Engineering and Technology Labour Market Study

Changing Roles in Engineering and Technology

Engineers Canada
and
Canadian Council of Technicians and Technologists

Funded by the Government of Canada's
Sector Council Program.

Canada

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Executive Summary

- This report examines changes in the professional roles of engineers, technologists and technicians. The findings are based on five focus groups conducted with engineers and engineering technologists and technicians and on 41 executive interviews.

Trends:

- Key Findings (See Figure S-1 on the following page):

1. There do not appear to be any trends in technology, in the organization of engineering and technology work, or in the system of post-secondary education that will eliminate or fundamentally alter the distinction between engineers and technologists/technicians. *None of our findings call into question the fundamental distinction between university trained engineers and college trained technologists/technicians nor the regulatory systems that have developed to license or certify engineers and technologists/technicians respectively*.

2. There are *two functions in which occupational overlap blurs the distinction between engineers and technologists/technicians*. These are 'process control' (especially in mid-sized manufacturing establishments) and 'project management' (especially in construction and IT).

3. 'Technical specification', which is part of project management, has seen a moderate degree of occupational overlap, aided by the widespread reliance on published standards and software applications that, in part, substitute for engineering judgement.

4. There has been *a more limited degree of occupational overlap in 'engineering design', principally at intermediate levels of complexity*. As well, *there is evidence of advancement of more technologists/technicians into 'engineering management' positions that were previously held almost exclusively by engineers*. Regulatory changes in some jurisdictions have also allowed technologists/technicians to approve certain types of designs or 'technical evaluations'. Nevertheless, these functions are predominantly carried out or overseen by engineers.

- *The overlapping of occupational roles affects perhaps 10% of technologists/technicians*, though no precise measurement is possible. However, occupational overlap is now an important and incontrovertible phenomenon in certain types of engineering and technology functions.

- *There is no consistency between how industry uses the terms 'technologist' and 'technician' and how the post-secondary system or professional bodies use these designations*. While there are differences in training and responsibility across the range of technology occupations, the manner in which professional associations reflect these differences in their certification systems does not correspond, in any consistent manner, with the way in which industry defines technology jobs and selects individuals for those jobs.

Figure No. S-1
Summary of Trends in Occupational Overlap between
Engineers and Technologists/Technicians by Technical Function

	Predominantly Carried out by Engineers	Predominantly Carried out by Engineers but Limited Overlap	Predominantly Carried out by Engineers but Moderate Overlap	Significant Overlap	Predominantly Carried out by Technologists/ technicians
Engineering Design		●			
Engineering Management		●			
Project Management				●	
Technical Specification			●		
Technical Approvals		●			
On-Site Technical Inspection					●
Technical Testing					●
Technical Evaluation		●			
Feasibility Analysis	●				
Process Control				●	
Quality Control					●
Cost and Quantity Estimating					●
Technical Procurement					●
Installation and Repair					●
Service and Support					●
Technical Sales					●

Figure No. S-2 summarizes occupational overlap trends by technical field.

Figure No. S-2
Incidence of Occupational Overlap between
Engineers and Technologists/Technicians by Technical Field

	High Incidence	Moderate Incidence	Very Little Incidence	Virtually No Incidence
Civil		●		
Mechanical		●		
Chemical				●
Aeronautical				●
Environmental			●	
Electrical & Electronic		●		
Mining				●

Factors Inhibiting or Encouraging Occupational Overlap:

- *The most important factor inhibiting occupational overlap is the ethic and culture of professionalism that is associated with engineers*. Attraction to the ethic and culture of professionalism significantly shapes how employers organize engineering work and assign responsibility for that work. As well, the ethic and culture of professionalism also affects how clients expect contracted services to be performed.
- *Concerns over liability are an important factor in determining who performs and takes responsibility for engineering work, separate and apart from the regulatory system.*
- The distinction between engineers and technologists/technicians rests ultimately on real differences in the training and experience required to carry out different types of technical functions. *While the regulatory system inhibits occupational overlap in some fields, in the main, the regulatory system reflects, rather than creates occupational distinctions*.
- Occupational overlap is enabled or encouraged by at least five factors:

1. Focus group participants emphasized *the importance of differences in remuneration norms between engineers and technologists/technicians*. Where it is practical to substitute a technologist/technician for an engineer, it results in a cost savings of approximately 20%.
2. In western Canada, *recruitment difficulties appear to be encouraging substitution* where it is practical to hire a technologist/technician in lieu of an engineer.
3. *The influx of international engineering graduates (IEGs) into the Canadian labour market has been particularly important*. Many international engineering graduates were qualified as engineers outside of Canada, but did not (or chose not to) become licensed in Canada. As a result, these individuals often entered technologist/technician occupations. Many employers recognize the value of international engineering graduates' prior training and experience and assign to them tasks that would previously have been assigned to professional engineers. Many international engineering graduates subsequently advance into project management or engineering management roles. A strong impression emerges that in some regions of Canada, the significant presence of international engineering graduates in the labour market has tipped the balance in terms of occupational overlap. That is to say, what was a comparatively modest phenomenon prior to the 1990s has become significantly more evident since the immigration influx.
4. The calibre of college training in technology is generally viewed positively. For certain types of *entry* level positions in engineering and technology work, the widespread adoption of co-op and internship programs has given college graduates a competitive advantage.
5. There is an increased number of technologists/technicians who obtained their college qualifications after having completed an undergraduate degree in science. For some employers this combination of university training in science and mathematics and college training in technology is an attractive combination and a satisfactory substitute for university training in engineering.

Potential Implications:

- Occupational Demand Trends: *the implications of occupational overlap for long-run demand trends are real, but should not be overstated. Overlap has reduced employment opportunities for engineers primarily in three areas: 'process control', 'project management', and 'technical specification'*. The movement of technologists/technicians into 'engineering design' and 'engineering management' functions has been less significant, but will still affect long-term occupational demand trends. Both of these substitution trends, however, have occurred in the context of a growing demand for *both* engineers and technologists/technicians. *It would be an error to significantly discount expected future demand for engineers solely on the basis of substitution.* Globalization, capital spending and research and development trends are far more important in determining career opportunities for professional engineers than occupational overlap with technologists/technicians.

- Professional Licensure: *the potential implications of occupational overlap for the system of professional licensure are likely to be greater than the implications for employment trends*. In particular, occupational overlap could weaken employer commitment to the system of professional licensure. *It may be more appropriate, therefore for engineering regulators to reflect the realities of occupational overlap within the system of professional licensure, rather than treating occupational overlap as antithetical to the principles that underlie licensure*.

- Certification of Technologists and Technicians: industry does not consistently use the terms 'technologist' and 'technician' in the same manner as regulators. This asymmetry may raise policy questions for certifying bodies. Foremost among these is *whether it is practical to certify two different levels of technology occupations, namely 'technologists' and 'technicians', if industry does not apply the same criteria or use the same terminology when defining technology jobs or selecting individuals for those jobs*.

