ASSISTIVE TECHNOLOGY IN CANADA: EXPLORING RELATIONSHIPS BETWEEN INDUSTRY AND ACADEMIA

by

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DEDICATION

The author wishes to dedicate this thesis to those who motivate and inspire her most: Her parents, John and Patti Crupi, for their wisdom, love, and support throughout her education and entire life. Her partner, Ramsey Wright, for his invaluable guidance, laughter, and encouragement on the days when it was most needed. The millions of Canadian men, women, and children who live with disabilities, and those who dedicate their lives to making the world they live in a little easier to navigate.

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ABSTRACT

Assistive technologies (AT) help people with disabilities perform activities of daily living, promoting accessibility and independence. Currently, there is a lack of information relating to the scope, function and nature of the AT industry in Canada. Two major stakeholders from this field is the focus for discussion: (1) assistive technology industry members, and (2) academic institutions that conduct research and train personnel for the industry. Data stems from the results of two surveys. The first survey targets companies who design, develop, and supply AT. The second survey is directed to university and college departments identified as recruitment targets for the ATI. Results indicate that both practical and knowledge gaps exist between the two stakeholder groups studied. The outcomes of this research can be used to help bridge these gaps by providing the government with a better understanding of the nature and competencies of the ATI in Canada.

LIST OF ABBREVIATIONS USED

ACAD:	Advisory Committee on Assistive Devices
ADIO:	Assistive Devices Industry Office
AT:	Assistive Technology
ATI:	Assistive Technology Industry
CCC:	Canadian Companies Capabilities Index
HQP:	Highly Qualified Personnel
HRM:	Human Resource Management
SME:	Small or Medium Sized Enterprise

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CHAPTER ONE: INTRODUCTION

ASSISTIVE TECHNOLOGY

Technology is embedded in the context of everyday life in Canada and around the world. Listed in the Merriam-Webster dictionary, technology is defined as "the practical application of knowledge". This common definition evokes no emotion, yet technology has a profound effect on our lives. Capturing the depth of its impact, Jonsson, Anderberg, Eftring, and Falkvall (1997) describe technology as:

- Honest: it is what it purports to be - no more, no less
- Neutral: providing the greatest amount of respect for individuality
- Concrete: tangible objects help express abstract concepts or desires
- Surprising and Provoking: stimulating conversation, thought, and creativity
- Liberating: people from dependency
- Empowering: bringing revolution

Technology exists through a number of interfaces: telecommunications, medicine, the environment, personal, and assistive technologies (Wylde, 1995). Assistive technologies or devices (AT) are tools or products designed to increase, maintain, or improve the abilities of people with disabilities in performing tasks of daily living at home, at work or at play (Alliance for Technology Access, 2005; Wylde, 1995). AT enhance the ability of an individual with a disability to engage in major life activities, actions and tasks (DeWitt, 1991). An Assistive Technology Service is any service that directly assists a person with a disability in selecting, acquiring or using an assistive technology device

(Alliance for Technology Access, 2005). Together, these services and technologies form what is known as the Assistive Technology Industry (ATI).

Wheelchairs, reading machines, devices for grasping, prosthetics, speech synthesizers, and computer software are all examples of AT. They are often required when the design of other mainstream technology or devices limit use by individuals with differing abilities (Wylde, 1995). For example, computers are a type of technology that often presents a problem for people with vision or mobility impairments. Screen readers or voice recognition software are types of AT that can make mainstream technology more accessible to them. When employed effectively, AT have the potential to help people attain their personal and vocational aspirations (Peterson & Murray, 2006). Some even describe AT as 'the great equalizer of opportunity' for persons with disabilities (Reuben & Roessler, 2001).

Definitions for related AT terminology often vary. Up until the mid 1990's in the United States, 'Rehabilitation Technology' was the term used to describe AT. It was defined by the Federal Register as "the systematic application of technologies, engineering methodologies, and scientific principles to meet the needs of, and address the barriers confronted by individuals with handicaps in areas which include education, rehabilitation, employment, transportation, independent living, and recreation" (Reuben & Roessler, 2001). The 'Social Model' is a dominant paradigm in researching and understanding disability. It defines disability in terms of a 'disabling environment' positioning disabled people as citizens with rights, and placing responsibility on society to create sustainable environments for all (Dewsbury, Clarke, Randall, Rouncefield, & Sommerville, 2004).

According to Dewsbury et al (2004), social constructivist disability theorists argue that concepts of disability are shifting and that many of them – previously accepted as matters of fact, and embedded in the ideologies of a particular point in time – are now commonly seen as wrong. However, far more important than any formal definition given to AT, is the meaning ascribed to it, or how AT is conceptualized, accessed and utilized by end users.

Recent advances in technology have led some researchers to propose that as new tools and interfaces provide positive changes and improvements to accessibility, it is critical that the entire area of AT continually be re-conceptualized to maintain relevance for end users (Vanderheiden, 2007). Meta-analyses have shown that the uptake of AT may be influenced by psychosocial and cultural issues shaping individualized meanings held by users (Louise-Bender Pape, Kim, & Weiner, 2002). Specifically, Louise-Bender Pape et al. (2002) suggest that for successful integration of AT, users must explore the meanings and expectations they assign to devices, as well as their perceptions of the larger social picture, including how and whether or not they understand and integrate their disability into their identity. For example, what does AT mean to end users? Is it a help or a hindrance? Is it conceptualized as a symbol of their disability or does it free and empower them? A working paper by the European Technology Assessment Network argues that successful innovation in any field requires an explicit or tacit recognition of the fact that technology is both technical and social in nature (ETAN, 1998). There are many questions that are important to consider when undertaking disability research. Given this overview of the relevant concepts and terminology within the field, the following section outlines the origin and purpose of this study.

Project Origin and Purpose

This thesis is one component of a larger project – a joint venture between the Assistive Devices Industry Office of Industry Canada (ADIO) and the Atlantic Regional Training Centre in Applied Health Services Research based at the University of New Brunswick – that uses a series of quantitative studies to examine the Canadian ATI in detail. The Office for Disability Issues (Human Resources and Social Development Canada) has also contributed to the funding for this research.

As technological discoveries and capabilities are advancing at a rapid rate, and because many Canadians depend on different forms of technology for daily life, it is critical for the ATI to work effectively and efficiently to provide equal access to all citizens. Williams (1995) asserts that creating true access means building in proper training, and support for AT. Relative to existing AT research, very little work has explored the ATI within a Canadian context. Therefore, many questions remain about the way in which it operates. As such, there is a need to keep the current research focus broad. By consciously deciding to work with a heterogeneous sample (limiting the generalizability of findings) this study aims to produce a baseline of information about the ATI from which further research can begin to explore more specific areas of interest and impact.

The present research explores the relationship between two major contributors or stakeholders in the AT field: Industry (Canadian companies[1] that design, manufacture, and supply AT and related services) and Academia (Canadian colleges and universities

[1] Canadian companies in this study include both for profit and not for profit volunteer agencies, as well as some government agencies. Individuals and Federal/Provincial government departments are excluded.

that train students in areas related to the ATI, creating the future workforce for this industry). There is a third and very important stakeholder group that is not directly targeted through this thesis: end users of AT. The issues affecting AT users are being explored through another component of the overall study. Mary Hill, a graduate student in Applied Health Services Research at the University of New Brunswick is conducting research on "Acquiring Technology for Vision and Hearing Impairments: The Experience of End Users as Consumers in Canada". Her work investigates the consumer experience of adult end users of AT for vision and hearing impairments.

The goal of this thesis is to determine the core competencies and characteristics of the ATI in Canada, and to understand how Canadian academic institutions are positioned within and interact with it. The following sections will help to frame the purpose and objectives of this research by first identifying relevant literature from the field. Included will be an international review of literature that explores the demand for the ATI; past, present and suggested research in the field of AT and, information detailing some of the characteristics, challenges, and opportunities for industry members and academic institutions as they relate to AT. This review will help to frame the context of the current study, leading to the statement of research objectives at the end of the chapter.

LITERATURE REVIEW

Demand for the ATI

It is estimated that at least 5 million Canadians – over 15% of the population – have disabilities that require one or more AT (PHAC, 2006). Although there are a huge number and variety of ATs on the market, they are not being accessed by all those who

could benefit from their use (Yaeda & Rubin, 1992). The 'National Survey of Children with Special Health Care Needs' reports that many children with special needs under-access recommended AT due to financial barriers (Centres for Disease Control and Prevention, 2007). However, it should be noted that the demand for AT varies across age groups. The Participation and Activity Limitation Survey (PALS) indicates that in Canada, seniors have the highest rate of disability (41%) compared to other age groups. Children (aged 0-14) have the lowest rates (3%) while adults aged 15-64 also have much lower rates than seniors (10%) (Human Resources and Social Development Canada, 2001). Older adults are major consumers of AT, and as this demographic bracket continues to grow, additional demands will be placed on the system to provide access to AT that will maintain, if not increase their quality of life.

In 2005, the average life expectancy of Canadians was 78 years, but only 68 of those years are estimated as being "disability-free" (Statistics Canada, 2006). Therefore, on average at least 10 years of life will be lived with at least one disability. Moreover, chances of developing a chronic condition (and co-morbid conditions) increase with age (Horiuchi, Finch, Mesle, & Vallin, 2003). Although chronic conditions are not necessarily associated with disability, some do cause challenges or limitations in activities of daily life. Illustrated in Table 1 are a number of chronic conditions and the percent of total reported cases that experience limitations in functions of daily life as a result of their condition. Research shows that need for assistance in performing activities of daily living (such as dressing and bathing) are closely related to presence of chronic conditions and in particular, the pain they cause (Gilmour & Park, 2003). Therefore, it is

a plausible assumption that some of these activity limitations might be aided by the application of appropriate AT.

Table 1: The proportion of chronic conditions causing limitations in performing basic life activities

Condition	Basic life limitation
Rheumatoid Arthritis	51.0
Intervertebral Disk Disorders	48.7
Orthopedic Impairment Upper	27.9
Orthopedic Impairment Lower	26.5
Ischemic Heart Disease	35.0
Other Heart Disorders	46.9
Emphysema	43.6
Multiple Sclerosis	70.6

(LaPlante, 1991)

The prevalence of chronic conditions in combination with population ageing causes significant concern about the rate at which demand on the ATI is growing. Despite recognition that this shift in demographics is happening, there is concern that mainstream technology industries, manufacturers, and service providers have not shifted their focus or adapted product planning strategies that will support this rapidly growing segment of the market (Dickinson, Eisma, Syme, & Gregor, 2002; Normie & Gavrish, n.d.). Some might think that technology is a field more successfully marketed towards youth but Wylde (1995) refutes a common misconception that older adults are "techno-phobic". However she also warns that age in and of it self is not the most effective predictor of technology use or purchase. Wylde (1995) also maintains that the ways in which products are marketed or positioned plays a larger role in their acceptance. For example, assistive technologies presented with a prevention orientation (devices to prevent injury/accidents)

are more accepted than a device presented with an impairment orientation (device compensates for loss or abnormality of structure or function). However technology is presented, the bottom line is that appropriate AT has the potential to prolong independence for elderly men and women and reduce or postpone the need for specialized care; improving quality of life and reducing the cost of their care (Adam, 1994).

While seniors have the highest rate of disability in Canada, the importance of AT for working age Canadians must not be overlooked. PALS research has shown that adults of core working age (24-54) face inequalities in several areas compared to adults of the same age without disabilities (Human Resources and Social Development Canada, 2001). Adults with disabilities have lower rates of post-secondary education (13.9% vs. 24.8%) employment (51% vs.82 %), and average household income ($52,835 vs. $72,951). Adults in this age bracket are also more than twice as likely to be living below Statistic's Canada's low income cutoff (Human Resources and Social Development Canada, 2001). The PALS research has also identified that 30.8% of adults aged 25-54 receive some assistance but need more, and 8.1% indicate that despite being in need of assistance, they do not receive any. The Canadian Association of Occupational Therapists (CAOT) has also acknowledged that many individuals do not have the use of available assistive technology and related services that would help them attain their desired potential in daily occupations (CAOT, 2005). Addressing the needs of this segment of the population is another complex but important role for the ATI. If AT were better able to serve young and working age adults in a way that improved their opportunities for education and employment, an overall consequence may be improvements to the Canadian economy. In

addition to facilitating tasks of daily living, enhanced access to ATI has the potential to improve the health of individuals, thereby mitigating potential health care needs of this future generation of seniors with disabilities.

The context in which disability is placed is complex and requires interdisciplinary expertise and consultation. The following section explores concepts and priorities related to research and development in the ATI.

Assistive Technology Research

Assistive Technology research is a relatively young field, but one that is rapidly growing. Some perceive research priorities in this field as being overly focused on problems that are well known and have "quick technological fixes" (Newell, 1998). Research is more likely to be undertaken when it has the potential to provide: the greatest support for an individual, support for the largest number of clients, the most effective lobby, or the most popular cause (Newell, 1998). Vanderheiden and Tobias (2005) explain that AT researchers and mainstream technology researchers can benefit from one another if they work collaboratively, or at the very least are tapped into one another's work. The Association for the Advancement of Assistive Technology in Europe (AAATE) (2002) state that accessibility gaps are either enlarged or bridged depending on physical characteristics of the environment, and availability of technologies and products – both mainstream (designed for the general public) and assistive (designed specifically for those with disabilities). The AAATE supports a framework that places mainstream design and AT on a continuum, where both maintain distinct and important roles that are also complementary and compatible. This framework encourages AT researchers to be aware

of cutting edge mainstream technologies, and be able to adapt them into both usable and accessible forms of AT. Clayton (2007) explains that the power of cutting edge technology often comes in a package that is complex, intimidating, and inaccessible to many users. This has led to calls for more AT research and designs that are user friendly and accessible.

In Scotland, a consortium of universities have come together to address this issue. A three year collaboration between the universities of Dundee, Abertay, Glasgow and Napier was funded by the Scottish Higher Education Funding Council in 2001 and is called: UTOPIA (Usable Technology for Older People: Inclusive and Appropriate). The UTOPIA project aims to develop methodological approaches to design technologies for older people while influencing industry to recognize the issues involved in designing for older people and the necessity to do so (Dickinson et al, 2002). Initiatives such as these that have integrated mainstream and AT research in the past have seen great success. For example, hearing aids were one of the first commercially successful examples of miniaturization technology and speech recognition and synthesis systems – originally developed for use by fighter pilots –have been used much more widely as AT rather than in mainstream application areas (Adam, 1994; Newell, Langer, & Hickey, 1998). The next part of this review will explore of some other functions, priorities, and characteristics of industry in general and also specifically in relation to the ATI.

Industry

The ATI is often perceived as highly fragmented as it serves small and specific user markets that require specialized and often sophisticated technology (Bauer, 2003;

Gordon, 2006). Yaeda and Rubin (1992) note that the ATI can be more effective when the roles of its member organizations and their employees are more accurately defined, and understood. Six specific job roles that exist within the ATI were identified (Yaeda & Rubin, 1992):

- Device Selection and Maintenance Activities
- Environmental Modification Activities
- Dissemination of Information on AT Activities
- Evaluation of Suitability of AT Activities
- Administration Activities, and
- Product Development Activities

To gain a more complete understanding of any industry, it is important to know where their supply of labour comes from, and whether or not it is meeting the demands of the particular industry. Although this study will focus on Canadian data, international trends in economics, health, and sustainability also help to explain the current context in which the ATI is based.

Global trends can be particularly helpful when trying to understand issues of labour supply and demand of an industry. Is the supply of AT professionals and services matched with the demand for the industry described above? It does not appear to be so. Although the literature is lacking on the ATI as a system, a common view is that there is an insufficient number of rehabilitation service providers with the skills and proficiencies to provide AT services - a trend that has been linked with the under-utilization of AT (Yaeda & Rubin, 1992). An article published in The Economist (Frymire, 2006) explains that this issue is not unique to the ATI: companies around the world are currently struggling to find the skilled labour they require, and that the demand for talent-intensive

skills is rising. The author of this article offers a partial explanation for this shortage of skilled labour:

> "There is a mismatch between what schools are producing and what companies need. Western countries are not churning out enough scientists and engineers." (Frymire, 2006)

This finding suggests a need to involve educational institutions (the origin of the potential workforce) in planning that attempts to support the demand of labour for the ATI. Literature that examines the roles of schools offering relevant educational training is explored below.

Academia

Research from the United States has suggested for a number of years that there is a need for increased AT training and research at post secondary institutions, which should be supported by federal contributions (Flynn & Clark, 1995). Although the literature suggests that this has not yet happened in a comprehensive way[2], there have been some efforts in Canada to increase training in this area. For example, the Natural Sciences and Engineering Research Council of Canada (NSERC) has established the Undergraduate Student Research Award (URSA) and the Industrial Postgraduate Scholarships (IPS) to stimulate interest in the area of science and engineering. The URSA award enables students to gain experience working in an academic research setting by providing them with funding over 16 week periods. The IPS provides graduate students with funding to

[2] Some efforts noted include work by New York Governor George E. Pataki and the New York Legislature. Since 1995 they have invested more than $1 billion in research laboratories and academic centres with the purpose of fostering the growth of high technology and biotechnology industries (Bessette, 2003).

pursue research experience in industry while undertaking advanced studies. It aims to build a link between academia and industry, where scholars can experience research careers in an industry which contributes to Canadian innovation (NSERC, 2006).

It is hoped that increased training in this area could reduce the shortage of qualified providers of AT rehabilitation and counseling services (Peterson & Murray, 2006). Increased funding in this area is also hoped to address the need for a multidisciplinary range of professionals to be sufficiently trained in AT (Scherer, 2005; Fifield & Fifield, 1997; Pacinelli & Stude, 1994; Justesen & Menlove, 1994; Carney, 1991). Seelman (1998) explains that the development of appropriate training programs for ATI is very complex due to the many different types of people in a variety of environments and professions who require training. Seelman's (1998) work cites a notable list of examples illustrating that virtually anybody could be a candidate for AT education and training. She explains that:

- A teacher needs training in how to write integrated education plans that incorporate AT.
- Rehabilitation counselors need information about a wide range of devices and how to obtain them.
- Design students need an integrated curriculum to learn how to design accessible features in passenger trains.
- A psychiatrist needs information on assistive devices for patients with traumatic brain injury.
- A landscape architect needs training on how to design a totally accessible city park, including a playground for children with and without disabilities (Seelman, 1998).

Two of the educational disciplines that have been most traditionally associated with the ATI are applied sciences (engineers and computer scientists - who design and develop AT); and rehabilitation sciences (physiotherapists and occupational therapists - who help end users of AT) (Center for Assistive Technology, 2005; Gregor, Alm, Arnott & Newell, 1999). In some universities and colleges, the field of Rehabilitation Engineering – a combination of two of the major professional disciplines in this field – is being promoted to meet the growing demands of the industry. The literature suggests that it is emerging as a professional discipline which incorporates several applied disciplines involved with assistive technology devices and services (Lane, 2003a).

Rehabilitation Engineering aims to address the needs of people with disabilities by conducting and translating engineering research on assistive devices into practical applications (Cooper, 2006). Leifer, Larsson, Larsson, Van der Loos, and Feland (2005) assert that despite the growing need for engineering designers to produce innovative products and technologies for the benefit of society, this type of work is heavily under-prioritized in the field. In order to develop and encourage research and development with a focus on wellbeing, changes must be implemented right from the beginning stages of formal education. One suggestion is that through their training, students should be encouraged to conceptualize and design in ways that are user-centeric (Leifer et al, 2005; Gregor, Alm, Arnott & Newell, 1999). Although the above research speaks specifically to rehabilitation engineering, many of the principles underlying the recommendations can be transferred to a number of disciplines that provide AT education in general. The challenge and importance of building a user-centric approach into education is described below:

> "While creativity is important, and may even be teachable, design is not invention as caricatured by the shouting of 'Eureka' and the flashing of a light bulb. Design problems reflect the fact that the designer has a client (or customer) who, in turn, has in mind a set of users (or customers) for whose benefit the designed artifact is being developed." (Dym, Agogino, Eris, Frey, & Leifer, 2005)

Thus, engineers and computer scientists are required who will keep the needs of end users of AT at the forefront of their designs. Although such principles must also be applied at the industry level (Craddock & McCormack, 2002), these examples illustrate how relevant pedagogy can more effectively support the ATI. However, more information needs to be gathered on the types and content of, and enrollment in such programs in Canada.

Industry-Academia Interface

Not only is it valuable to understand the roles and characteristics of academic institutions and industry members respectively in relation to the ATI, there is also tremendous value in understanding why and how they interact with each other. This section explores different ways in which industry and academia have come together in the past (in general, as well as in relation to the ATI). It will also draw on literature outlining facilitators and barriers to successful collaborations, suggesting ways that they might come together in the future. Translational research is often thought of as work that bridges scientific discovery with clinical application, and it commonly occurs at the boundary between academia and industry (Clackson, 2006).

According to Clackson (2006), successful collaborations between industry and academia require that both parties are fully aware of and in agreement about the expectations, priorities and plans for the research. He also explains that despite the many challenges associated with this work (e.g. agreeing on intellectual property rights and publishing practices), benefits can be great as the team builds on each others strengths (e.g. access to cutting edge technology or patient pools for clinical trials).

In Japan, the nature and practice of collaborative ventures have evolved over the past few decades, and translational research and development initiatives are now quite common in the field of science and technology (Shirakawa, 2006). As scientific and technological advances grew rapidly within universities, Japanese industry began outsourcing research and development projects and employees to academia where they could engage in collaborative work (Shirakawa, 2006). The Japanese government has also enacted a series of policies resulting in the "corporatization" of national universities with the objective of enhancing social welfare by increasing research capacity with industry members. This was primarily accomplished through a deregulation process which allows industry based researchers to participate in academic research. Previously, researchers with concurrent industry interests and activities were not allowed to affiliate with university based projects because of perceived conflicts of interest (Shirakawa, 2006). Currently in Japan, common forms of collaboration include academia providing technological licenses to industry, and industry approaching academia to establish joint business ventures.

These kinds of ventures are predominantly seen in the field of Electronic Design Automation, and the development of 'smart appliances' (Shirakawa, 2006). In the United

States, technological licensing of university research by the private sector is also commonplace. However, as the practice grows, so are concerns that it diverts academics attention too far from their primary responsibilities of teaching and basic research (Thursby & Thursby, 2003).

Occupational therapy is another area where a collaborative and multidisciplinary approach is beneficial (Lansley, 2006). Despite the fact that occupational therapists provide a critical role in the uptake of AT through the rehabilitation process, their experience has at times been overlooked during the early stages of product development. Lansley (2006) suggests that this situation could be improved by linking practicing clinicians - like occupational therapists – with university-based engineers who are working in the field of AT. In the UK, the Engineering and Physical Science Research Council is promoting such collaboration through the research programme called EQUAL (Extending Quality of Life) (EPSRC, 2006). To date, over £8.4 million has been spent on funding projects whose research aims to enhance AT in the built environment, design accessibility, and rehabilitation. The Biotechnology and Biological Sciences Research Council of the UK is another agency that has adopted this approach to promoting interdisciplinary research. Through the SPARC (Strategic Promotion of Aging Research Capacity) programme, both practicing and studying occupational therapists are given the opportunity to work side by side with scientists to develop AT systems (Lansey, 2006).

There are also more indirect methods of industry - academia collaboration. One example is through joint training initiatives. The Manufacturing Institute (MI) in North West England has taken action to address the concerns of the manufacturing industry that there is a skill shortage in the field (Wilson, 2005). The MI is now offering scholarships for part time study to workers at local manufacturing Small and Medium Sized Enterprises (SMEs). Electronics manufacturers are taking advantage of these scholarships and supporting their employees to complete a part time 'Diploma in Manufacturing' that will provide them with high level innovation skills to benefit their companies in the long run. The program appears to have great success so far as 70% of graduates have gained promotion within their organizations (Wilson, 2005). Now that different types of collaborative ventures that take place between industry and academia have been explored, it is also important to understand factors that facilitate or stifle these relationships.

Santoro and Gopalakrishnan (2000) undertook a study to explore Industry – University collaborations with a particular focus on engineering programs (a major player in the field of AT). Specifically, they looked at organization structure (size) and culture (trust, stability and flexibility), and geographic proximity of team members. They posit that due to an "ever evolving and competitive industry", organizations must increasingly acquire "external knowledge" to advance new technologies. Findings revealed that relationships are facilitated when industrial firms have more mechanistic structures, cultures that are more stable and direction-oriented, and when the firm is more trusting of its university research center partner (Santoro and Gopalakrishnan, 2000). There are a number of forms that academia-industry collaboration can take, but it is equally important to understand why they occur, and their potential for success.

Academic and industrial institutions have complimentary resources and skills, which make their motivations for collaboration different (Betz, 1996; Bower, 1993; NSF, 1982). Sometimes motivation is thought to stem from the combining of individual core competencies, which enhances each group's competitive advantage (Higgins & Maciariello, 2004). Other theories postulate that strategic alliances between two sectors may arise from competition between the two. According to McGill and Santoro (2004), this is especially common in high tech industries, where choosing collaborative structures that foster the transfer and integration of some resources simultaneously protect other resources. Although the literature reviewed provides some examples of ways and conditions under which industry and academia interact with one another, there is a paucity of Canadian data on this subject. This gap in the literature is hoped to be reminded in part by the current research. The following section explores the placement of the ATI within a Canadian context by examining perceptions of its infrastructure and support systems.

ATI Representation and Governance in Canada

In 2005, the Conservative Party of Canada committed in their electoral platform to "Introduce a National Disability Act to promote reasonable access to medical care, medical equipment, education, employment, transportation, and housing for Canadians with disabilities" (Gordon, 2006). In anticipation of the Act, the Council of Canadians with Disabilities and the Canadian Association for Community Living jointly commissioned a paper to contribute to the dialogue. The aim of the paper was to further the understanding of both the potential for and limitations of a Federal Disability Act (Gordon, 2006). The paper outlines a multiple-strategy approach to building an effective

Federal Disability Act. Two of the strategies put forth in the document that directly relate to the ATI are: (1) promoting universal design as a necessary tool to successful achievement of full inclusion; (2) providing federal purchasing power to encourage development of accessible products and services (Gordon, 2006). This is just one example of how issues related to AT and ATI are presented to the government by not for profit advocacy groups like the Council of Canadians with Disabilities, whose mission is to:

> "...provide a united voice for consumer driven disability organizations, and ensures the right of persons with disabilities to be heard in social policy debates, similar to other disadvantaged groups" (Hutchison, Arai, Pedlar, & