CAPE COUNCIL FOR ACCESS TO THE PROFESSION OF ENGINEERING

SKILLS COMMENSURATE ENGINEERING ACCESS PROJECT

Final Research Report

February 23, 2008

CAPE has just completed its Skills Commensurate Engineering Access (SCEA) community action research project under which a total of 423 immigrants with engineering backgrounds were surveyed. 277 participated in a general profile survey and 146 participated in the detailed skills survey. 274 engineering employers were identified who were hiring those fitting the general profile of this survey sample. 272 job postings put out by these employers were analyzed in detail and resulted in the identification of 43 skills commensurate occupations. Six sets of skills were identified for each of these 43 occupations and a second skills survey was carried out against this framework to establish a comparative analysis of employer requirements and skills of immigrants with engineering backgrounds. This report presents the findings of this survey and concludes with general and specific conclusions about the findings from this comparative analysis for different cluster of employers. Finally, recommendations are made in the form of next steps on leveraging immigrant skills for skills commensurate occupations in engineering.

Skills Commensurate Engineering Access Project – Research Report
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The Project Team for this research comprised of Gurmeet Bambrah, Principal Researcher; Mohan Doss, Labor Market Researcher; Ali Mirzaee, Database Researcher; Mohammed Jahanzeb Khan, Technical Consultant and Clue Design Database Developers.

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EXECUTIVE SUMMARY

In recent years, Canadian immigration has undergone some rapid, large-scale changes. Immigrants arriving after 1984 are more numerous, possess higher skills and credentials, and are more concentrated in certain occupational groups and countries than in previous decades. A significant proportion of these skilled immigrants are struggling to get licensed and the majority is unable to convert their foreign qualifications into jobs commensurate with their education and training.

In 2005, CAPE first brought to the fore the fact that out of a total Ontario engineering workforce of over 220,000 who held university degrees in engineering only 66,653 were professionally licensed. The Skills Commensurate Engineering Access project initiated by CAPE Council for Access to the Profession of Engineering in December 2006 is a community action research project that aims to create greater understanding of the nature of engineering occupations that engineers opting out of licensure are currently holding in Ontario. The project is funded through in-kind contributions by CAPE and research funding from Human Resources and Skills Development, Labour Market Partnerships.

Both immigrants with engineering backgrounds and employers were engaged in this research to develop a database of employers who have hired and are hiring non-licensed and/or non-certified engineering graduates, the type of employment offered and the skills and competencies required for these occupations. These skills and competencies have then been compared to a sample of immigrants with engineering backgrounds. Two distinct categories of engineering occupations not subject to the engineering-licensing process were the main focus of this project: those jobs that support recognized licensed occupations and those jobs that fall under emerging fields in engineering, which are currently not subject to licensing.

For this project, an action research approach was adopted that was based on the Systematic, Integrated and Strategic Approach (SISA), developed by the author of this report through over a decade of research. This incorporated a multi-dimensional, interactive and dynamic database and analysis, focusing on:

1. Types of skills-commensurate occupations of interest to those with engineering backgrounds
2. Skills and competencies required for these occupations
3. Employers hiring these occupations
4. Skills and competencies of immigrants with engineering backgrounds in comparison with those required for the skills commensurate occupations identified above
5. Organizations offering language, technology-based upgrading and employment supports to this group of newcomers

A total of 423 immigrants with engineering backgrounds were surveyed under the skills commensurate community action research project. 277 participated in a general profile survey and 146 participated in the detailed skills survey. 274 engineering employers were identified who were hiring those fitting the general profile of this survey sample. 272 job postings put out by these employers were analyzed in detail and resulted in 43 skills commensurate occupations. Six sets of skills were identified for each of these 43 occupations and subsequently a second skills survey was carried out against this framework to establish a comparative analysis.

The report concludes with general and specific conclusions about the findings from this comparative analysis for different cluster of employers. Finally, recommendations are made in the form of next steps on leveraging immigrant skills for skills commensurate occupations in engineering.

1 BACKGROUND

1.1 Skilled Worker Immigration

The profile of recent immigrants to Canada holding university degrees has changed greatly in recent decades. In 2001, some 60% or more of those aged 25 to 54 held a Bachelor's degree and belonged to a visible minority. 21% of recent immigrant men with a degree in 2001 were from South Asia compared with only 11% in 1991. Also, recent immigrants with a university degree tended to be older in 2001 than in 1991. For example, 64% of recent immigrant men were aged 35 or older in 2001, compared with 56% in 1991. Thus, immigrants who arrived during the 1990s helped to lift the education level in Canada. In 2001, 41% of new immigrants had a university education, 13% a college diploma and 8% a trade school certificate.[1]

The leading source countries for immigrants for the twelve year period from 1995 to 2006 are shown in Table 1.1 below.

Table 1.1: Leading Source Countries of Immigrants via Annual Numbers of Landings

Source countries	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
China, People's Republic of	13,309	17,533	18,526	19,789	29,138	36,746	40,363	33,294	36,236	36,411	42,291	33,080
India	16,261	21,291	19,615	15,376	17,452	26,126	27,906	28,838	24,589	25,569	33,146	30,753
Philippines	15,160	13,158	10,872	8,185	9,202	10,119	12,927	11,011	11,986	13,301	17,525	17,717
Pakistan	4,002	7,761	11,239	8,091	9,303	14,199	15,353	14,169	12,351	12,796	13,576	12,332
United States	5,195	5,850	5,030	4,776	5,532	5,827	5,911	5,293	5,992	7,494	9,262	10,943

The proportion of recent immigrants with a degree in engineering, mathematics or computer science also increased during the last decade. Together, these fields of study accounted for 59% of immigrant men with degrees in 2001, compared with 44% in 1991. The proportions were more modest amongst women rising from 15% in 1991 to 26% in 2001.[2]

125,110 of the 235,824 immigrants who came to Canada in 2004 settled in Ontario alone. 35,941 (15.2%) had professional skill sets while 13,683 (5.8%) were skilled technical workers.[3] This trend has continued so that between July 2005 and June 2006, the number of immigrants arriving in Canada for permanent residency had increased to 254,359 and 133,116 of them settled in Ontario.[4] As reported in Bambrah 2005[5], an estimated 75% of these professional and technical skilled workers intended to work in engineering. Conservative estimates indicate that in 2003, 7,160 new Ontarians self-identified as engineers and more than 1,000 identified themselves as either engineering technicians or technologists.

[1] Statistics Canada (2006), Overview: Education. http://www41.statcan.ca/1821/ceb1821_000_e.htm
[2] Diane Galarneau and René Morissette, Immigrants: Settling for less? Perspectives on labor and income, June 2004 Vol. 5, No. 6
[3] CIC (2004) Facts and Figures http://www.cic.gc.ca/english/pub/facts2004/permanent/27.html
[4] Statistics Canada (2007), Components of population growth, by province and territory
[5] Bambrah G. (2005), Canadian Experiments in Diversity - The Case of Immigrants with Engineering Backgrounds: CERIS Working Paper Number 41. November 2005

1.2 Engineering Workforce in Ontario

In terms of its homegrown knowledge workforce, Ontario's university graduates tend to aim for degrees in the disciplines most valued by corporate recruiters. These include engineering, business, science, medicine and law according to the Ontario facts website[6]. A detailed breakdown of this workforce derived from the 2001 census is contained in Table 1.2 below.