Introduction and Methodology

Introduction:

This report examines changes in the professional roles of engineers, technologists and technicians. In particular, the report examines factors that are changing the boundaries between 'engineering work' and 'technology work' and the possible implications of these changes for the respective professions.

This study is part of the *Engineering and Technology Labour Market Study* that is being undertaken by Engineers Canada and the Canadian Council of Technicians and Technologists, with support from Human Resources and Skills Development Canada. The objectives of the *Engineering and Technology Labour Market Study* are to collect and analyze quantitative and qualitative labour market information that will:

- deepen our understanding about changing skill requirements and changing occupational roles
- depict a detailed picture of supply and demand trends
- provide analytical support for strategies to improve the integration of international engineering graduates and the entry into engineering and technology occupations of recent engineering and technology graduates
- identify trends relevant to licensure, certification and continuing professional development
- support strategies to improve diversity in the engineering and technology labour force
- improve our understanding of the impact of global trends on the Canadian engineering and technology labour market

Additional information on the Engineering and Technology Labour Market Study is available from the study's website: http://www.engineerscanada.ca/etlms/index.cfm

Methodology:

The findings summarized in this report are based on five focus groups conducted with engineers and engineering technologists and technicians and on 41 executive interviews. A total of 65 persons participated in the focus groups. The focus groups were conducted in the first half of 2008. The regional and occupational distribution of these participants is set out in Figure No. 1.

Figure No.1
Regional and Occupational Distribution of Focus Group Participants

	Engineers	Technologists	Technicians	**Total**
Toronto (February 21, 2008)	8	3	2	**13**
Fredericton (February 26, 2008)	7	6	1	**14**
Vancouver (March 12, 2008)	6	6	0	**12**
Calgary (March 26, 2008)	9	3	0	**12**
Montreal (July 3, 2008)	5	9		**14**
Total	**35**	**27**	**3**	**65**

Figure No. 2 summarizes the regional and industry distribution of the executive interviews. Persons interviewed were generally chief engineers, chief technology officers, CEOs, or directors of human resources.

Figure No. 2
Regional and Industry Distribution of Executive Interviews

	Consulting	Manufacturing	Government	Oil & Gas	Other	**Total**
Atlantic	2		2		3	**7**
Quebec	5	2	1			**8**
Ontario	4	1	2		1	**8**
Manitoba – Saskatchewan	1	2	3			**6**
Alberta	2		1	3	1	**7**
British Columbia	2	1	1		1	**5**
Total	**16**	**6**	**10**	**3**	**6**	**41**

Source materials are appended as follows:

Appendix A: Executive Interview Outline
Appendix B: Focus Group Discussion Outline

Related reports arising from this research examine employer attitudes towards licensure and certification, and employer policies on continuing professional development.

Structure of Report:

Part One of this report reviews trends in the occupational roles of engineers and technologists/ technicians in relation to various engineering and technology functions. Part One also discusses asymmetries between industry uses of the titles 'technologist' and 'technician' and the use of those terms by certifying bodies and the college system.

Part Two discusses the overlapping of occupational roles in terms of particular technical fields or industries.

Part Three examines the factors that are causing occupational roles to change and also the factors that are fostering stability in occupational roles.

Part Four considers the potential implications of occupational overlapping where it occurs.

Part One: Change and Stability in Occupational Roles

Overview of Trends in Occupational Roles:

While attention is often (and perhaps rightly) focused on changes in occupational roles, *there is considerable stability across a range of engineering and technology functions*. Moreover, there do not appear to be any trends in technology, in the organization of engineering and technology work, or in the system of post-secondary education that will eliminate or fundamentally alter the distinction between engineers and technologists/technicians. Nor is there any reason to believe that engineering and technology professions will merge or that the distinction between engineers and technologists/technicians will lose its relevance.

> "I don't see many changes between engineers and technologists, mainly because work needs to get stamped."
>
> Engineer
> ***Calgary Focus Group***

There are significant differences in the education that engineers and technologists/technicians receive. These differences both reflect, and in turn support, real and continuing differences in occupational roles and career paths.

Graduates of university engineering programmes are much more likely to begin their professional careers in design functions that draw on their university training in applied science. College graduates of technology programmes, by contrast, are more likely to begin their careers in non-design technical functions, such as process and quality control, testing and inspection, cost and quantity estimating, installation and repair, or technical sales. It is in the later stages of a career that occupational roles sometimes overlap in certain types of engineering and technology functions.

The blurring of occupational roles does not occur across all types of engineering and technology functions nor does it occur in all sectors or technical fields. *The overlapping of occupational roles affects no more than 10% of technologists/technicians, though no precise measurement is possible*. *However, occupational overlap is now an important and incontrovertible phenomenon in certain types of engineering and technology functions:*

> "In terms of qualifications and training, engineers are better positioned than technologists and technicians. Their training is more diverse and versatile. They have more potential to be promoted if they have good communication skills."
>
> Engineer
> ***Toronto Focus Group***

- There are two functions in which occupational overlap blurs the distinction between engineers and technologists/technicians. These are 'process control' (especially in mid-sized manufacturing establishments) and 'project management' (especially in construction and IT).
- 'Technical specification' has seen a moderate degree of occupational overlap, aided by the widespread reliance on published standards and software applications that, in part, substitute for engineering judgement.
- There has been a more limited degree of occupational overlap in 'engineering design', principally at intermediate levels of complexity.

- As well, there is evidence of advancement of more technologists/technicians into 'engineering management' positions that were previously held almost exclusively by engineers.

- Regulatory changes in some jurisdictions have also allowed technologists/technicians to approve certain types of designs or 'technical evaluations'. Nevertheless, these functions are predominantly carried out or overseen by engineers.

> "Technologists have a narrow focus. Engineers, because of their science training, are focused on broader issues. That has not changed in the 12 years that I have been working."
>
> Engineer
> ***Vancouver Focus Group***

There are, and will continue to be, many types of engineering work which are undertaken exclusively or almost exclusively by university trained engineers. Similarly, there are many types of technology work that are, and will continue to be, carried out entirely, or almost entirely, by technologists/technicians. In other words, we are *not* in the midst of an upheaval in occupational roles.

> "In our industry, we have not seen radical changes. We've been carrying on for the last 20 – 40 years in pretty much the same way."
>
> Engineer
> ***Vancouver Focus Group***

Our focus groups and executive interviews identified a limited number of areas in which roles have changed or become blurred. Though limited in number, these areas of occupational overlap are nevertheless important to examine. There may be implications for curricula in university engineering programs or college technology programs or for continuing professional standards. There may also be implications for how certain types of engineering and technology professionals are regulated. It is to be stressed, however, that *none of our findings call into question the fundamental distinction between university-trained engineers and college-trained technologists/technicians nor the regulatory systems that have developed to license or certify engineers and technologists/technicians respectively*.

Engineering Design:

Design functions comprise the application of science principles to the technical design of a structure, a process, or a piece of machinery. *Regulatory requirements and liability considerations underpin the leading role of engineers in design functions*. Where engineers do not directly carry out design functions, almost invariably they have final responsibility for those functions. Minimally, the principle of 'final responsibility' – which is signified by 'stamping' a design – entails reviewing the work of non-engineers. More commonly, final responsibility also has organizational implications in that it often (though not always) also entails assigning and overseeing the work of non-engineers.

> "In Canada, engineering is design focused. Elsewhere there are other types of engineers: maintenance engineers, operations engineers, technical sales engineers, and project engineers. These are real categories of engineering employment, but they are not recognized by the Canadian engineering education system, which is focused on design, as is the regulatory system."
>
> Engineer
> ***Toronto Focus Group***

There are varying degrees of complexity to design work. For purposes of this discussion, it is useful to distinguish basic, intermediate and advanced or specialized design functions. *The most significant changes in occupational roles have been in the performance of intermediate design functions.*

Basic design functions involve a limited number of technical options and are computationally or procedurally straight forward. They are often supported by software applications, technical codes, or reference manuals. Errors are readily detectable. Basic design functions do not require university-level training in science. As such, these functions are typically carried out by technologists/technicians under the supervision of an engineer (or a senior technologist). *Software applications have automated some design functions, thereby enabling technologists/technicians to undertake* *some design functions that were previously carried out by engineers*. Software applications accomplish this by automating complex calculations, limiting design choices to pre-programmed options, and preventing design instructions from being executed when they are not compliant with pre-programmed stipulations. In essence, the software substitutes for engineering judgement.

Advanced or specialized design functions often require a sophisticated design strategy that may involve selecting among a number of potentially feasible options. Aspects of the design may be computationally complex. Errors may not be readily detectable. These types of design functions typically require a university-level training in engineering. Advanced or specialized design functions are almost invariably carried out by engineers.

> "Over the last ten to fifteen years, I have seen technologists doing more detailed engineering work. Technologists are being given more responsibility with peer review by an engineer."
>
> Technologist
> ***Fredericton Focus Group***

As noted, the most important changes in occupational roles have been in the performance of intermediate design functions. Indeed, *the movement of intermediate design functions to senior technologists/technicians has been one of the more important changes over the past twenty years in the respective roles of engineers and technologists/technicians.*

College training in science principles is not sufficient, in itself, to carry out intermediate design functions. At a minimum, technologists/technicians who perform intermediate design functions must have significant experience or, alternatively, be university trained. Based on our focus groups and executive interviews, we identify three types of technologists/technicians who are taking on an increasing share of intermediate design functions:

first: senior technologists/technicians whose experience, and sometimes additional training, is judged sufficient by their employers or managers (who are often engineers).

second: individuals who were trained *at the university level* in engineering outside Canada, but who are not licensed as engineers in Canada. *In some regions of Canada it is the presence of a large pool of unlicensed, international engineering graduates that is the most significant factor in redrawing the traditional boundary lines between engineers and technologists/technicians*.

> "The technologists have a supporting role: They are not involved in design, just procurement."
>
> Engineer
> ***Toronto Focus Group***

third: university science graduates who have obtained additional college qualifications in technology.

It is evident from the above description that there is no wholesale transfer of design work from engineers to technologists/technicians. Rather, certain types of technologists/technicians – numbering perhaps 10-15% of the total, depending on the region – are viewed by their employers and managers (who are often licensed engineers) as being technically competent to carry out intermediate design work. As will be discussed in Part Three of this report, many employers and managers (which include licensed engineers) view with considerable sympathy the career and professional aspirations of these senior technologists/technicians. The approach taken by engineering regulatory bodies to these senior technologists/technicians is viewed by many employers as important in determining their own policies or attitudes towards professional licensure.

Engineering Management:

'Engineering management' entails directing the technical staff who monitor various types of ongoing engineered processes, structures or installations. ('Project management' will be discussed separately). *For engineers, advancement into engineering management has been, and continues to be, a normal career step.*

> "There are management positions that used to be filled by engineers. Now technologists are being considered for these jobs. "
>
> Engineer
> ***Toronto Focus Group***

Over the past twenty years there has been an increase in the number of technologists/technicians who have advanced into engineering management and who, by virtue of this advancement, supervise the work of engineers. However, notwithstanding instances of technologists/technicians advancing into engineering management, *engineering management functions are still predominantly carried out by engineers*.

Project Management:

'Project management' comprises the oversight of design projects, technical feasibility studies, technical evaluations, and environmental impact analysis, as well as leading the execution or implementation of technical designs. *As with engineering management, for engineers, advancement into project management has been, and continues to be, a normal career step and one for which employers expect engineers to be prepared*.

The advancement of technologists/technicians into project management is much more common than their advancement into 'engineering management'. Indeed, the increase in the number of technologists/technicians in project management roles has been one of the most significant developments of the past twenty years and is one of the more important changes in the respective roles of engineers and technologists/technicians. An important implication of this trend is that an increasing number of junior engineers are supervised by project managers who are technologists/technicians. The advancement of technologists/technicians into project management roles may also increase the overall proportion of engineering and technology work that is undertaken by technologists/technicians, rather than engineers.

> "Engineers are usually in the lead role. Clients often impose the condition that engineers are project managers."
>
> Engineer
> ***Toronto Focus Group***

Project management is seen by many employers as requiring a distinct set of skills that are acquired after an individual completes his or her post-secondary training. In other words, employers, in the main, do not appear to expect recent graduates to have the training and experience necessary to undertake project management. Some employers see project management as entirely an experience-based skill. Others attach importance to formal training in project management. While many employers view project management skills as distinct from professional qualifications as either an engineer or a technologist/technician, some consulting firms assign project management roles only to engineers, as a matter of company policy. This is done in deference to client requirements, in the expectation that it will strengthen a consultancy's competitive position or as a matter of company philosophy.

> "We have technologists who oversee engineers."
>
> Technologist
> ***Calgary Focus Group***

Technical Specification:

Technical specification is closely related to design work. Setting technical specifications for advanced or specialized structures, processes or machinery continues to be an engineering function. However, *the widespread reliance on published standards (whether emanating from regulatory bodies or suppliers) has supported the migration of basic and intermediate specification functions to technologists/ technicians.* In essence, these standards embody engineering judgement and allow the specification function to be carried out by a technologist/ technician. *There is a perception in industry that standards have become more prevalent and that, as a result, the role of technologists/technicians in technical specification has increased.*

> "There are well developed codes and standards. These replace the need for engineers."
>
> Technologist
> ***Toronto Focus Group***

Technical Approvals:

Technical approvals are a function of governments and quasi-government bodies. Owing to either regulatory requirements or concern to mitigate liability, *technical approvals have been and continue to be mostly carried out by engineers or under the managerial oversight of engineers*. However, the role of technologists has increased. Most low-rise residential construction does not require an engineer's stamp, nor do government building departments require an engineer to review these plans. In recent years, some governments have privatized certain types of approvals. Concurrent with this trend, consideration has been given to broadening the professional designations that would make an individual eligible to confer a technical approval. The principal impact of such changes is to enhance the standing and importance of professional certification for technologists/technicians.

On-Site Technical Inspection:

Except where highly complex designs are involved or where there is a potentially calamitous risk to public safety, *on-site inspection functions are almost entirely carried out by technologists/technicians*.

Technical Testing:

Technical testing is almost entirely carried out by technologists/ technicians, although testing protocols are established by engineers (and other university trained science professionals).

> "Technologists execute field work, e.g. drilling, and do compaction tests with prescriptive procedures, or as directed by engineer."
>
> Technologist
> ***Vancouver Focus Group***

Technical Evaluation:

Technical evaluation is the assessment of the engineering performance or condition of an existing structure or process (as opposed to the evaluation of a notional structure or process which is the focus of feasibility analysis, discussed below). Technical evaluation is usually preceded by testing and inspection which is the basis for the subsequent technical evaluation or professional opinion. In general, technical evaluation is undertaken by engineers. For many types of structures and processes, evaluation by a licensed engineer is a regulatory requirement. Less complex structures or processes may be evaluated by technologists/technicians. *This is an area in which senior technologists/technicians have played a more prominent role in recent years, either acting independently or under the direction of an engineer*.

> "In Quebec, those who inspect petroleum installations must be certified. To obtain this certification you can be either licensed by OIQ or certified by OTPQ."
>
> Technologist
> ***Montreal Focus Group***

Technical evaluation also includes the evaluation of proposed structures or processes in terms of their compliance with regulatory standards.

In some jurisdictions, statutes requiring technical evaluations allow certain types of evaluations to be carried out by a certified technologist/technician. This is most evident in certain areas of building code compliance. *The statutory recognition of a technical evaluation role for technologists/technicians often overlaps the technical evaluation role of engineers*.

Feasibility Analysis:

A feasibility analysis is a preliminary study undertaken to determine a potential investment project's technical and economic viability. Feasibility analysis is predominantly undertaken by the consulting industry, although many large organizations have an in-house capacity to undertake this type of work. Studies with a high technical quotient (as opposed to financial, marketing, or legal quotient) are typically undertaken by engineering consultancies. *Engineers usually play the lead role in this type of work and take responsibility for final recommendations.* In many jurisdictions, practice licences are required for consultancies. As a practical matter, engineering consultancies are typically owned by engineers and managed by engineers.

> "We outsource our engineering requirements. We tend to employ mostly technologists."
>
> Technologist
> ***Vancouver Focus Group***

It is common practice for consultancies to use technologists/technicians to do the 'nuts and bolts' work, wherever this is practical. Lower salary costs are the major driver behind this. There are, however, important limits on how far consultancies can carry the substitution of technologists/technicians for engineers. These limits arise both from the skill requirements of the assignment and from client specifications that often set out the minimum qualifications and experience of the individuals who will carry out the study. Overall, the number of technologists/technicians employed in consultancies is approximately equal to the number of engineers. In larger consultancies, the proportion of technical staff who are technologists/technicians tends to be somewhat greater than in the smaller consulting firms.

Process Control:

In large manufacturing establishments and in facilities that undertake complex production processes, process control functions are typically led by an engineer and supported by technologists/technicians. The evidence from focus groups and interviews suggests that technologists/technicians have displaced many junior engineers. This is also the pattern in resource industries and in regulated industries (*e.g.*, nuclear, telecom). In many cases, these technologists/technicians are internationally educated professionals with non-Canadian engineering qualifications and experience.

> "When I started in nuclear, about 50% of the people in the control rooms were engineers. Now fewer and fewer engineers are working in the control rooms. "
>
> Technologist
> ***Fredericton Focus Group***

In small and medium-sized manufacturing establishments, technologists/technicians occupy a large, and possibly a preponderant, share of process control positions. In Ontario, where 39% of manufacturing establishments are located, the shift to technologists/technicians may have been facilitated by the 'industrial exemption' in the *Professional Engineers Act*.[1]

> "At Hydro Quebec, over the past thirty years, the work of technologists has taken on more and more emphasis."
>
> Engineer
> ***Montreal Focus Group***

> "In small and medium-sized enterprises – more so small – the engineering role is increasingly played by a technologist or technician. In large organizations, there is more compartmentalization."
>
> Technologist
> ***Montreal Focus Group***

Quality Control:

Quality control is predominantly carried out by technologists/technicians, although engineers are more likely to be responsible for setting the procedures and standards that underpin quality control systems. Technologists/technicians also play an important role in assisting organizations to qualify for third-party quality control designations (*e.g.*, ISO). To some degree the role of technologists/technicians in quality control was an evolution of their established testing and inspection functions. In larger companies, the emergence of more sophisticated quality control systems in the 1980s – *e.g.*, Deming's statistical process control, 'total quality management' (TQM), and Motorola's Six Sigma – was accompanied by an increase in the importance of in-house corporate training. These in-house training programs provided many technologists/technicians with access to the training required to implement these systems.

Cost and Quantity Estimating:

Cost and quantity estimating are predominantly carried out by technologists/technicians. In the construction industry, cost and quantity estimating are important career entry points for technologists/technicians.

> "In construction, typically, engineers start as junior project managers and technologists start as junior estimators and site supervisors…"
>
> Technologist
> ***Fredericton Focus Group***

1. Section 12(3) of Ontario's *Professional Engineers Act* lists the allowed exceptions to the requirement for professional engineering to be done solely by licensed professional engineers. The first of these exempts "doing an act that is within the practice of professional engineering in relation to machinery or equipment, other than equipment of a structural nature, for use in the facilities of the person's employer in the production of products by the person's employer." Professional Engineers Ontario (PEO) explains that, an industrial facility does not need to employ or retain a professional engineer for the purpose of designing or evaluating production equipment and processes or for supervising its use. However, the exemption is not a permit for non-licensed persons to assume total control over design of production equipment and process. Other legislation imposes requirements for a professional engineer to be involved in aspects of the work. For instance, the *Occupational Health and Safety Act*, Regulation for Industrial Facilities requires all new or modified production equipment to be reviewed by a professional engineer to confirm its compliance with all health and safety standards prior to use. Non-engineers can design the equipment or process but a P. Eng. must attest that it is safe to use. There is similar legislation specifying that professional engineers design electrical systems, buildings or other structures, and pressure vessels. The exemption does not pertain to persons designing, evaluating, commissioning or otherwise practising engineering in relation to production equipment and facilities for someone other than their employer. Custom equipment builders and others must have the design done by professional engineers.

Technical Procurement:

Technical procurement is predominantly undertaken by technologists/technicians, pursuant to specifications. (See discussion of Technical Specifications above.)

Installation and Repair:

Installation and repair work is undertaken almost entirely by technologists/technicians. Large industrial installations and related commissioning may be overseen by an engineer. Such work is usually undertaken through an engineering consultancy.

Service and Support:

Service and support for installed systems and equipment is almost entirely undertaken by technologists/technicians.

Technical Sales:

Technical sales are predominantly undertaken by technologists/technicians, although highly sophisticated technical sales requiring significant product customization is often handled by engineers.

Technologists or Technicians? – Asymmetries in Terminology

There is no consistency between how industry uses the terms 'technologist' and 'technician' and how the post-secondary system or professional bodies use these designations. In the post-secondary system, the distinction between 'technologists' and 'technicians', where it applies, usually pertains to the duration of training (three years versus two years) and to the weight of science and mathematics in the curriculum. It should be noted, however, that there are two-year technologist programs in some jurisdictions. Professional bodies distinguish between 'technologists' and 'technicians' based on education and responsibilities. The qualifying examinations for the respective designations are also different. In Quebec, however, only the technologist occupation is eligible for certification.

In industry, there is no consistent or standard nomenclature. Some employers distinguish between 'technologists' and 'technicians' in much the same way as the post-secondary system or professional bodies. Other employers utilize the terms, but only in relation to responsibilities, not educational qualifications. In some workplaces, persons who are professionally qualified as technicians may be employed as technologists, and conversely, persons who are qualified as technologists may be working as technicians. Still other employers make no distinction between 'technologists' and 'technicians' and use the terms interchangeably.

Participants in our focus groups and executive interviews did not dispute that there are differences in technology work based on such factors as: the amount of theoretical knowledge or experience required to carry out certain functions, the degree of autonomy with which an individual carries out those functions, and the consequences of errors in performing the functions. However, *the manner in which professional associations reflect these differences in their certification systems does not correspond, in any consistent manner, with the way in which industry defines technology jobs and selects individuals for those jobs*.

Figure No. 3, summarizes trends in occupational overlap between engineers and technologists/ technicians by technical function.

Figure No. 3
Summary of Trends in Occupational Overlap

	Predominantly Carried out by Engineers	Predominantly Carried out by Engineers but Limited Overlap	Predominantly Carried out by Engineers but Moderate Overlap	Significant Overlap	Predominantly Carried out by Technologists/ technicians
Engineering Design		●			
Engineering Management		●			
Project Management				●	
Technical Specification			●		
Technical Approvals		●			
On-Site Technical Inspection					●
Technical Testing					●
Technical Evaluation		●			
Feasibility Analysis	●				
Process Control				●	
Quality Control					●
Cost and Quantity Estimating					●
Technical Procurement					●
Installation and Repair					●
Service and Support					●
Technical Sales					●

Part Two: Occupational Overlap in Certain Industries and Technical Fields

The comments summarized in this section should not be taken as representative owing to the limited number of individuals from some industries who participated in the focus groups or executive interviews.

Consulting:

> "In consulting, in general, technologists stay in their field and it is the engineers who manage."
>
> Technologist
> ***Montreal Focus Group***

Consulting employs approximately 37% of all engineers (*i.e.,* university engineering graduates working an engineering occupation) and 24% of all technologists/technicians.[2]
The consulting industry is highly competitive. Canadian consultancies must compete with one another, and for some types of work, must compete with international consultancies.

Many considerations influence the award of a consulting assignment, of which cost is only one factor, albeit an important one. Cost control is especially important in determining the profitability of a consulting assignment. *The cost savings from having work performed by a technologist/technician, rather than an engineer, go directly to the 'bottom line'.* The opportunity to substitute increases with the size of a consulting assignment. Consequently, substitution is said to be more evident in larger projects and in larger consultancies. *In the main, this substitution occurs at the intermediate level of technical complexity.*

In the consulting industry, overall leadership responsibility and formal accountability for a consulting assignment typically rests with engineers, although an increased number of technologists/technicians have advanced into project management roles. Practice areas, however, are typically led by an engineer.

The substitution of technologists/technicians appears to be more evident in regions where consultancies can recruit from large pools of internationally educated professionals who were trained in engineering outside Canada, but have not qualified for licensure in Canada. *There is a widespread perception that substitution increased over the past 10-15 years*. However, views are mixed on whether the pace of substitution will continue or will drop off as the feasible limits are reached.

Governments:

Historically, in governments, the occupational boundaries between engineers and technologists/technicians were clear-cut. It was unusual for technologists/technicians to be promoted into supervisory positions where they would be senior to engineers. These distinctions in occupational roles were supported by job classification systems that established educational requirements or professional qualifications for different job levels. While 'equivalent experience' was nominally considered a potential substitute for formal educational or professional qualifications, it was unusual to actually allow experience to override requirements for formal educational or professional qualifications. The cycles of compensation freezes and pay restraints that characterized government employment in much of the 1980s and 1990s, led to recruitment and retention challenges. In the government sector, aging factors are also having a greater impact. *Faced with increased difficulty in recruiting or retaining professionally qualified engineers, many government departments moved away from the rigid reliance on formal educational or professional qualifications and gave more*

2. 2006 Census

scope to experience, especially in promotions. As a result, in many government departments a greater number of technologists/technicians have been able to advance into engineering management positions.

Regulated Industries:

Like governments, regulated industries (*e.g.,* telecom, hydro, nuclear) historically relied on organizational structures in which it was uncommon for a technologist/technician to advance into engineering management and have supervisory responsibility over engineers. Well defined career ladders and the associated expectations were the norm. *De-regulation changed this picture by encouraging the adoption of more market-oriented human resource management policies.* Among the consequences of this change in organizational culture were the flattening of management structures, the early retirement of many incumbent engineering managers, and an *opening of engineering management positions to technologists/technicians.* Concurrent with this change was a trend to substitute, where practical, technologists/technicians for engineers in functions of intermediate complexity. This trend was reinforced by the movement of some senior technologists/technicians into engineering management roles. As in other sectors, the change in occupational roles was supported by the increased opportunities in the 1990s to recruit from a growing pool of internationally educated engineers who had not qualified for licensure in Canada and who were employed in technologist/technician positions.

Resources:

> "In mines, where there is a possibility of arsenic, it is always an engineer who is in charge of the sampling and testing."
>
> Engineer
> ***Montreal Focus Group***

The resource industries historically assigned leading roles to engineers and maintained comparatively clear-cut distinctions between engineers and technologists/technicians, with the latter playing a supportive role. The resource industries were also conscious of their need to recruit junior engineers so as to replenish their engineering talent pool and ensure a sufficient pool of experienced junior and intermediate engineers from which to recruit new engineering managers. Occupational health and safety concerns and related regulatory requirements contributed to the resource industries' strong preference to employ qualified engineers for virtually all engineering management positions and for the majority of engineering design and process management positions. This occupational structure largely remains intact in central and eastern Canada. *In western Canada, skill shortages appear to be driving a change in traditional practice. Unable to meet all of their hiring needs – or anticipating difficulties in meeting those needs – employers in the oil and gas industry are increasingly recruiting experienced technologists/technicians.*

Manufacturing:

> "In programming PLCs and pre-operations verification the roles have switched. This work is now done by technologists."
>
> Technologist
> ***Montreal Focus Group***

In the manufacturing industry, there appears to have been an incremental increase in the share of engineering and technology jobs held by technologists/technicians and a corresponding outsourcing of work that for technical or regulatory reasons needs to be performed by engineers. Especially in Ontario, there is said to have been an increase in the number of internationally educated professionals who were trained in engineering outside Canada, but have not qualified for licensure in Canada. Many of these individuals occupy positions that previously would have been filled by engineers. As discussed earlier, specific features of the *Professional Engineers Act* (*i.e.,* the 'industrial exemption') may have facilitated this substitution.

While an increased number of technologists/technicians appear to have advanced into engineering management positions in small and medium-sized manufacturing establishments, this trend is not so evident in larger manufacturing establishments. More common is the trend of engineers obtaining additional MBA qualifications. While the substitution of technologists/technicians for engineers was an important trend in the 1980s and especially the 1990s, the scope for this substitution may be approaching or have reached its practical limits.

Construction:

In the construction industry, design is still predominantly a contracted service performed by consultancies, although under the influence of 'design-build' projects, there has been a modest increase in the amount of design work that is done in-house by large general contractors. For the most part, however, construction companies *per se* do not undertake design work. Their principal engineering and technology needs pertain to estimating, project management, technical procurement, specification writing, and the verification that work has been performed according to specification. Technologists/technicians outnumber engineers in the construction industry by approximately 3:1. Estimating was, and continues to be, predominantly a function undertaken by technologists/technicians and accounts for almost half of all technologist/technician employment in the construction industry.[3] *A significant change in the construction industry has been in the number of technologists/technicians who are now in project management roles*.

> "On more and more large construction projects, there is an engineer who is in charge of the project and a senior technologist who is an assistant project leader."
>
> Technologist
> ***Montreal Focus Group***

Information Technology:

Three segments of the IT industry account for the bulk of engineering and technical employment: hardware manufacturers, software developers, and consultancies. All three segments employ computer science graduates, in addition to engineers and technologists/technicians. *Hardware manufacturing appears to replicate the general pattern of occupational employment found in the manufacturing sector*. That is to say, engineering management functions and complex process control functions tend to be held by engineers, although there is also significant presence of internationally educated engineering professionals. Similarly, research and development leadership roles tend to be held by engineers, often with advanced graduate training. *In software development and consultancy work, there do not appear to be any clear-cut occupational boundaries. Apparently similar jobs can be filled by engineers, computer science graduates, or technologists/technicians depending on their experience and competence in using particular programming languages.* This is especially the case in project management functions where experience and track record command an overarching premium. There do not appear to be any clear-cut patterns of qualification for Chief Information Officers (CIOs) among major users of IT. Indeed, the formal professional training of some CIOs is in financial management rather than technology.

> "In IT, there is little demand for engineers. It is sufficient to have experience."
>
> Technologist
> ***Montreal Focus Group***

3. 2006 Census

Occupational Overlap in Different Technical Fields

Based on the evidence from both executive interviews and focus groups discussions, it is clear that the phenomenon of occupational overlap between engineers and technologists/technicians varies by technical field, as well as by technical function. Figure No. 4 summarizes the incidence or significance of occupational overlap by technical field:

Figure No. 4
Incidence of Occupational Overlap between
Engineers and Technologists/Technicians by Technical Field

	High Incidence	Moderate Incidence	Very Little Incidence	Virtually No Incidence
Civil		•		
Mechanical		•		
Chemical				•
Aeronautical				•
Environmental			•	
Electrical & Electronic		•		
Mining				•

Part Three: Factors Influencing the Degree of Occupational Overlap

This section discusses factors which encourage or support occupational overlap, as well as factors that inhibit or constrain overlap.

Inhibiting Factors

Regulatory Environment:

It is clear from our focus groups and executive interviews that regulations limiting the performance of engineering work to licensed engineers or requiring licensed engineers to assume final responsibility for that work affect how engineering and technology work is organized. However, *the impact of occupational regulation should not be exaggerated.* Engineers and technologists/technicians carry out different functions because, for the most part, those different functions are inherent in engineering and technology work. The system of occupational regulation does not create those differences.

> "The boundaries are blurred until the engineers have to sign-off on the designs."
>
> Engineer
> ***Toronto Focus Group***

In some sectors, however, the regulatory environment may support an organizational culture which discourages substitution of technologists/technicians for engineers in areas where either might competently carry out the same function. As well, there may be circumstances in which regulations that require an engineer to approve a design or a technical evaluation may limit the scope for technologists/technicians, even though senior technologists/technicians are competent to perform some of this work.

Legal Liability:

Some employers may prefer particular types of work to be undertaken by engineers because they believe that this will limit legal liability. Relying on an engineer's professional judgement may qualify as due diligence and thereby reduce liability in the event of a subsequent engineering failure of deficiency. A client may require an engineer to perform work so as to be able to assign liability in the event of an engineering failure.

> "When there is a risk of litigation, the company wants to be assured that the documents have been reviewed by an engineer."
>
> Engineer
> ***Montreal Focus Group***

Our focus groups and interviews lead us to conclude that *concerns over liability are an important factor in determining who performs and takes responsibility for engineering work, separate and apart from the regulatory system.* Indeed, in situations where both engineers and senior technologists/technicians could competently perform a task, liability concerns often determine that the work will be done by engineers.

Employer Philosophy / Organizational Culture:

Many employers assign responsibilities to engineers because they share, or are drawn to, the ethic of professionalism that they associate with engineers. Many factors contribute to the image of professionalism. These include statutes that govern the practice of engineering, the place of professional ethics in the formal training that an engineering intern must take, the iron ring ceremony, and history, which views engineering as an independent profession. *It is clear, especially* *from our executive interviews, that belief in the professionalism of engineers is a major consideration on the part of employers in how they organize engineering work and, in particular, whom they recruit into positions of engineering management*.

> "Engineers are usually in the lead role. Clients often impose the condition that engineers are project managers."
>
> Engineer
> ***Toronto Focus Group***

Among the more important *changes identified in our focus groups and interviews were changes in organizational culture that have opened up engineering management and project management roles to senior technologists/technicians.* On balance, however, organizational culture and employer philosophy tend to maintain the distinction between engineers and technologists/ technicians, rather than blur those distinctions.

Enabling or Encouraging Factors

Relative Costs:

Focus group participants emphasized *the importance of differences in remuneration norms as an important factor encouraging the substitution of technologists/technicians for engineers where this is practical*. The cost savings to employers are difficult to compute owing to the complexities in selecting appropriate functions and making valid comparisons. However, *a cost savings of approximately 20% seems a reasonable estimate.*[4] *This is certainly sufficient to create an incentive to substitute where it is feasible to do so.*

> "We don't have lines between technologists, technicians and engineers. That's the reality of the job market in Calgary."
>
> Engineer
> ***Calgary Focus Group***

Skill Availability:

Recruitment difficulties appear to be encouraging substitution where it is practical to hire a technologist/technician in lieu of an engineer. Interviews suggested that it is usually easier to recruit technologists/technicians.

International Engineering Graduates:

Our focus group participants and interviewees attached particular importance to *the influx of international engineering graduates into the Canadian labour market over the past 15 years.*[5] Many of these individuals were qualified as engineers outside of Canada, but did not (or chose not to) become licensed in Canada. As a result, these individuals often entered technologist/technician occupations, for which some were undoubtedly over-qualified on the basis of their training and experience. Many employers recognize the value of these qualifications and assign to these individuals tasks that would previously have been assigned to engineers. Many of these individuals also advance into project management or

> "In our company, IEGs are treated as technologists, but I consider them as engineers. IEGs make much less than one who is registered…"
>
> Technologist
> ***Calgary Focus Group***

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4. Based on the Census, the average difference in salaried earnings between engineers and technologists/ technicians is approximately 33%. However, this earnings difference overstates the potential cost savings. When tasks and responsibilities are shifted from professional engineers to technicians/ technologists, it is likely to be more experienced and better paid technicians/technologists who are involved. These technicians/technologists are likely to have above average earnings. The 20% estimate, which is admittedly not a hard estimate, is based on industry consultations.

5. Over the ten years from 1997 to 2006, 111,374 persons immigrated to Canada and stated engineering as their intended occupation. Not all of these individuals would have had university degrees in engineering. Nevertheless, the comparison to the number of persons working in engineering occupations is instructive. According to the 2006 Census, there were 199,755 persons working as engineers.

engineering management roles. A strong impression emerges that in some regions of Canada, the significant presence of international engineering graduates in the labour market has tipped the balance in terms of occupational overlap. That is to say, what was a comparatively modest phenomenon prior to the 1990s has become significantly more evident since the immigration influx. *While the immigration influx does not explain the overlap phenomenon, it has clearly been a major contributor to that phenomenon*.[6]

Quality of College Training:

The calibre of college training in technology is generally viewed positively. As well, many colleges operate co-op programs or require a practicum as part of their curriculum. These policies have strengthened the relationship between colleges and employers. Many employers use their participation in a co-op or internship program as a screening mechanism for permanent recruiting. *For certain types of entry level positions in engineering and technology work, these co-op and internship programs may give college graduates an advantage*. Some universities, of course, also operate co-op and internship programs, though these programs are not as widespread in the university system.

Science Graduates:

It was noted in some focus groups that there is an increased number of technologists/technicians who obtained their college qualifications after having completed an undergraduate degree in science. *These individuals therefore have university level training in science and mathematics in addition to the more practical training in applied science that is offered through college technology programs*. For some employers, this combination of university training in science and mathematics and college training in technology is an attractive combination and a satisfactory substitute for university training in engineering.

6. While it was not discussed in focus groups or interviews, the immigration influx may also have increased the relative supply of technologists/technicians and thereby widened the remuneration spread between technologists/technicians and engineers. This would add further weight to the cost factors discussed previously.

Part Four: Potential Implications of Occupational Overlap

Impact of Occupational Overlap on Employment Trends:

Does occupational overlap imply fewer employment opportunities for engineers and a commensurate increase for technologists/technicians? The implications of our focus groups and executive interviews is that this question must be answered affirmatively if we are looking at three engineering and technology functions, namely 'process control', 'project management', and 'technical specification'. The movement of technologists/technicians into 'engineering design' and 'engineering management' functions has been less significant, but still sufficiently important to affect estimates of long-term occupational demand trends. Nevertheless, these conclusions need to be nuanced.

> "There has been significant displacement."
>
> Technologist
> ***Montreal Focus Group***

Some of the technologists/technicians who now occupy jobs that would previously have been held by engineers are international engineering graduates who have not qualified in Canada as engineers. That is to say, many of these individuals are university trained and have prior experience as engineers, though not in Canada. To some degree, therefore, the apparent substitution of technologists/technicians for engineers is a statistical artefact that arises from the way that occupations are labelled.

It would be an error to significantly discount expected future demand for engineers solely on the basis that the substitution of technologists/technicians for engineers has fundamentally altered demand trajectories. The disparities in demand trajectories arise primarily from the differential effects on engineering and technology occupations of basic economic factors: capital spending, the sectoral composition of investment, trends in research and development spending, etc. Compared to technologist/technician occupations, engineering occupations are more sensitive to fluctuations in capital spending and in research and development spending. Globalization factors and broad economic trends related to capital spending and research and development are far more important determinants of career opportunities for professional engineers than occupational overlap with technologists/technicians.

Potential Implications of Occupational Overlap for Licensure:

The potential implications of occupational overlap for the professional licensure system are likely to be greater than the implications for how employment opportunities are configured. Occupational overlap implies that technical functions, formerly carried out by professional engineers, are now carried out by individuals who are not licensed. This could weaken, to some degree, the public policy rationale for licensure. More importantly, occupational overlap could weaken employer commitment to the system of professional licensure if regulatory efforts to counter occupational overlap are seen as imposing costs on companies that make them uncompetitive. An engineering manager who is not a licensed engineer will have less commitment to the system of professional licensure than an engineering manager who is. A weakening of employer commitment to the system of professional licensure was noted anecdotally in some regions and sectors. Occupational overlap may be contributing to this weakening. Some engineering regulators may be attracted to a strict enforcement philosophy which would bring them into conflict with employers' organizational practices and with what has become a reality of the engineering and technology workplace. *It may* *be more appropriate, therefore, for engineering regulators to reflect the realities of occupational overlap within the system of professional licensure, rather than treating occupational overlap as antithetical to the principles that underlie licensure*.

Pathways to Licensure:

> "The engineering stamp is a guarantee that a product is safe and is going to operate well."
>
> Engineer
> ***Toronto Focus Group***

Occupational overlap is a reality of the engineering and technology workplace. *If the system of professional licensure wishes to accommodate this reality, it may need to devise multiple pathways to licensure and possibly restricted licences that are limited to a specific scope of practice.* This is a complex challenge. One of the clear findings of our interviews and focus groups is that the term 'professional engineer' connotes an ethic and culture of professionalism which is an important economic asset from both an individual and a social perspective. The 'professional engineer' designation is relied on by employers and clients as an assurance of competence and integrity. Similarly, the designation is relied on by engineers to convey these same qualities. Neither employers, nor engineers would be served by inadvertently diminishing the value of the designation. At the same time, the 'professional engineer' designation could lose value if occupational overlap leads to an erosion of employer and managerial commitment to the system of professional licensure. The challenge to regulators, therefore, is to identify new pathways to licensure that do not jeopardize the value of the 'professional engineer' designation.[7]

> "I learned 80% of what I know from attending a technical college [outside Canada]…I think engineers abuse their stamping privileges."
>
> International engineering graduate,
> in process of qualifying for P. Eng
> ***Toronto Focus Group***

Technologists and Technicians:

A clear finding from our focus groups and interviews is that industry does not consistently use the terms technologist and technician to connote the same differences in technical competence and responsibility levels as do colleges (in some jurisdictions) and certifying bodies, where they distinguish between the two occupations.

The asymmetry between industry practice and the certification system, as it operates in most jurisdictions, potentially raises policy questions for certifying bodies. Foremost among these is whether it is practical to certify two different levels of technology occupations, namely 'technologists' and 'technicians', if industry does not apply the same criteria or use the same terminology when defining technology jobs or selecting individuals for those jobs. In this regard it is noteworthy that Quebec certifies only one technology occupation.

There also appears to be some confusion caused by the diversity of designations which apply to essentially the same occupational skills.

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7. An innovation which other regulators 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." As well, 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).

Appendix A: Executive Interview Outline

1. What are your firm's policies regarding continuing professional development for engineers, technologists and technicians? Do you have a budget allocation for continuing professional development? Do you have a benchmark in terms of the number of days allowed for continuing professional development? Does your company maintain records on the continuing professional development of its engineering and technology employees? Do requirements by professional associations for continuing professional development affect your company/organization's policies or practices?

2. Do your engineers or technicians/technologists tend to belong to *professional* associations (i.e., the provincial and territorial associations that undertake licensure of engineers or certification of technicians/technologists)? Are there any advantages to you, as an employer, that you associate with your engineers or technicians/technologists having membership in professional associations (e.g., differences in professional attitudes, differences in involvement in continuing professional development, etc.)? Does your company subsidize membership fees, sponsor association activities, or subsidize attendance at association conferences, seminars, etc.?

3. Do your engineers or technologists tend to belong to *technical* associations? (e.g., Canadian Society for Civil Engineering, Canadian Society for Chemical Engineering, Institute of Electrical and Electronics Engineers – IEEE, etc.)? If so, does your company subsidize membership fees, sponsor association activities, or subsidize attendance at association conferences, seminars, etc.?

4. What channels does your company rely on for continuing professional development for engineering and technology employees? (e.g., University-based professional development centres, colleges, private seminars, technical associations, in-house seminars, etc.). Does your company/organization have a preference for any particular channel?

5. Are there any broad trends that you observe in terms of the strengths or weaknesses of the skills of recent graduates? - technical skills, non-technical skills?

6. Should participation in continuing professional development be a requirement for renewal of an engineer's professional license? for renewal of a technologist's or technician's certification? (Note: this is a requirement in some provinces.)

7. In terms of supporting the cost of continuing professional development, where do you see the balance across individual responsibility, employer responsibility, and government support (through the tax system)?

8. In your experience, have there been any trends in shifting responsibilities between engineers and technologists? between technologists and technicians? between technologists and technicians, on the one hand, and tradespersons on the other? If so, what is behind these changes? (e.g., cost pressures, differences in training, internationally trained professionals who are educated as technologists, but employed as technicians, technology.)

9. Do you see any implications of these shifting responsibilities for the system licensing engineers or certifying technicians or technologists?

10. What is your company's policy towards professional licensure for engineers and professional certification for technologists and technicians? Do you provide financial support for annual registration or membership fees?

- If policy is to require licensure and certification: what are the main reasons that you require licensure and certification?
- If policy is to prefer licensure and certification: what are the main reasons that you encourage licensure and certification? Why do you opt for a policy of encouraging, rather than requiring?
- If policy is mixed, i.e., require for some employees, but not for all: what factors determine where you draw the line between requiring licensure or certification vs. not requiring.
- If policy is non-supportive: why does your company not see value in licensure or certification?
- Have there been any changes in your company's policy or attitude towards licensure or certification? If so, what was behind these changes?

Appendix B: Focus Group Discussion Outline

1. Introductions
   - Background to the study
   - Purpose of Focus Group
   - Introduction of participants
2. Please describe the types of responsibilities undertaken by engineers and technologists in workplaces with which you are familiar.
3. Do you see any changes in the respective roles of engineers and technologists?

   In particular, are there functions or responsibilities that were formerly undertaken mainly by engineers, which are now increasingly undertaken by technologists?

   Has there been any movement in the opposite direction?

   Are these changes more evident in some technical fields or disciplines?

   Are these changes more evident in some industries?
4. Do you see any changes in the respective roles of technologists and technicians vis à vis one another and vis à vis the skilled trades?

   Are these differences between technologists and technicians becoming more or less pronounced, in practice?

   Are these changes more evident in some technical fields or disciplines?

   Are these changes more evident in some industries?
5. Break
6. What factors are behind the changes in the roles and shifting work boundaries?
   - cost pressures?
   - business organization models?
   - differences in training?
   - internationally trained professionals who are educated as engineers, but employed as technologists?
   - technology?

   Are these factors more important in some industries or in some technical fields?
7. Do you see any trends in shifting roles and work responsibilities between engineers/technologists/technicians on the one hand and other science-based professionals, e.g., computer science graduates, life sciences graduates, mathematics graduates, etc.

Appendix C: Members of Steering Committee

Kim Allen
Professional Engineers Ontario

Jean Luc Archambault
Order des Technologues Professionels du Quebec

Michelle Branigan
Electricity Sector Council

David Chalcroft
Association of Professional Engineers, Geologists and Geophysicists of Alberta

Samantha Colasante
Engineers Canada

Manjeet Dhiman
ACCES Employment Services

Brian George
Northwest Territories and Nunavut Association of Professional Engineers, Geoscientists

Stephen Gould
Canadian Council of Technicians and Technologists

Kevin Hodgins
Northwest Territories and Nunavut Association of Professional Engineers, Geoscientists

Cheryl Jensen
Mohawk College

Ellie Khaksar
Diversity Integration and Retention Services Inc.

Lise Lauzon
Réseau des ingénieurs du Québec

Edward Leslie
New Brunswick Society of Certified Engineering Technicians and Technologists

Andrew McLeod
Engineers and Geoscientists New Brunswick

Perry Nelson
The Association of Science and Engineering Technology Professionals of Alberta

Robert Okabe
City of Winnipeg

D'Arcy Phillips
Manitoba Aerospace

Pat Quinn
Professional Engineers Ontario

Colette Rivet
BioTalent Canada

Tom Roemer
Camosun College

Kyle Ruttan
Canadian Federation of Engineering Students

Deborah Shaman
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Len Shrimpton
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Andrew Steeves
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Al Stewart
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Richard Tachuk
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Jean-Pierre Trudeau
Ordre des ingénieurs du Québec

Gina van den Burg
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Deborah Wolfe
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Bruce Wornell
Engineers Nova Scotia

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