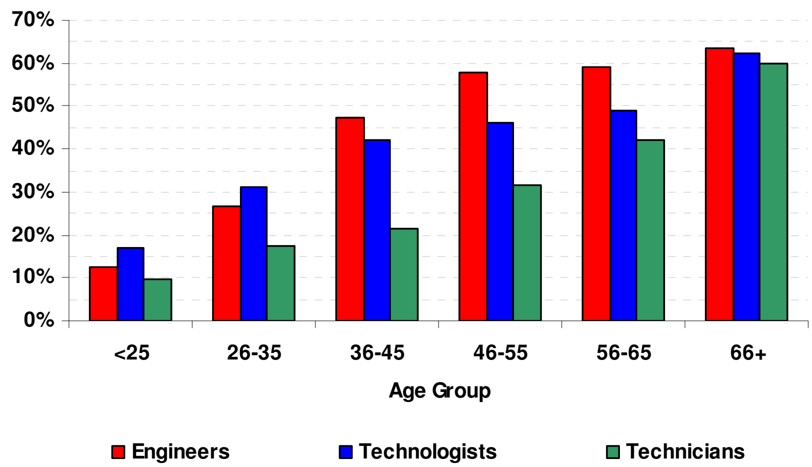
Figure No. 5
Estimated Employment in 'Engineering Occupations' and
Total Number of Registered Professional Engineers (excluding Retirees, but including Interns), Canada, 2000-2007, Index: 2000 = 100
Statistics Canada, *Labour Force Survey* and Association Administrative Data
(Labour Market Tracking System Source Files–Canada)



Changing Roles and the Regulation of Engineering

The study, *Changing Roles in Engineering and Technology* concluded that "occupational overlap [between engineers and technicians/technologists] is now an important and incontrovertible phenomenon…" The study also reported that a greater number of engineering technicians and technologists are advancing into 'engineering management' with the result that increasing numbers of working-level engineers and engineering technicians and technologists report to technologists. This finding is confirmed by the *Survey of Engineers and Engineering Technicians and Technologists*.

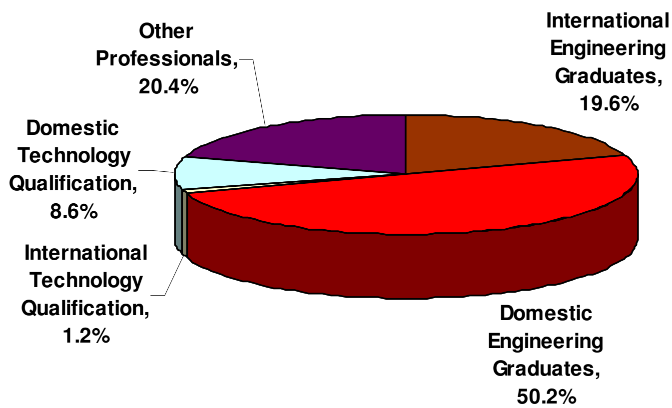
Figure No. 6
Percent of Engineers and Engineering Technicians and Technologists by Age Group describing their Current Job as Managerial
Survey of Engineers and Engineering Technicians and Technologists[4]



Data from the 2006 Census draw attention both to the overlap phenomenon and also to engineering work that is being undertaken by persons without university training in engineering. Figure No. 7 shows that, in 2006, more than 30% of persons in engineering occupations did not have a university degree in engineering. Figure No. 7 also shows that international engineering graduates now account for almost 20% of persons in engineering occupations.

[4] Note that the sample of engineering technicians and technologists was strongly skewed to persons who held certifications: 57% reported being certified. It is believed that this sampling bias skewed the results to more experienced technicians and technologists. The survey, therefore, may have over-estimated the incidence of managerial jobs for engineering technicians and technologists. However, even taking this sampling bias into account, the survey results still confirm the central finding, namely that a significant number of engineering technicians and technologists advanced into engineering management roles.

Figure No. 7
Educational Qualifications of persons in Engineering Occupations
2006 Census



These trends suggest that the system of professional regulation faces new challenges. These challenges include ensuring the technical and ethical integrity of engineering practice, integrating international engineering graduates into the system of professional regulation, and opening pathways to licensure for experienced technicians and technologists.

Changing Roles and Professional Identity:

Data from the 2006 *Census* show that only 25.9% of persons who held a university degree in engineering were working in an engineering occupation. A further 12.4% worked in other natural or applied science occupations, while 15.9% were in management, positions. Business, finance or administrative occupations accounted for 7.3% of university engineering graduates, the education and government sector, 6.1%. Some of these non-engineering occupations would have required engineering qualifications, for example, engineering management jobs or teaching positions. In other occupations, training as an engineer may have been advantageous, though not, strictly speaking, a requirement. Even making these allowances, the picture that emerges is that, in 2006, a large number of persons with university degrees in engineering were working in fields where other educational qualifications might be equally suitable and which, for the most part, did not fall under the ambit of statutory regulation.

Technicians or Technologists?

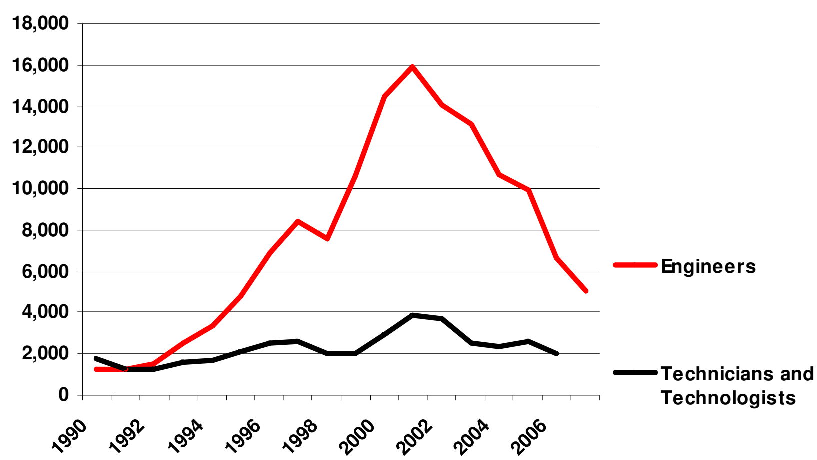
Certifying bodies in every province and territory, except Quebec, distinguish between technicians and technologists. Quebec certifies only technologists. It is significant therefore that focus groups and interviews show that industry does not consistently use the terms 'technician' and 'technologist' to connote the same differences in technical competence and responsibility levels as do colleges (in some jurisdictions) and certifying bodies. Some employers use both occupational titles, but do not necessarily intend the same distinction as certifying bodies. Other employers use the terms 'technician' and 'technologist' interchangeably.

In some provinces, the asymmetry between industry practice and the certification system may impede employer adoption of the competence standards promoted by certifying bodies. Given that survey evidence suggests that close to half of employers have no requirement or preference for certification, the asymmetry between industry practice and the certification system should be a matter of concern.

Immigration:

Immigration is changing the face of the engineering and technology professions in Canada. In the early 1990s, the framework for Canadian immigration policy was changed. In place of labour market absorption criteria, which were always difficult to apply, economic applicants were assessed on their post-secondary qualifications and related employment experience. This change in policy had significant implications for the engineering and technology professions, but especially the engineering profession. Figure No. 8 shows that the immigration of persons whose intended occupation was an engineering or technology occupation rose sharply after the change in policy, peaking at 19,772 persons in 2001. Eighty percent of these immigrant professionals had an undergraduate degree in engineering. Roughly half had a graduate degree.

Figure No. 8
Immigration of Persons whose Intended Occupation
was Engineer or Technician/Technologist,1990-2007
Citizenship and Immigration Canada
(Labour Market Tracking System Source Files–Canada)



The challenge of integrating internationally educated professionals into the Canadian labour market was seriously under-estimated. Numerous studies have now documented the difficult transition that many internationally educated professionals experienced in the past decade.[5] In the engineering profession, and in particular in Ontario, these integration challenges were made even more difficult by the fact that, for a number of years, the combined total of recent graduates and internationally educated engineers exceeded employers' overall hiring requirements. After 2001, overall immigration declined to levels that are more sustainable. However, the integration challenges remain serious, including serious asymmetries between settlement patterns and where jobs are.

Globalization:

Engineering work is becoming increasing internationalized. The *Engineering News Record* estimates that the international market for engineering services more than tripled in the last decade.[6] A recent study by McKinsey & Co. concluded that engineering occupations are the most amenable to offshoring.[7] C*anada's Consulting Engineering Sector in the International Economy*, which was undertaken as part of the *Engineering and Technology Labour Market Study* estimated that at least one in every five

[5] Numerous studies have documented the difficult transition that many internationally educated professionals experienced in the past decade. See, for example, the recent Statistics Canada study: Diane Galarneau and René Morissette, "Immigrants' education and required job skills," *Perspectives on Labour and Income*, vol. 21, no. 1 (Spring 2009), Statistics Canada, Cat. No. 75-001-XPE. The authors conclude, "During the 1991 to 2006 period, the proportion of immigrants with a university degree in jobs with low educational requirements (such as clerks, truck drivers, salespersons, cashiers, and taxi drivers) increased. For recent immigrants, the proportion varied between 22% and 28% for men and between 36% and 44% for women. For established male immigrants, the trend was quite pronounced, as their proportion rose from 12% to 21%, while their female counterparts posted a more modest advance, climbing from 24% to 29%. Those proportions contrasted sharply with the stable proportion for native-born Canadians, about 10% for both men and women. The increases [in under-employment] for established immigrants suggest that the difficulties, which have long plagued recent immigrants, are today affecting established immigrants, which also suggests that difficulties experienced by recent immigrants are not necessarily temporary." p 15 [Emphasis added.]

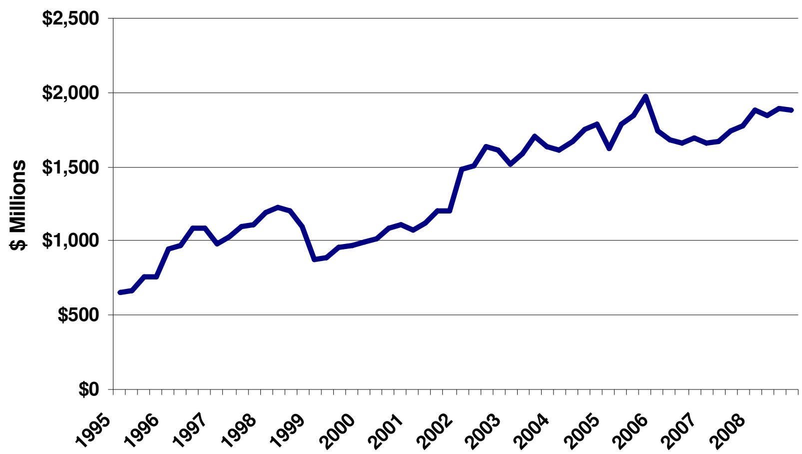
The recent empirical literature is reviewed by Oliver Schmidtke *et al.*., "Policy Memo: Canada's immigration and integration policies: A multi-national evaluation of labour market integration of skilled immigrants" www.carleton.ca/europecluster/Workshop-September8-2006/Memo-Schmidtke-Kovacev-Marry.pdf

[6] This is based on the *Engineering News Record*'s annual tabulation of the international billings of the 200+ largest engineering consultancies.

[7] McKinsey & Co., *The Emerging Global Labor Market*, McKinsey Global Institute (June 2005) p 23. The McKinsey estimate should not be estimated as a prediction that 52% of OECD engineering work will be off-shored. Supply-side constraints in countries with lower salary norms limit the amount of international work that they can absorb. The McKinsey analysis should be interpreted as an estimate of the potential amount of engineering work that could be offshored in the absence of any regulatory constraints in the OECD or supply-side constraints in developing countries.

professionals in Canada's consulting engineering sector was supported, at least in part, by international work. Since 1995, Canada's international trade in the broad category 'architectural, engineering and other technical services' has increased in tandem with this process of globalization, growing by approximately 8.4% per year.[8]

Figure No. 9
Trade in 'Architectural, Engineering and Other Technical Services'
(Exports + Imports), 1995(i) – 2008(iv)
Statistics Canada, CANSIM



The *Engineering News Record* consistently ranks Canada as one of the top five leading exporters of engineering services. Most recently, Canada has ranked third, after the United States and the United Kingdom.

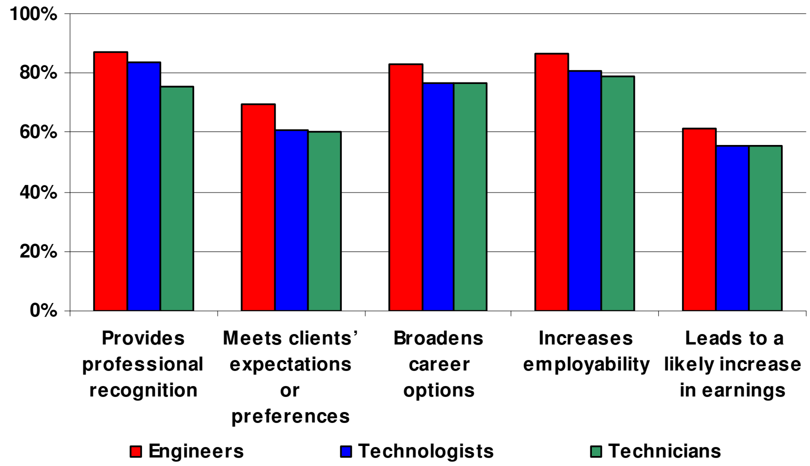
The forces driving globalization in engineering work are inexorable. The effect of globalization is to increase the premium on those engineering and technology skills that are in short supply internationally while, at the same time, putting downward pressure on standard or 'commodity' engineering and technology skills.

The Ethic and Culture of Professionalism:

Survey data show broad support for the ethic and culture of professionalism among engineers and engineering technicians and technologists. Survey data also show that professionalism is strongly associated with licensure or certification.

[8] The rate of growth in actual trade volume may be greater or lesser than the rate of growth in 'measured' trade volume. A significant amount trade in engineering services is internal to companies and is not captured by trade data.

Figure No. 10
Significance of Licensure or Certification for Engineers, Technologists and Technicians
Survey of Engineers and Engineering Technicians and Technologists



The *2007 Survey of Engineering and Technology Employers* confirms that employers are also strongly drawn to the ethic of professionalism and similarly associate that ethic with licensure or certification. This broad philosophical support for the ethic of professionalism on the part of engineering and technology employers has significant implications for how licensure and certification are portrayed to employers.

Continuing Professional Development:

Continuing professional development is one of the core values associated with the ethic of professionalism. In Canada, a majority of the professional associations responsible for regulated professions have policies that require or expect their members to undertake a minimum amount of continuing professional development training. Throughout the OECD region, professional associations of engineers and technologists have focused increased attention on continuing professional development, often establishing norms or requirements. In both the UK and Japan, professional associations have established both requirements and standards for continuing professional development for engineers. In the United States, it is common for state registration boards to make continuing professional development a requirement for maintaining registered status. In Australia, evidence of participation in continuing professional development is required to maintain registration as a Chartered Professional Engineer or as a Chartered Engineering Technologist.[9]

[9] Evidence on the policies of other professions is summarized in *Trends in Continuing Professional Development* which was published as part of the Engineering and Technology Labour Market Study.

In Canada, the majority of engineering licensing bodies have mandatory continuing development policies. However, licensing authorities in the larger provinces do not have mandatory policies.[10] At this time, therefore, mandatory policies do not apply to the majority of professional engineers. None of the provincial and territorial associations that certify technologists and technicians has a mandatory policy for continuing professional development, although three have voluntary policies, and one association may adopt a mandatory policy. Data from the *Survey of Engineers and Engineering Technicians and Technologists* show that there is significant participation in continuing professional development. Approximately 69% of survey respondents reported that, over the past three years, they had taken courses in technical subjects, while 58% reported taking courses on non-technical topics. On average, survey participants undertook approximately four days of continuing professional development per year. This is somewhat lower than the benchmark established by associations in those provinces that have set minimum requirements.

While there are important exceptions, the engineering and technology professions in Canada appear to lag the majority of regulated professions in this country in adopting continuing professional development standards and also lag trends that are emerging for engineering and technology professionals in the United States, the United Kingdom and Japan.

Recommendations

Re-thinking Professional Formation

Bridging the 'Skills Gap':

The 'skills gap' arises from the asymmetry between the skills profile of new entrants into the professional labour market and the skills that employers require. Recent graduates, as well as the majority of immigrant professionals, enter the labour market with a good grounding in technical skills. Survey data shows a high level of employer satisfaction with these skills.[11] Core technical skills are *not* the problem. The skills gap arises from the additional skill depth and skill breadth that employers require. Skills depth

[10] *Trends in Continuing Professional Development* summarizes the policies of the provincial and territorial associations/ordres that license or certify the Canadian engineering and technology professions.

[11] In the *2007 Engineering and Technology Employer Survey,* 87% of respondents expressed satisfaction with the science-based skills of recent engineering graduates, while for technologists and technicians the satisfaction levels were respectively 89% and 84%.

consists of specific industry or technology skills. Skill breadth encompasses various non-technical skills. The most often cited are[12]:

- written and oral communications,
- experience administering contracts,
- project management,
- the ability to work in a team,
- knowing how to prepare a business case analysis, and
- communicating technical issues to non-technical colleagues.

Skill depth and skill breadth are acquired principally through experience. This is the rationale for experience requirements for licensure and certification. It is also the rationale for internship programs. In requiring a period of experience-based learning prior to licensure or certification, the engineering and technology professions are no different than the vast majority of regulated and certified professions.

Professions differ in how they structure the experience-based component of professional formation. In the health care professions, a *practicum* is incorporated into the undergraduate curriculum. This is typically followed by a formal and highly structured internship that exposes intern professionals to various aspects of professional practice. The internship period may be supervised by either a post-secondary institution or by the professional association. In the legal profession, admission to the bar is preceded by additional study (the bar admission courses) and by a period of articles. While there is no obligation on the part of a law firm to hire articling students, the vast majority of firms do. The law societies must approve lawyers who wish to serve as an 'articling principal'.

In the engineering and technology, the structuring of internships is quite different from many other professions. The professional associations prescribe experience requirements, but it is left to individuals to find employment which will provide them with this experience. There is a high degree of formality and structure in the prescribed experience requirements, but much less formality and structure on the employment side. For many years, this approach worked. The entry-level jobs in large employers, and many small and medium-sized employers, largely corresponded to the experience requirements set by professional associations. There were, of course, always some recent graduates and internationally educated professionals who were unable to obtain employment that provided the required experience. Nevertheless, in the main, there was a sufficient number of entry-level positions to prevent the emergence of a skills gap. That the 'system' worked is attested by the high standards of Canadian engineering and technology professions and by Canada's international competitiveness in these fields. *Circumstances, however have changed: the 'system' is not working as well as it used to.*

The number of graduates in the early 1990s averaged around 7,300-7,400. In recent years, the number of engineering graduates has averaged around 10,500. As well, the number of international graduates entering the engineering and technology labour market has also increased – from under 2,000 in the early

[12] Both the *2007 Engineering and Technology Employer Survey* and the *Survey of Engineers and Engineering Technicians and Technologists* provide more detail around technical and non-technical skills.

1990s to around 5,000 today. In other words, there has been a significant increase in the demand for entry-level positions. At the same time, off-shoring, the overlapping of technologist and engineering roles, and a move away from entry-level recruiting in small and medium-sized employers has led to an insufficient number of entry-level positions, relative to the increased demand. The consequences of this are the skills shortages which many employers cited and the increased incidence of under-employment among formally qualified graduates – both domestic and international.

These changed circumstances require a serious re-thinking of how experience-based skills should be incorporated into professional formation. There are various models that may have relevance. These include:

- increasing the role of co-op programs or undergraduate internships,
- incorporating unpaid *practicum* components into engineering and technology curriculum,
- regulating through statute or through practice licenses a minimum number of internship positions in relation to total engineering and technology employment,
- accessing government support for internship positions,
- promoting an increase in the number of internship positions.

A serious re-thinking of how experience-based skills should fit into professional formation will doubtless generate other approaches.

Achieving Diversity: Strategies that Work documents three programs that focus on the needs of international engineering and technology graduates. The report describes an approach that has yielded encouraging results. The key elements of the model include: a close relationship with licensing or certifying bodies, language training to a professional level of fluency, careful evaluation and remediation of technical skill gaps, placement periods with Canadian employers, and the use of professional mentors.

Recommendation No. 1.

The engineering and technology professions should launch a discussion with industry, with the post-secondary system, and with governments on how experience-based skills should be incorporated into professional formation.

Recommendation No. 2.

Any review of how the development of experience-based skills is managed should take specific account of the distinct needs of internationally educated professionals, many of whom already have prior experience, but lack training and experience in Canadian codes, standards, and practices.

The Structure of Engineering and Technology Education

Employers and focus group participants expressed general satisfaction with the way in which college technology programs were structured. There is some discussion about the future of two-year programs. However, no consensus has emerged. The structure of engineering education, however, elicits much more discussion and comment.

Some professional degrees, such as engineering and certain fields in the health sciences, are first degrees. Other professional degrees, such as architecture, law, and medicine, are second degrees. That is to say, graduates in architecture, law or medicine, typically obtain another undergraduate degree before entering these fields. Three trends are encouraging a re-think of how engineering education is structured. First, many in industry want the non-technical skills of engineering students to be strengthened. Second, many in industry also want engineering students to have more practical exposure. And third, Census data tell us that a large number of engineering graduates work in non-engineering occupations. It would appear, therefore, that in addition to being a professional degree, engineering degrees are also under pressure to be 'foundation' degrees that better equip graduates to enter engineering jobs (which have significant non-technical skill requirements) and also to equip students to pursue a broader range of career options. There is clearly a limit to what can be accomplished within the framework of a traditional four-year undergraduate program. Some engineering schools have already moved away from this model in favour of co-op programs which typically extend the duration of studies, as well as incorporating more practical experience. Other schools allow a year-long internship option prior to fourth year. Combined engineering/MBA degrees are also offered by some universities. In Europe, under the 'Bologna Process' that was launched in 1999, there is a move to change the structure of professional education such that it is based on a three-year foundation degree and a two-year specialist degree.[13] In architecture, the

[13]The 'Bologna Process' is a commitment by 46 European countries to restructure higher education to facilitate mutual recognition and mobility. The 'Bologna Process' was launched in 1999 with the intention of substantially implementing its principles by 2010. The 'Bologna Process' has important implications for the structuring of all types of professional education, including engineering and technology, within the European Higher Education Area. The signatories to the 'Bologna Process' include the EU members, but also many non-UE countries in Europe, including, for example, Russia. The 'Bologna Process' envisions higher education proceeding through three cycles. These are defined in terms standardized credits. One academic year corresponds to 60 credits that are equivalent to 1500-1800 hours of study. The three cycles are:

1st Cycle	180-240 Credits	usually 3 years	usually a Bachelor's degree
2nd Cycle	90 – 120 Credits	usually 2 years	usually a Master's degree
3rd Cycle		usually 3 years	usually a Doctoral degree

The 'Bologna Process' also means that, in Europe, there will be two levels of engineering qualifications - a 1st Cycle and a 2nd Cycle qualification. It is expected that the 2nd Cycle qualification will become the recognized standard for professional purposes. This implies five years of higher education.

professional degree used to be an undergraduate degree, as in engineering. Throughout North America, the professional degree in architecture is now the master's degree.

All of these developments suggest that it is appropriate to review the expectations of an engineering degree and to consider the structure that is best suited to meeting those expectations. The further evolution of the 'three years + two years' model, which underpins the 'Bologna Process', bears watching by both the engineering and the technology professions. An international consensus around this model will have implications for the engineering and the technology professions in Canada.

Recommendation No. 3.

a. **Engineers Canada should commence a dialogue involving the provincial and territorial associations/ordre, industry, and the universities to consider the structure of engineering education that is best suited to meeting the diverse and increasing demands that are being placed on an engineering degree.**

b. **Engineers Canada and the Canadian Council of Technicians and Technologists should continue to monitor the implementation of the 'Bologna Process' which structures European higher education in terms of a three-year foundation degree and a two-year specialist degree.**

Ensuring Supply by addressing the Gender Imbalance

The decline in the age cohort 15-19, that will set in after 2009, will have long-term implications for enrolment in engineering and technology programs. Unless the acute gender imbalance in enrolments is addressed, universities and colleges will have to reduce their enrolments, lower admission standards, or increase the number of foreign students they admit. None of these 'alternatives' to addressing the gender imbalance will ensure the long-term calibre and sufficiency of the number of graduates. Increasing the number of female students in engineering and technology will not be easy. After the events at École Polytechnique in 1989, there was a new resolve in industry, in the engineering and technology professions, and in the post-secondary system to encourage and support more women pursue engineering and technology studies. The data show that, in engineering, female enrolments increased both in absolute numbers and as a share of the total. However, the momentum was lost. The female share of enrolments peaked in 2001. The number female enrolments declined after 2002.

There is nothing inevitable about the current gender imbalance in engineering and technology. The evidence from other fields (*e.g.*, medicine and law) is that the gender balance can be changed. *Achieving*

Diversity: Strategies that Work describes a number of programs that address the gender imbalance. One of the central conclusions of the *Achieving Diversity* study is that "well focused programs work."

There is a broad consensus that a strategy to change the gender balance in engineering and technology must begin in early secondary school, or even in primary school. *Right for Me?* examined the factors that influence young women to pursue mathematics and science studies and to consider (or reject) careers in engineering or technology. Among the study's key findings are that

- A large majority of young women do not have a good understanding of what engineering and technology careers entail. Neither National Engineering Month nor National Technology Week has bridged this gap.
- A large majority of young women have negative perceptions of engineering and technology occupations often equating engineering and technology (but especially engineering) with construction work, outdoor work, working in cubicles, and relating primarily to computers and machines, rather than people.
- Compared to young men, young women do not have role models who encourage them to consider engineering and technology careers.

Recommendation No. 4.

The engineering and technology professions, in conjunction with industry, need to establish progressive, but realistic, targets for addressing the gender imbalance in engineering and technology enrolments and fashion strategies that will achieve these targets. These strategies should include support for outreach programs, improved career awareness information, and a concerted effort to provide young women in high school with role models. The strategies to address the gender imbalance also should include ongoing monitoring of enrolment trends and improvement of data quality and currency, where necessary.

Strengthening Professionalism

Evidence discussed earlier in this report indicated strong support for the ethic and culture of professionalism, but at the same time, suggested that, in some regions and in some fields, there is evidence that support may be weakening. There are both similarities and differences in the challenges facing the associations/ordre that license professional engineers and the associations/ordre that certify engineering technicians and technologists.

***Engineers*:**
Some jurisdictions have recently updated their regulatory statutes, while in others the legislation has not been reviewed for some time. The scope of practice in some jurisdictions may need to be updated to take account of the importance of IT systems as part of the new economic infrastructure. Employers' obligations and liabilities may also need to be clarified, especially, but not solely in regard to engineering work that is performed outside Canada. Ontario's 'industrial exemption' may have encouraged a tendency to operate outside the statutory framework than the province's *Professional Engineers Act*. All regions of Canada will see major investments undertaken to modernize our infrastructure. Globalization will make the maintenance of high professional standards even more important than it already is. *These are appropriate circumstances for those jurisdictions that have not updated their statutes to consider doing so*.

In addition to addressing the scope of practice and employers' obligations, the regulatory framework also needs to take account of changes that have taken place in the way that engineering work is undertaken. Though limited, occupational overlap between engineers and engineering technicians and technologists is nevertheless a reality. To some degree this is already reflected in provisions that require a professional engineer to take final responsibility for a design. However, *it may also be appropriate to open additional pathways to licensure that would allow experienced technicians and technologists to obtain restricted licences and possibly to advance thereafter to full licensure. Additional pathways to licensure may also be relevant to international engineering graduates whose professional experience, though substantial, is more focused than is often the case in Canada.* It will be important when considering additional pathways to preserve the integrity of the professional engineer designation. The 'professional engineer' designation is relied on by employers and clients as an assurance of competence and integrity. At the same time, the 'professional engineer' designation could lose value if occupational overlap leads to a further erosion of employer and managerial commitment to the system of professional licensure.[14]

The associations/ordre that license and regulate professional engineers also need to consider the most *appropriate ways to retain the loyalty and support for engineering graduates whose employment duties and responsibilities do not fall within the scope of practice defined by engineering statutes*. As discussed earlier, a large number of engineering graduates work in non-engineering occupations for which they do not need to hold license. Many of these individuals are still committed to the ethic and culture of professionalism. The professional associations/ordre need to consider how the professional commitment and identity of these engineering graduates can be sustained.

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[14] An innovation which other associations/ordre may wish to monitor is the 'Registered Professional Technologist' (RPT) designation developed by the Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA). APEGGA describes the RPT designation as "a professional license allowing you to practice engineering or geo-science within a clearly defined scope of practice." Alberta has also moved towards the principle of 'one Act, two associations' in regulating engineering and technology occupations. This principle was supported by members of both APEGGA and the Association of Science and Engineering Technology Professionals of Alberta (ASET).

Recommendation No. 5.

a. **The engineering associations/ordre should consider whether the current circumstances make it timely in their jurisdiction to update their engineering statute particularly, but not solely, in regard to expanding and making more current the scope of regulated practice and also clarifying employer responsibilities.**

b. **The engineering associations/ordre should consider opening additional pathways to licensure that would allow experienced technologists and experienced international engineering graduates to obtain restricted licenses.**

c. **The engineering associations/ordre should consider strategies for facilitating the adherence to the profession of engineering graduates who work in non-engineering fields.**

d. **The engineering associations/ordre should undertake a marketing study as part of a process to develop a strategy for promoting licensure to engineering employers and to all engineering graduates.**

Technicians and Technologists:

There are approximately 52,000 certified technicians and technologists. All provinces, except Quebec certify both technologists and technicians. Quebec certifies only technologists. The 2006 Census identified approximately 245,510 engineering technology jobs. Since 2006, this number has increased by about 6-7%. While most of the 52,000 certified technicians and technologists were employed in technician and technologist occupations, about 10% were working in management, teaching, technical sales or other jobs. A reasonable estimate of the coverage of certification with respect to the number of technician and technologist jobs is, therefore, around one in five or one in six.

The central challenges facing the technology profession are to promote adoption of recognized occupational standards and to increase employer and employee support for certification. Two policy challenges impede achievement of these goals. First, industry does not consistently use the terms 'technician' and 'technologist' to connote the same distinction in qualifications that underpins the separate certifications issued by provincial associations, excluding Quebec which only certifies technologists. Second, there is a welter of different designations – 7 for technologists and 3 for technicians. These policy problems need to be addressed before resources are devoted to raising the profile of certification and promoting industry adoption of professional standards. The Canadian Council of Technicians and Technologists has commenced a discussion of these issues. Recent amendments to the federal-provincial *Agreement on Internal Trade* are intended to eliminate, or radically reduce, remaining barriers to inter-provincial mobility in Canada. These amendments have made it more urgent to resolve issues of terminology and to establish a common designation (or designations) for certified technology professionals.

Recommendation No. 6.

a. **In light of recent amendments to the federal-provincial *Agreement on Internal Trade*, the associations/ordre certifying technicians and technologists should make it a priority to create a simplified, national structure for certification of technology professionals. The engineering profession is a relevant comparator. In engineering, there is only one professional designation in English (PEng) and an equivalent designation (ing.) in Quebec.**

b. **After addressing the policy issues related to professional standards and professional designations, the associations/ordre that certify technicians and technologists should undertake a marketing study as part of a process to develop a strategy for promoting professional standards and professional certification to employers and to qualified technology professionals.**

Continuing Professional Development

Continuing professional development has become one of the defining attributes of professionalism in Canada. Both the engineering profession and the technology professions lag somewhat behind the other regulated professions in Canada in setting standards for continuing professional development. Any policy or guideline on continuing professional development should reflect the distinctive responsibilities and career paths of engineering and technology professionals. There is considerable diversity in the types of continuing professional development that engineering and technology professionals currently take. This includes participation in technical associations, formal in-house training, especially in large employers, university and college courses, courses offered by continuing professional development centres, and self-study. Any policy or guideline would need to reflect this diversity. As well, a policy or guideline would need to take account of the stage that an individual is at in their professional career.

Recommendation No. 7.

Standards for continuing professional development for engineers and for engineering technicians and technologists should be commensurate with standards for other licensed and certified professions in Canada and should keep pace with standards for engineers and for engineering technicians and technologists in other major international jurisdictions. To this end:

a. Engineers Canada should convene a discussion with the provincial and territorial associations/ordre that license professional engineers to:

   i. assess how the engineering profession compares to other professions in Canada with respect to continuing professional development requirements and with respect to engineering professions in other countries,

   ii. address policy gaps that may exist, and

   iii. adopt, as far as practical, a common, national standard.

b. The Canadian Council of Technicians and Technologists should convene a discussion with the provincial and territorial associations/ordre that certify engineering technicians and technologists to:

   i. assess how the technology professions compare to other voluntarily certified professions in Canada with respect to continuing professional development requirements and with technology professions in other countries,

   ii. address policy gaps that may exist, and

   iii. adopt, as far as practical a common, national standard.

Ongoing Monitoring of the Engineering and Technology Labour Market

The discussion at the beginning of this report pointed out that employment growth in engineering and technology occupations had been significantly more rapid than employment growth in non-engineering and technology occupations. *As well as experiencing more rapid employment growth, engineering and technology occupations also experienced significantly more volatility in their growth trajectory.*

The greater volatility of the engineering and technology labour market reflects the central importance of investment intentions and capital spending as key drivers in the demand for engineering and technology professionals. Moreover, as the Canadian economy has become more open to the international economy, this volatility may have increased.

The greater volatility of the engineering and technology labour market leads to fluctuations of over-supply and under-supply. These fluctuations are even more marked when looked at from the regional perspective or in terms of particular technical fields. One of the important, negative consequences of the volatility is to encourage short-term recruiting and human resource management strategies on the part of many employers. Enrolment patterns in universities and colleges are also influenced by fluctuations from the overall trend. These fluctuations from the overall trend are often reversed by the time that students graduate. Immigration trends are similarly influenced by short-term fluctuations from the overall trend.

Sound human resources planning requires that we manage long-term supply based on the underlying trends, not on fluctuations from the overall trend, nor on the optimism or pessimism that accompanies those fluctuations. At the same time, *sound human resources planning also requires that we have timely information on where shortages are occurring and in what technical fields*. Governments and industry need to know whether skill supply constraints in the engineering and technology professions put at risk the ability to implement major technology, infrastructure and other initiatives. Timely and detailed labour market information also provides guidance to new entrants into the labour market, as well as providing an informed basis to manage accelerated immigration approvals for priority skills or admissions for temporary foreign workers.

One of the key outputs of the *Engineering and Technology Labour Market Study* has been the development of a *Labour Market Tracking System.*[15] This *Tracking System* provides the engineering and technology professions with an important new tool to guide their human resource planning and to inform dialogue with employers and governments.

Recommendation No. 8.

Engineers Canada and the Canadian Council of Technicians and Technologists should maintain and further develop the Labour Market Tracking System so that it can provide timely and relevant data on labour market conditions and identify underlying trends. Reports should be developed in close and continuing collaboration with provincial and territorial associations/ordres and, as appropriate, with employers, the post-secondary system, industry associations, and governments.

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[15] The occupational scope of the *Tracking System* is the list of occupations set out in Appendix A.

Appendix A: Engineering and Technology Occupations – 2006 Census

Canada	Occupational Total	Labour Force	Employed	Unemployed	Not in the Labour Force
Total population 15 years and over by NOC-S 2006 - 20% sample data	**25,664,220**	**17,146,135**	**16,021,180**	**1,124,955**	**8,518,090**
Engineers:					
C03 Civil, mechanical, electrical and chemical engineers	127,015	120,260	117,210	3,050	6,750
C031 Civil engineers	44,810	42,360	41,255	1,100	2,450
C032 Mechanical engineers	38,060	36,050	35,135	910	2,010
C033 Electrical and electronics engineers	34,380	32,705	31,880	825	1,675
C034 Chemical engineers	9,765	9,150	8,935	215	615
C04 Other engineers	72,740	69,165	67,330	1,830	3,575
C041 Industrial and manufacturing engineers	20,220	19,330	18,655	670	885
C042 Metallurgical and materials engineers	2,310	2,185	2,145	45	125
C043 Mining engineers	2,830	2,640	2,540	100	190
C044 Geological engineers	1,875	1,750	1,740	10	125
C045 Petroleum engineers	9,845	9,260	9,040	220	590
C046 Aerospace engineers	5,735	5,500	5,360	140	230
C047 Computer engineers (except software engineers)	26,830	25,605	25,010	590	1,225
C048 Other professional engineers, n.e.c.	3,085	2,895	2,830	60	195
Sub-Total: Engineers	**199,755**	**189,425**	**184,540**	**4,880**	**10,325**
Technicians and Technologists					
C11 Technical occupations in physical sciences	42,710	39,325	37,125	2,200	3,385
C111 Chemical technologists and technicians	30,805	28,595	27,050	1,545	2,215
C112 Geological and mineral technologists and technicians	11,150	10,080	9,430	645	1,075
C113 Meteorological technicians	750	655	645	-	95
C13 Technical occupations in civil, mechanical and industrial engineering	61,705	57,675	55,755	1,915	4,030
C131 Civil engineering technologists and technicians	13,945	12,920	12,435	480	1,025
C132 Mechanical engineering technologists and technicians	14,435	13,220	12,765	455	1,215
C133 Industrial engineering and manufacturing technologists and technicians	18,120	17,080	16,445	635	1,035
C134 Construction estimators	15,205	14,460	14,110	345	750
C14 Technical occupations in electronics and electrical engineering excl C142	54,600	51,590	50,060	1,525	3,005
C141 Electrical and electronics engineering technologists and technicians	34,495	32,435	31,380	1,050	2,060
C143 Industrial instrument technicians and mechanics	11,210	10,630	10,335	295	575
C144 Aircraft instrument, electrical and avionics mechanics, technicians and inspectors	8,895	8,525	8,345	180	370
C15 Technical occupations in architecture, drafting, surveying and mapping	67,325	63,465	61,210	2,255	3,855
C151 Architectural technologists and technicians	8,670	8,220	8,050	170	450
C152 Industrial designers	10,815	10,250	9,995	250	560
C153 Drafting technologists and technicians	35,515	33,535	32,420	1,115	1,985
C154 Land survey technologists and technicians	4,945	4,475	4,120	350	470
C155 Mapping and related technologists and technicians	7,380	6,985	6,615	365	390
C16 Other technical inspectors and regulatory officers	45,625	43,000	41,360	1,640	2,625
C161 Non-destructive testers and inspectors	5,310	5,065	4,820	240	245
C162 Engineering inspectors and regulatory officers	3,755	3,550	3,435	115	205
C163 Inspectors in public and environmental health and occupational health and safety	21,315	20,080	19,385	695	1,240
C164 Construction inspectors	15,240	14,310	13,720	585	930
Sub-Total: Technicians and Technologists	**271,965**	**255,055**	**245,510**	**9,535**	**16,900**
Total: Engineers, and Technicians and Technologists	**471,720**	**444,480**	**430,050**	**14,415**	**27,225**

Engineering and Technology Labour Market Study

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