Table 1.2: Ontario's Knowledge Workforce

Program	Number
Engineering (All)	220,050
Electrical/electronic	44,685
Mechanical	37,070
Industrial	5,570
Aeronautical	3,230
Biomedical	600
Civil	29,595
Computer	8,065
Chemical	13,730
Computer Science	50,600
Business	144,055
Law	46,550
Physics	14,490
Mathematics	22,310
Biology	31,575
Chemistry	21,210
Animal Science	1,305
Medicine	32,795
Pharmacy	12,720
Veterinary	4,420

Source: Statistics Canada Census, 2001 (08/2006)

An analysis of the licensed membership of Professional Engineers Ontario (PEO), the provincial regulator for the engineering profession in Ontario in 2005 is shown in Figure 1.1. CAPE first brought to the forefront the fact that out of a total Ontario engineering workforce of over 220,000 i.e. those who held university degrees in engineering only 66,653 (including some retirees) were professionally licensed in 2005. In other words, using the most conservative estimates, only about 30% of the total engineering workforce in Ontario is currently licensed. As stated by Patrick J. Quinn, President of PEO, **"…**graduates, at the rate of four to one, are opting not to become licensed as professional engineers."[7] Therefore a large number of engineering graduates are opting not to get the license or to work in occupations requiring the Professional Engineer designation.

The Skills Commensurate Engineering Access Project, begun in December 2006, was rooted in creating a greater understanding of the nature of engineering occupations that are held by those in the homegrown workforce who opt not to obtain a professional engineer license.

[6] Statistics Canada (2006) Statistics Canada Census, 2001 (08/2006) and Ontario Government (2008), Ontario thrives on knowledge. Equipped for a knowledge-based economy, http://www.2ontario.com/welcome/ooed_616.asp

[7] Patrick J. Quinn, PEO. Engineering Dimensions May /June 2006, The big picture, President's Message, pg 3

Figure 1.1: Analysis of PEO Licensed Engineers

Source: Bambrah K. (2006)[8]

1.3 About the Skills Commensurate Engineering Access Project

Skills Commensurate Engineering Access is a community action research project that CAPE initiated in early 2006 to compile information about engineering skills, educational levels and experience required by employers compared with the skills of immigrants with engineering backgrounds in order to enter the non-licensed engineering-workplace in Ontario. The primary objective of the proposed project was to increase the access of immigrants with engineering backgrounds to skills commensurate occupations not requiring licensing or certification in Ontario through the identifications of these occupations, as well as a comparison of the skill sets between those of the immigrant population and those required by employers.

The long-term objective of CAPE is to improve the social and economic integration of immigrants with engineering backgrounds into meaningful employment commensurate with their skills and to do so in a timely fashion that does not squander human capital.

2 ENGINEERING EMPLOYMENT

2.1 Defining Engineering

Defined in the most traditional terms, engineering is the application of the principles of science and mathematics to develop effective solutions to technical problems linking scientific discovery, innovation, application and commercialization to societal and consumer needs. Engineers develop new products defining functional requirements, quality, safety, design, manufacturing, testing, reliability and safety requirements for these. Recent advances mean that computers are now widely used to produce and analyze designs; to simulate and test how a machine, structure, or system operates; to generate specifications for parts; and to monitor product quality and control process efficiency.

In this framework, entry to engineering has called for two to four years of post secondary education. Most engineering degree programs involve concentration in an engineering discipline along with courses in mathematics and the physical and life sciences. Many programs include courses in general

[8] Bambrah G. (2006) Final Report on Survey of Immigrants with Engineering Backgrounds Settling in Ontario, Engineering Employers and Community Supports. CAPE Council for Access to the Profession of Engineering. pg. 20

engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs. In addition to the standard engineering degree, colleges offer two to four year programs in engineering techniques or technology. These programs include various hands-on laboratory classes that focus on current issues in the application of engineering principles and prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge.

Several areas of engineering have seen increased activity since the beginning of this decade. These include multiphase or free surface flows; the modeling of complex processes in material science; and the development of mathematical models and tools to describe multiple scale phenomena. In addition, the coupling between mathematical modeling and optimization and control processes is becoming generalized. In terms of the future, it appears that competitiveness will depend on the robustness of future algorithms (decision algorithms) that allow the management of increasingly complex systems. Studies on solvers and the development of mathematical models have become major activities. Mechanical sciences were the preferential area for the application of scientific computing but this has spread to new sectors: material science, chemistry, biology, immunology, image processing, etc. Nanotechnology, which involves the creation of high-performance materials and components by integrating atoms and molecules, is now introducing entirely new principles to the design processes in engineering. New dimensions are therefore being introduced into the traditional framework defining engineering.

2.2 Sectors Employing Engineering Graduates

Canadian engineering jobs are found in manufacturing industries and in the professional, scientific, and technical services sector, primarily in architectural, engineering, and related services. Many engineers also work in the construction, telecommunications, and wholesale trade industries. Federal, Provincial, and local governments employ engineers as well in Departments of Defense, Transportation, Agriculture, Interior, and Energy, and in the National Aeronautics and Space Administration. Most engineers in Provincial and local government agencies work in highway and public works departments. Some are self-employed, many as consultants.

In a diversified economy such as Canada's, some sectors have experienced job losses while others are adding workers. In the late 1990s, manufacturing as well as professional, scientific and technical services (which has a heavy high-tech presence) provided about 40% of the net job gains (Table 2.1)[9]. For the most part, these industries have not shown the same strength in this decade. In fact, manufacturing has been the major source of job losses in, and since, 2005.

Table 2.1: Employment Growth by Industry

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
						% change					
All industries	0.8	1.0	3.0	2.4	2.9	2.9	0.3	0.9	1.7	1.3	1.6
Goods	-0.6	1.5	3.3	1.9	3.6	0.3	-3.0	0.2	-0.2	1.6	-0.1
Agriculture	-5.8	5.1	-2.2	-0.8	-6.0	-11.5	-13.2	14.1	-2.9	-4.3	7.9
Natural resources	0.7	0.2	1.7	-5.2	-3.7	0.4	8.4	-1.9	0.9	6.0	2.2
Utilities	-2.3	-0.3	8.0	5.5	-2.5	0.9	7.7	0.9	1.9	-5.4	-0.2
Construction	-3.4	-2.6	2.6	5.2	5.6	1.8	1.7	7.4	4.0	7.7	5.1
Manufacturing	1.6	2.7	5.7	2.1	4.1	2.0	-4.0	0.6	-2.1	-0.1	-4.2
Services	1.3	0.8	2.8	2.5	2.7	2.5	1.5	1.2	2.2	1.3	2.5
Trade	1.9	-0.7	0.5	3.3	3.4	4.5	2.0	2.3	1.9	1.5	3.0
Transportation and warehousing	3.0	1.6	3.6	1.1	6.0	3.5	-3.7	3.5	4.0	-4.2	2.3
Finance, insurance, real estate, leasing	1.5	2.2	-1.3	-0.2	8.3	2.8	0.1	2.1	3.4	5.5	1.1
Professional, scientific and technical	5.0	6.5	3.1	10.9	3.4	6.7	-0.1	3.4	-1.7	4.1	5.4
Business, building and other support	7.4	3.1	0.2	3.0	8.8	4.1	2.6	3.7	4.5	0.1	4.8
Education	-0.5	-2.4	1.5	3.1	4.9	-3.8	3.7	2.9	-1.6	2.2	6.7
Health care and social assistance	1.4	-0.9	1.5	4.5	5.4	3.8	2.6	0.1	4.0	0.8	-0.9
Information, culture and recreation	3.2	0.3	7.7	0.8	2.0	9.5	1.3	-1.6	4.3	1.6	1.4
Accommodation and food	1.9	2.9	0.4	1.0	3.2	-0.4	2.4	4.8	0.1	2.8	-0.6
Other	-0.3	1.0	7.1	1.4	-1.3	-4.2	6.7	3.1	1.8	-2.8	-3.0
Public administration	-3.9	0.7	-1.9	-3.6	8.5	0.9	2.6	-0.2	4.1	0.1	0.8

Source: Labour Force Survey, seasonally adjusted December data

[9] Vincent Ferrao (2006), Recent Changes In Employment By Industry, Perspectives on Labour and Income, January 2006, vol. 7 no. 1

2.3 Conventional Engineering Occupations

In the Skills Commensurate Engineering Access Project, two sources of data were used to define engineering occupations based on the traditional (conventional) definition of engineering including:

- The National Occupations Classification (NOC)[10] an authoritative resource on occupational information in Canada. This provides a standardized framework for organizing the world of work in a coherent system and is implemented in a number of major services and products throughout the private and public sectors. NOC is updated in partnership with Statistics Canada according to 5 year census cycles. It is based on extensive occupational research and consultation conducted across the country, reflecting the evolution of the Canadian labour market.
- Occupations based on the technical examinations classification by Professional Engineers Ontario (PEO), the regulator of the engineering profession in Ontario[11]

Table 2.2 presents the occupations classification adopted for the project.

Table 2.2: Engineering Occupations Classification Indices

NOC	PEO	SCEA
1. Civil Engineers	1. Agricultural/Biosystems /Bioresource/ Food Engineering	1. Agriculture and forestry
2. Mechanical Engineers	2. Biomedical/Biochemical Engineering	2. Aerospace/ Avionics/Aeronautical
3. Electrical and Electronics Engineers	3. Building Engineering	3. Biomedical/Biochemical
4. Chemical Engineers	4. Chemical Engineering	4. Chemical
5. Industrial and Manufacturing Engineers	5. Civil Engineering	5. Civil, infrastructure and building
6. Metallurgical and Materials Engineers	6. Computer Engineering	6. Computer
7. Mining Engineers	7. Electrical Engineering	7. Electrical/Electronic
8. Geological Engineers	8. Engineering Physics	8. Management
9. Petroleum Engineers	9. Environmental Engineering	9. Environmental
10. Aerospace Engineers	10. Forest Engineering	10. Geological
11. Computer Engineers (Except Software Engineers and Designers)	11. Geological Engineering	11. Industrial/Manufacturing/Production
12. Other Professional Engineers, n.e.c.	12. Geomatics Engineering	12. Integrated
	13. Industrial Engineering	13. Marine/Ocean/Naval
	14. Marine Engineering	14. Materials and metallurgical
	15. Mechanical Engineering	15. Mechanical
	16. Metallurgical Engineering	16. Mining/Minerals
	17. Mining and Mineral Processing Engineering	17. Nuclear
	18. Naval Architectural Engineering	18. Petroleum/Oil and Gas
	19. Petroleum Engineering	19. Software
	20. Software Engineering	20. Systems
	21. Structural Engineering	21. Textile

[10]Human Resources and Social Development (2006), National Occupation Classification
[11] Professional Engineers Ontario (2007) PEO's Technical Examination Programs, listing all engineering disciplines www.peo.on.ca

2.4 Emerging Engineering Occupations

Recent advances in nanotechnology have allowed companies to look at new techniques when considering modification of surfaces through engineering[12]. Surface Engineering assumes modification of surface properties of materials by means of application of coatings or surface treatments. Recent advances in nanotechnology have opened an opportunity to modify surfaces in a nanoscale range. Nanoscale surface engineering has found use in many fields. It is driving the miniaturization of electronics and medical devices, fabrication of new sensors and actuators as well as the creation of new classes of materials and devices.

Molecular Vapor Deposition (MVDR) technology is a surface engineering alternative to solution based methods used in many laboratories and provides solvent-free, low material waste and an environmentally friendly processing method. It also produces high quality nanocoatings in the form of organic monolayer films, used to reduce the surface energy in micro-structures to improve their performance and reliability. Another exciting area of MVD surface engineering is emerging technologies, and mainly Nanoimprint Lithography (NIL). NIL is maturing as an alternative to optical lithography, at least (and for now) in niche market applications, like hard disk drives, LEDs, photonics, micro optics, and microfluidics. One of the most promising areas of NIL is Data Storage.

Another promising application of NIL, replication of micro optics (diffractive optical elements, phase masks, Bragg gratings, microlens arrays) is very useful in driving down the cost of manufacturing optical components. Micro lenses and microlens arrays are finding applications mainly in the domain of optical microsystems including optical interconnects, biomedical instruments, optical data storage and optical communications. Another important potential application for NIL is high-brightness LEDs, which are enhanced with photonic crystals.

Other specific growth areas of engineering include environmental issues[13] - primarily mould; odor and air emission from industrial sites and farm operations; and pollution prevention programs. Originating in the US, concerns over indoor mould growth spread to Atlantic Canada and more recently to Ontario and Western Canada. Growth of a variety of moulds can occur in buildings whenever water leakage occurs. Detection, remediation and particularly building alteration to prevent future leakage are the major areas of work, involving the engineering profession. Large-scale mould remediation projects in high rise office and residential towers are an interesting market. Brownfields residential development and infilling as well as the construction of housing in farming areas contribute to this market. Engineering services to address this market include stack testing, predictive impact modeling, olfactometry, product reformulation, and industrial ventilation and pollution abatement systems.

Pollution prevention plans are now being implemented at the municipal level through sewer use by-laws. The city of Toronto now requires all sectors to develop a Pollution Prevention (P2) Plan and Summary Plan. The Region of Waterloo has adopted a Business Pollution Prevention (P2) Plan for small and medium size businesses and the Greater Vancouver Regional District is currently reviewing their sewer use by-law. It is anticipated that all major cities will move towards P2 plans as concerns over contaminants entering their sewage treatment plants increase. This will lead to a significant increase in the work of auditing professionals, and in the process, reformulation and pollutant removal processes.

The application of fractals in the engineering sciences is evolving swiftly through the rapid growth in techniques available for the employment of the ideas of fractals and complexity to a variety of disciplines in, and associated with, the engineering field. The strong potential of this research can be

[12] EuroAsia Semiconductor (2007) Surface engineering opportunities, News Update October 13, 2007
[13] Dr. Don Pinchin, New engineering trends are emerging, President, Pinchin Environmental Ltd.

seen in real industrial situations with recent progress being made in areas such as chemical engineering, internet traffic, physics and finance. Image processing continues to be a major field of application for fractal analysis. Examples of new and emerging engineering occupations are presented in Table 2.3 below.

Table 2.3: Emerging Occupations in Engineering

Occupation	Sector	Description
Composite Technicians (Bond Assembler)	Manufacturing	Work with metals, ceramics, plastics, semiconductors, and combinations of materials called composites to create new materials that meet certain mechanical, electrical, and chemical requirements.
Micro-electromechanical Systems (MEMS) Technician	Manufacturing	Miniaturized, self contained systems that integrate electrical and mechanical functionality allowing them to gather and process information and decide on a course of action and control the surrounding environment.
Nanotechnology Technician	Manufacturing	Operate and service microscopy equipment capable of characterizing nanostructures. Must have extensive background in materials science and optics.
Mechatronics Engineers Advanced	Manufacturing	Apply knowledge of mechanical, electrical, and computer engineering theory and methods to devices.
Microsystems Engineers Advanced	Manufacturing	Apply knowledge of electronic and mechanical engineering theory and methods to design micro-electromechanical systems (MEMS).
Photonics Engineers Advanced	Manufacturing	Apply knowledge of engineering and mathematical theory and methods to design technologies.
Managers of Quality Control Systems	Biotechnology	Plan, direct, or coordinate quality assurance programs. Formulate quality control policies and control quality of laboratory and production efforts.
Managers of Regulatory Affairs	Biotechnology	Plan, direct, or coordinate production activities to ensure compliance with regulations and standard operating procedures.
Geospatial Information Scientists and Technologists	Geospatial	Research and develop geospatial technologies. May produce databases, perform applications programming or coordinate projects. May specialize in areas such as agriculture, mining, health care, retail trade, urban planning or military intelligence.
Environmental Engineers	Environmental	Work on environmental regulations, disposal of hazardous waste, monitoring pollutants, or safety of employees on the job.

Further, there is an increasing convergence of different sectors as engineering draws in different disciplines through new advances in technology and innovation. Examples of these inter-disciplinary occupations are presented in Table 2.4.

Table 2.4: Emerging Inter-Disciplinary Occupations in Engineering

Occupation	Sector	Description
Biochemical Engineers	Biotechnology	Apply knowledge of engineering science principles to biological materials, processes, and systems to create new products such as vaccines and foods.
Clinical Engineers	Biomedical	Apply engineering technology for the improvement and delivery of health services.
Neural Engineering	Biomedical	Interdisciplinary use of engineering techniques to investigate the function and manipulate the behavior of the central or peripheral nervous systems. Includes fields of, clinical neurology, electrical engineering and signal processing of living neural tissue, , tissue engineering, materials science, and nanotechnology.
Tissue Engineering	Biomedical	Combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions.
Biomechatronics engineering	Mechatronics	Biomechatronics is an applied interdisciplinary science that aims to integrate mechanical elements in the human body, both for therapeutic uses and for the augmentation of existing abilities. It comprises aspects of biology, mechanics, and electronics.
Cognitive systems Engineering	Systems Engineering	Systems Engineering with the human integrated as an explicit part of the system incorporating experience and research in both Cognitive Psychology and Systems Engineering. Cognitive Systems Engineering focuses on how man interacts with the environment
System of systems Engineering	Systems Engineering	System-of-Systems Engineering is relatively new and is more than systems engineering since it is performed under uncertainty and it involves considerations in multiple levels and domains.
Hurricane Engineering	Civil Engineering	Hurricane Engineering encompasses planning, analysis, design, response, and recovery of civil engineering systems and infrastructure for hurricane hazards. Hurricane Engineering is a relatively new and emerging discipline within the field of civil engineering. An integration of many recognized branches of engineering such as wind engineering, coastal engineering, structural engineering, and forensic engineering with other recognized sciences and planning functions such as climatology, oceanography, architecture, emergency management and preparedness, hazard mitigation, and hazard vulnerability analysis.

3 RESEARCH HYPOTHESIS AND PRINCIPLES

3.1 Research Hypothesis

The employment rate for the 220,050 homegrown engineering workers in Ontario is between 97 and 96%[14]. Only one out of five of these workers in Ontario opts to become licensed.[15] The majority of those forming the homegrown engineering workforce in Ontario are therefore gainfully employed in a skills commensurate engineering occupation that does not require a license or other certification.

On the other hand, the employment status of nearly 1000 immigrants with engineering backgrounds[16] surveyed by CAPE between May 2004 and December 2005 showed that over 65% of them were unemployed or under-employed while 28% were working in non-engineering occupations.

[14] Natural and Applied Sciences Occupations, Browse Occupations by National Occupational Code http://www.jobfutures.ca/noc/browse_occupations_sector2.shtml

[15] Patrick J. Quinn, PEO. Engineering Dimensions May /June 2006, The big picture, President's Message, pg 3

[16] Bambrah G, (2006), Final Report, Survey of Immigrants with Engineering Backgrounds Settling in Ontario, Engineering Employers and Community Supports

Yet over 95 percent held a Bachelor's degree in engineering or higher. The difficulty immigrants' face in finding an engineering job has been attributed to several factors: de-legitimization and non-recognition of credentials, education levels or experience abroad. [17] To become licensed or certified engineers, technicians or technologists in Ontario, applicants must undergo accreditation, examinations and show that they have work experience in Canada, as well as good knowledge of English or French. Such requirements affect chances of finding a job that matches the education level of immigrants with engineering backgrounds adversely.

The hypothesis of this project is that majority of engineering occupations do not require licensing or certification are commensurate with the skills, education and competencies of immigrants with engineering backgrounds.

3.2 Research Principles

Both immigrants with engineering backgrounds and employers were engaged in this research to develop a database of employers hiring non-licensed or non-certified engineering graduates, the type of employment offered and the skills and competencies required for these occupations. These were then compared to the skills and competencies of immigrants with engineering backgrounds.

Labor market information was consolidated from all sources to develop a comprehensive overview of skills-commensurate non-licensed engineering occupations and the current and future demands of the profession as these relate to immigrants with engineering backgrounds.

3.3 Research Approach

Two distinct categories of engineering occupations not subject to the engineering-licensing process were the main focus of this project:

- Those jobs that support the recognized licensed occupations. Examples of these include property management, building inspections, construction plant leasing and sales, management information systems, institutional strengthening, consultative and community planning, technology sales, research and educational services.
- Those jobs that are not licensed, as these fall under emerging fields that may or may not fall under the licensing process in the future. These include software development, biotechnology, bio-medical engineering, tele-engineering, packaged on-site technology and value-add environmental products manufacturing (air purifiers, water purifiers etc).

The focus of the research was to collect and analyze sample data on:

- Types of skills-commensurate occupations of interest to those with engineering backgrounds
- Skills and competencies required for these occupations
- Employers hiring for these occupations
- Skills and competencies of immigrants with engineering backgrounds in comparison with those required for the skills commensurate occupations identified above
- Identifying partners that provide appropriate support through language, technology-based upgrading and employment programs

[17] Green, D. A. and Christopher, W. (2002). Earnings of immigrant men in Canada: The roles of labour market entry effects and returns to foreign experience. Paper prepared for Citizenship and Immigration Canada. Internet: www.cic.gc.ca/english/research/papers/earnings/earnings-toc.html

3.4 Principal Activities

The following activities were undertaken in the course of this action research project:

- Definition of community action research principles and methodology for employment and occupation data collection, processing and analysis using the CAPE engineering occupations classification index set out in Table 4
- General and detailed surveys of a community of immigrants with engineering backgrounds to develop a profile of their engineering education and experience based on the CAPE occupation classification index contained in Table 4 as well as their skills and competencies
- Identification and validation of the definition of skills commensurate occupations based on general engineering profile of immigrants with engineering backgrounds
- A detailed review and engagement of employers to develop a detailed understanding of the nature of skills commensurate engineering occupations
- A detailed analysis of skills commensurate occupations offered by these employers
- A multi-level matrix analysis to establish the degree to which the skills and competencies of immigrants with engineering backgrounds match those required by employers hiring for these positions
- Identification of partners offering appropriate language, technology-based upgrading and employment programs to support skills development for these occupations
- Online dissemination of the research findings to CAPE members, engineering employers and others

3.5 Action Research

Action research is a process rather than a one-off effort that leads to progressive problem solving led by a community of practice to improve the way they address issues facing them. Action research can be undertaken by organizations or institutions, assisted or guided by professional researchers, with the aim of improving strategies, practices, knowledge and capacity of the community to solve its own problems.

In his 1946 paper entitled "Action Research and Minority Problems" Kurt Lewin described action research as "a comparative research on the conditions and effects of various forms of social action and research leading to social action" that uses "a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action".

3.6 Systematic, Integrated and Strategic Analysis (SISA) Approach

For this project, an action research approach based on the systematic, integrated and strategic approach developed through over a decade of research, by the author of this report, was adopted. This incorporated a multi-level matrix framework and dynamic analysis calling for a database modeled on the following three dimensions:

- The first dimension focused on identifying the nature and categories of a sample of engineering occupations not requiring licensing or certification and the skills, experience and education associated with these types of jobs
- The second dimension focused on identifying and creating sub-categories of employers hiring engineering graduates for the identified sample of non-licensed or non-certified occupations
- The third dimension focused on the skills, experience and education attributes of the immigrants with engineering backgrounds and how these compared with those required by the employers

All three dimensions were developed systematically, simultaneously and interactively using real-time online tools. A dynamic database model was set up to capture the three dimensions of data. Finally this was expanded into a real-time analytical model to provide an understanding of the match between immigrant attributes and employer requirements making this a part of the CAPE research support structure for continued planning, action and evaluation.

4 SURVEYS - IMMIGRANTS WITH ENGINEERING BACKGROUNDS

4.1 Outreach

Based on a previous environmental scan of the community of immigrants with engineering backgrounds in Ontario the following were our key partners for outreach to immigrants with engineering backgrounds surveyed under this project:

- Ethno-cultural associations
- Settlement and service organizations serving immigrants with engineering backgrounds in particular: Skills for Change through the 'Engineering Your Future' program; ACCES through their 'Engineering Connections' program; and the Settlement Integration Services Organization through the 'Engineering Bridges' Program
- Employment-based events for immigrants with engineering backgrounds
- Direct contact with the immigrants with engineering backgrounds

The survey sample is drawn from all these sources and its spatial outreach includes all of Ontario.

4.2 General Profile of Immigrants with Engineering Backgrounds

A total of 423 immigrants with engineering backgrounds were surveyed under the skills commensurate community action research project. 277 participated in a general profile survey and 146 participated in the detailed skills survey. The general findings of the surveys are presented in the following sections. For detailed survey results refer to the detailed Survey Report that accompanies this Research Report

The general survey showed that the 277 participants who participated in this originated from 47 countries with India and China being the lead countries. 85% of the sample can be classified as engineers, 12.5% as technicians and technologists and 2.5% had insufficient credentials to be categorized as either as shown by the analysis of the engineering occupational classification of this sample shown in Table 4.1 below: This is based on the SCEA engineering occupations index contained in table 2.2 above.

Table 4.1: Classification based on SCEA Index

Engineering Field/Industry	No. of Members	Percentage
Electrical and Electronics Engineering	53	19.13%
Civil Engineering	51	18.41%
Mechanical Engineering	45	16.25%
Engineering Managers	42	15.16%
Industrial and Manufacturing Engineering	42	15.16%
Chemical Engineering	15	5.42%
Computer Engineering (Except Software Engineering)	15	5.42%
Software Engineering	15	5.42%
Aerospace Engineering	11	3.97%
Engineering Officers, Water Transport	9	3.25%

Petroleum Engineering	7	2.53%
Geological Engineering	4	1.44%
Metallurgical and Materials Engineering	4	1.44%
Mining Engineering	4	1.44%
Railway and Yard Locomotive Engineering	3	1.08%
Other Engineering	20	7.22%
Electrical and Electronics Engineering Technologists and Technicians	12	4.33%
Mechanical Engineering Technologists and Technicians	10	3.61%
Industrial Engineering and Manufacturing Technologists and Technicians	8	2.89%
Civil Engineering Technologists and Technicians	6	2.17%
Engineering Inspectors and Regulatory Officers	5	1.81%
Stationary Engineering and Auxiliary Equipment Operators	2	0.72%

An analysis of post-secondary education of this sample is contained in Table 4.2. This shows that nearly 27% of the participants have completed graduate studies.

Table 4.2: Education Profile

Degree	No. of Members	Percentage
Post-Doctoral	1	0.36%
PhD	3	1.08%
Masters	70	25.27%
Bachelor	163	58.84%
Diploma	12	4.33%
Others	28	10.11%

The number of years of working experience of these participants is profiled in Table 4.3.

Table 4.3: Experience Profile

Years Of Experience	Number Of Participants
Less or Equal to 10	139
Between 11 to 20	94
Between 21 to 30	40
Greater Than 30	4

The employment status of this survey sample in comparison to the length of time they have been in Canada is shown in Table 4.4.

Table 4.4: Employment Status

Length of residency in Ontario	No. of Members (Percentage)			
	Not working	Working in Professional Engineering field	Working, but in another field	Sub-total
Less Than 1 Year	90 (32.49%)	9 (3.25%)	12 (4.33%)	111 (40.07%)
Between 1 and 2 Years	23 (8.30%)	3 (1.08%)	11 (3.97%)	37 (13.36%)
Between 2 and 3 Years	18 (6.50%)	2 (0.72%)	11 (3.97%)	31

				(11.19%)
Greater Than 3 Years	59 (21.30%)	13 (4.69%)	26 (9.38%)	98 (35.37%)
Total	**190 (68.59%)**	**27 (9.75%)**	**60 (21.66%)**	**277 (100.00%**

5 SKILLS COMMENSURATE ENGINEERING OCCUPATIONS

5.1 Definition and Validation of Skills Commensurate Engineering Occupations

Under the SCEA project, skills commensurate occupations were defined as those jobs that have the following characteristics:

- They matched the general education and experience profile of the 277 immigrants with engineering backgrounds from Ontario as presented above
- Required post-secondary education in an engineering occupation from the SCEA classification (Table 2.2)
- Did not require the applicant to be licensed or certified
- Were classified as new and emerging

5.2 Approach to Data Collection

The following groups of employers identified through previous research[18] were analyzed in detail:

- Universities
- Community Colleges
- Innovation Centers
- Centers of Research and Excellence
- Regional Councils and Municipalities
- Conservation Authorities
- Plant Manufactures and Leasers
- Construction Plant Leasers
- Technology Suppliers and Manufactures
- Property Management Companies and Social Housing Organizations
- Software Companies
- Government

5.3 Scope of research

A number of resources were used to locate 227 employers (or 274 employers if municipalities are counted as individual employers) as indicated in (Table 5.1) among the groups listed above. These sources included:

- Toronto Construction Association – Members Directory[19]
- Ontario General Contractors Association – Members Directory[20]

[18] Bambrah G. (2006), Final Report on Community Action Research To Engage Stakeholders In Documenting And Addressing Barriers To Effective Labour Market Integration And Participation Of Immigrants With Engineering Backgrounds Settling In Ontario. Engineering Access Project CAPE Council for Access to the Profession of Engineering

[19] Toronto Construction Association, Member Directory
http://www.tcanetworks.com/benefitsservices/marketing/tcamcamemdirectory_buyersguide.cfm

[20] Ontario General Contractors Association, Member Directory http://www.ogca.ca/members/directory

- Association of Consulting Engineers of Canada Online magazine "Canadian Consulting Engineer"[21]

272 skills commensurate job postings for engineers were derived from web-pages, advertisements, websites and the engagement of the listed employers. Detailed data on these job postings and employers is enclosed in a separate survey report (Tables 4.1-4.7).[22] After each of these job postings had been identified, they were validated through employer contact with a random sample of 50 employers to confirm that the postings were still open at the time of analysis. A summary of the number of job postings analyzed in each of these categories is presented in Table 5.1.

Table 5.1: Number of Employers and Postings

Employer Category	Number of Employers	Number of Postings
1. Universities	19	30
2. Community Colleges	20	16
3. Research Centers	7	05
4. Innovation Centers	9	22
5. Centers of Excellence	5	3
6. Regional Councils (Municipalities)	7 (54)	34
7. Conservation Authorities	36	09
8. Plant/Technology Manufacturers	10	50
9. Plant/Technology Rentals and Leasing	11	24
10. Plant/Technology/Materials Suppliers	49	25
11. Property Management and Social Housing	8	12
12. Government	25	12
13. Software Companies	10	18
14. Others	11	12
TOTAL	**227 (274)**	**272**

Description of skills commensurate occupations

An analysis of these 272 job postings led to the identification of 43 engineering skills commensurate occupations listed in table 5.2. The approach was to identify those occupations that listed similar education and experience requirements to those of the immigrants with engineering backgrounds that had been identified through the general survey as reported above. While not an exhaustive list of such occupations, they provided a useful sample of skills commensurate occupations for the present research.

[21] Canadian Consulting Engineer Magazine, Association of Consulting Engineers Links:
Professional Directory http://www.canadianconsultingengineer.com/prodDirectory/proddirectory.asp Internet Directory
http://www.canadianconsultingengineer.com/industrySuppliers/webdirectory.asp Company Search
http://www.canadianconsultingengineer.com/esource/default.asp Careers/Classifieds
http://www.canadianconsultingengineer.com/ads/Classifieds/default.asp?WT.svl=Classifieds_Side
[22] Skills Commensurate Engineering Access Project Survey Report (2008)

Table 5.2: Skills Commensurate Occupations

Employer	Occupation
Universities, Community Colleges, Research And Development And Innovation Centers	1. Academic 2. Research And Development 3. Research 4. Officer, Research and/or Technical 5. Research and Technology Advisors 6. Management (Facility Manager, Asset Manager, Infrastructure Manager) 7. Research Manager Or Coordinator (Project or Program) 8. Consultant 9. Technology Transfer Specialist 10. Safety Specialists 11. Quality Assurance Specialists 12. Business Development Director, Manager or Associate
Municipalities, Conservation Authorities And Utilities	13. Systems Analyst 14. Operations Manager 15. Engineering Manager 16. Specifications Expert 17. Systems Performance Analyst 18. Field Investigator 19. Quality And Standards Coordinator 20. Control Systems Specialist 21. Resource Planning 22. Environmental Protection
Plant, Technology And Materials Manufacture, Rentals And Leasing	23. Project Manager 24. Project Engineer 25. Manufacturing Engineer 26. Production And Maintenance Engineer 27. Manufacture/Assembly Specialist 28. Process Planner 29. Proposals Specialist 30. Plant And Technology Installers
Property Management And Social Housing	31. Building Services Coordinator 32. Building Operator 33. General Manager 34. Senior Operations Advisor
Government	35. Procurement Adviser 36. Municipal Adviser 37. Program Support Officer
Software Development	38. Associate Consultant 39. Technical Manager
Emerging Occupations	40. Nano-Electronics Engineer 41. Micro/Nano Instrumentation Specialist 42. Nano-Biosystems Expert 43. Nano-Materials Specialist

6 INTEGRATED SKILLS AND COMPETENCIES ANALYSES AND FINDINGS

6.1 Data Collection

An online data collection information tool was designed, incorporating a portfolio builder, for immigrants with engineering backgrounds that had been developed previously to capture detailed skills data. 146 immigrants with engineering backgrounds responded to this second survey. This captured data on the following:

- Post- Secondary education (degree and number of years of education)
- Experience (number of years)
- Language (number of years of instruction in English or French)
- Functional skills (based on type of jobs held)
- Soft Skills (workplace-based skills)
- Technical & Other Skills (engineering, leadership and responsibility)

Taking the sample size of the immigrants with engineering backgrounds from the detailed survey (n=146) and then matching their skills and competencies with the different requirements of skills commensurate jobs gave us a more detailed understanding of what percentage of IEBs have which requisite skills. This helped us to establish actual not perceived gaps in skill sets within the population. It also highlighted areas in which the sample was highly skilled as well as areas where they may choose to upgrade certain skills.

Tables (4.1-4.7) in the survey report[23] contain this schedule of different occupations, employers, education, experience, language, functional skills, soft skills and technical and other skills required for these occupations. These tables represent the occupational requirements database for the 43 skills commensurate occupations listed in table 5.2 previously. Table 6.1 shows an example of one set of typical job requirements.

Table 6.1: Universities, Community Colleges, Research & Development and Innovation Centers

Type Of Occupation	Employer	Education	Experience	Language	Functional Skills	Soft Skills	Technical & Other Skills
Academic / Teaching	Universities	Masters Degree or Higher	2-7 Years Post-Doctoral	10 years instruction in English (French)	• Research • Special-ization	• Interpersonal • Presentation • Problem solving • Public speaking • Report writing	• Data collection/ analysis • Delegates work • Develops new concept, philosophy, standard or policy • Engineering studies • Engineering techniques/methods • Independent analysis • Independent studies • Recognized as a specialist

6.2 Integrated Dynamic Analysis

A dynamic online analytical tool was developed that integrated all three data sets (skills commensurate occupations, skills and requirements for each of these occupations and skills and competencies of immigrants with engineering backgrounds) into a single database allowing for the analysis of all three dimensions on an instantaneous, real-time basis.

6.3 Results of the Dynamic, Multi-Dimensional Comparative Analysis

The results by each cluster of employers obtained from this online analysis abstracted from the detailed survey report (Tables 4.1-4.7). These are presented below.

6.3.1 General Findings

The hypothesis of this project was that most engineering occupations do not require licensing or certification and are commensurate with the skills, education and competencies of immigrants with engineering backgrounds.

Of the 43 occupations suitable for those with engineering backgrounds, derived from an analysis of 272 positions from a group of 274 employers, the majority showed a degree of match with immigrant education, experience, language abilities, functional and soft skills, technical and other skills.

Despite the very high and specific levels of education required for academic teaching and emerging occupations (6 out of 43 occupations), 32% of the sample matched these requirements. For the remaining (37 occupations), the sample matched exceptionally well (90-99%) with the requisite educational background whether the requirement was for Bachelors, Masters or Doctorate level of education.

For the most part, the sample showed the respondents to be highly matched in terms of language competencies based on the number of years of instruction in English/French languages (around 80-90%) with the majority of occupations (36 out of 43). Language was found to be a constraint for only a small number of occupations (7 out of 43) in the areas of advanced teaching and research, consultancy and high level management, in which around 5-7% match was found.

For 35 out of 43 occupations, the sample matched very highly (59-95%) with the experience requirements of the occupations. A significant finding in terms of experience was the lack of manufacturing, management (facilities, asset, and infrastructure), consultancy, and technical research experience (not general research in which the sample scored high) in the sample. These ranged from 5-31% match for 8 out of 43 occupations.

6.3.2 Detailed Findings

6.3.2.1 Skills Commensurate Occupations - Universities, Community Colleges, Research and Development and Innovation Centers

31-32% of the sample had adequate education and experience competence to join Academic Teaching related occupations and Research and Development occupations. Only 5% of this group had the requisite language skills and 6-10% of this group had the requisite functional, soft, technical and other skills to be considered work ready.

95% of the sample had adequate education to qualify for work the rest of the occupations, 88-90% matched both experience and language requirements in the Technology Transfer occupations. 59% of this group also matched the functional skills profile and around 30% matched the soft, and technical and other skills to be considered work ready in Technology Transfer which is quite high.

90% matched the experience and language competencies for Safety Specialist, Quality Assurance Specialists, and Business Development Directors, whole matching 11-23% in the functional, soft, technical and other skills areas.

In general Research occupations, the sample matched well with 88-90% matching the experience and language requirements and 16-21% matching the functional, soft, technical and other skills. However, in more Technical Research occupations, only 4-5% matched the latter skills.

In Management occupations, 26% matched the yet only 5% of this group matched the functional, soft, and technical and other skills to be considered work ready.

Finally, in the consulting arena, while 23-25% matched the language, functional, soft, and technical and other skills to be considered work ready, only 5% matched the experience requirements.

6.3.2.2 Skills Commensurate Occupations - Municipalities, Conservation Authorities and Utilities

95% of the sample matched all the different occupations in terms of education and around 84-88% matched the all the different occupations in terms of experience requirements (with the exception of the occupations of Engineering Manager (34%) and Operations Manager (34%). The language competencies were also fairly high averaging 90% across the board with the exception of Specifications Experts (5%), Quality and Standards Coordinator (5%) and Resource Planning (5%). However, differences did exist in the levels to which the sample matched functional, soft, technical and other skills within the municipal job profiles.

In other occupational profiles such as Field Investigator, Quality and Standards Coordinator, Control Systems Specialist and Environmental Protection the education, experience and language competencies ranged very high (83-99%) but functional, soft, technical and other skills ranked lower (3-7%).

6.3.2.3 Skills Commensurate Occupations - Plant, Technology and Materials Manufacture, Rentals and Leasing

95-99% of the sample matched the educational and language requirements for all the jobs, with the exception of Proposals Specialist in which the language competency was at 6%. Around 59-87% matched the experience requirements for the different occupations as well with the exception of Manufacturing Engineer, which fit 13% of sample respondents.

The occupational profiles of Project Manager, Project Engineer, Production and Maintenance Engineer, Manufacture/ Assembly Specialist and Plant and Technology Installers fared well with over 25-35% matching the functional, soft, technical and other skills, with the exception of the 'technical and other skills' of Manufacturing Engineers and Plant and Technology Installers.

11-14% of the sample match the Process Planner occupation and 3-4% match the Proposals Specialist occupation, although their matching of the educational, experience and language competencies is quite high (59-99%).

6.3.2.4 Skills Commensurate Occupations - Property Management and Social Housing

99% of those surveyed met the education requirements, and between 77-90% had the experience and language capabilities for entry into skills commensurate occupations related to property management and social housing. 10-12% of the sample had the requisite functional, soft, technical and other skills to enter these occupations in senior advisory positions while 24-29% had the same set of requisite skills to take up management occupations with this cluster of employers. However, only 7.5-14% of the sample had functional, soft, technical and other skills that were different from the skills required for operator and coordinator occupations offered by this cluster of employers.

6.3.2.5 Skills Commensurate Occupations- Public Sector (Government)

99% of those surveyed met the education requirements and between 77-90% had the experience and language capabilities for entry into the public sector skills commensurate occupations as advisors and officers. 10-12% had the requisite functional, soft, technical and other skills to enter senior procurement occupations while 4-7% had the same set of requisite skills to enter public sector occupations supporting its senior management. Only 2-3% had the requisite functional, soft, technical and other skills to enter municipal advisory occupations. 12-18% had the requisite functional, soft, technical and other skills to enter this occupation as technical managers.

6.3.2.6 Skills Commensurate Occupations - Software Companies

95% of those surveyed met the education requirements and 88-90% had the experience and language capabilities for software development. However, only 15-23% had the requisite functional, soft, technical and other skills to enter this occupation as consultants or associate consultants. A slightly lower number 12-18% had the requisite functional, soft, technical and other skills to enter this occupation as technical managers.

6.3.2.7 Skills Commensurate Occupations - Other (Emerging Occupations)

32% of those surveyed met the education requirements and 88-90% had the experience and language capabilities for emerging occupations. However, only 8-14% had the requisite functional, soft, technical and other skills to join these professions.

7 CONCLUSIONS, RECOMMENDATIONS & NEXT STEPS

7.1 General Conclusions and Recommendations

An analysis of 272 positions from a group of 274 employers resulting in the identification of 43 skills commensurate occupations leads to the conclusion that, in keeping with the hypothesis of this research, there is a good match between the educational, experience and language abilities of the sample (277 immigrants with engineering backgrounds) and the skills required by employers for these positions. However more detailed analysis of the skills of 146 immigrants with engineering backgrounds demonstrates that there is a wide range of abilities across different occupational profiles within the sample.

With a few exceptions discussed later, the educational background of the sample of 277 IEBs (measured by degree level and duration of the course), their experience (measured in terms of the length in years) and their language competence (based on the number of years of instruction in English/French in pre-and-post-secondary education) – around 59-99% – shows a high level of match between employer and occupational requirements and immigrant skills.

As stated previously, for the most part, the sample showed the respondents to be highly matched in terms of language competencies based on the number of years of instruction in English/French languages (around 80-90%) with the majority of occupations (36 out of 43). Language was found to be a constraint for only a small number of occupations (7 out of 43) in the areas of advanced teaching and research, consultancy and high level management, in which around 5-7% match was found. Given the highly specific nature of the qualifications for these occupations, as well as the restricted numbers of the general engineering fraternity entering these occupations, this is not unexpected.

Furthermore, as stated earlier, for 35 out of 43 occupations, the sample matched very highly (59-95%) with the experience requirements of the occupations. A significant finding in terms of

experience was the lack of manufacturing, management (facilities, asset, and infrastructure), consultancy, and technical research experience (not general research in which the sample scored high) in the sample. These ranged from 5-31% match for 8 out of 43 occupations. A possible explanation for this may be that in Canada, manufacturing tends to be a significantly different sector from countries such as India and China e.g. automotive manufacturing is a significant sector in Ontario and Canada, and this is not the case in India or China where the work is geared towards labor intensive manufacturing and assembly processes.

7.2 Detailed Conclusions and Recommendations

A significant finding in the detailed skills survey of 146 immigrants with engineering backgrounds was that the biggest disparity between the skills required for the occupations and those of the sample were in those occupational profiles that were either called for very high end skills (academia, research, management) or in those that required lower end skills (operators, coordinators, planners). Specific conclusions below are presented for each cluster of employers and the different occupations contained within.

7.2.1 Universities, Community Colleges, Research and Development and Innovation Centers

While 32% may have the potential to enter the high level academic teaching and research positions, most of them would require the sample to undertake advanced language training as well as an improvement in the soft skills and technical skills. Significantly, around 30% of the sample matched very well with the requirements for occupations related to technology transfer. 15-25% of the sample has reasonable potential to be employed by this cluster of employers in skills commensurate occupations.

7.2.2 Municipalities, Conservation Authorities and Utilities

In terms of the best matching functional, soft, technical and other skills, Systems Analyst (25-38%), Engineering Manager (21-23%), Specifications Experts (30-39%), Resource Planning (18-24%) profiles best matched the skill sets of the sample. However, in two areas: Specifications Expert and Resource Planning the sample was well matched with the requisite skills except for language which may indicate that this group could benefit from an advanced language training course.

For other lower end occupational profiles such as Field Investigator, Quality and Standards Coordinator, Control Systems Specialist and Environmental Protection the education, experience and language competencies ranged very high (83-99%) but functional, soft, technical and other skills ranked much lower (3-7%) and may indicate that these are not suitable occupations for this sample.

7.2.3 Plant, Technology and Materials Manufacture, Rentals and Leasing

Overall thus the sample matched very well the education, experience and language requirements for this cluster of employers. As mentioned earlier, the occupational profiles of Project Manager, Project Engineer, Production and Maintenance Engineer, Manufacture/ Assembly Specialist and Plant and Technology Installers matched well, with over 25-35% matching the functional, soft, and technical and other skills. However, the 'technical and other skills' of Manufacturing Engineers and Plant and Technology Installers were rather low indicating that the skill sets required for these may be more trade and manufacturing oriented.
A small number (4%) of the sample would match the Proposals Specialist occupation in the functional, soft, technical and other skills even though they are highly matched in the educational, experience and language competencies. This may indicate that if the sample wishes to enter these types of occupations, they may need to upgrade their skill sets.

7.2.4 Property Management and Social Housing

Between 15-25% of the sample matched well with the occupational requirements for this cluster of employers. There was a greater disparity in the skills required and skills available in this pool of immigrants with engineering backgrounds in the lower end occupational profiles e.g. coordinator, operator positions reinforcing the finding that these may not be suitable occupations for this sample.

7.2.5 Public Sector (Government)

Between 10-18% of the sample would appear to have the requisite skill sets to enter occupations in the public sector, mostly in the middle management positions such as Municipal Adviser. It seems there is limited scope for skills commensurate occupations in this sector with this cluster of employers.

7.2.6 Software Companies

15-18% of the sample would appear to have the requisite skills to enter consultancy occupations for this cluster of employers. However, the potential is lower for entry into the management positions.

7.2.7 Other (Emerging Occupations)

There is generally a lower match between the required functional, soft, technical and other skills of the sample with those required for emerging occupations, fundamentally because these are new jobs requiring new kinds of skills which are generally rare and evolving. There is great potential for the 32% in this sample who do have the requisite educational background to upgrade through advanced education and training.

7.3 Next Steps

Based on the skill sets analyzed under this research project, the following are areas of particular interest for further investigation:

7.3.1. Education, Experience and Language

The research indicates that to leverage the high levels of education and extensive experience of immigrants with engineering backgrounds, there is need to develop supports for this group that include advanced report-writing, public-speaking as well as advanced analytical techniques and methods in specialized areas. Universities and other institutions of higher education would be good partners for these programs. Further investigation is required to establish the nature and scope of this kind of support programs.

7.3.2. Functional Skills

The research indicates that there is a good match between the functional and soft skills of the immigrants with engineering backgrounds across a wide range of skills commensurate occupations. However to ensure maximum leverage of this attribute, focus needs to shift to short-term supports that link technical and other occupation specific requirements (engineering specificities, leadership and responsibility) to functional skills (based on type of jobs held) and soft skills (workplace-based).

An example of this would be a short program of six to eight weeks geared to leverage the technology transfer skills of immigrants with engineering backgrounds that includes: analyzing customer needs, carrying out negotiations, seeking and offering commercial advice, documentation, economic/

financial appraisal of a product/ process/ service, locating customers, identifying and analyzing new markets, offering consulting services and linking these to leadership training and innovation.

Potential partners may exist for this type of service programming in higher education institutions, including universities and community colleges, and would have to be linked to exposure to the work-place.

7.3.2. Soft Skills

The research indicates that the main soft skills required for the occupations analyzed include Communication, Consultation, Interpersonal, Presentation, Problem Solving and Report Writing. However, in order to be useful, any upgrading for the development of these skills needs to be linked to engineering Functional Skills. This area needs to be investigated and researched in much greater detail if these upgrading options are to be truly useful. Furthermore, any potential upgrading would have to be linked to workplace training by employers or through employee associations.

7.3.2 Second Language Support

The research indicates that around 10% of the sample would benefit from language training, whereas the rest of the sample seems well versed in the skills commensurate to the specific requirements of the occupation. In order to leverage the skill sets of this group, investigations need to be carried out to optimize the combination of soft skills training and language supports.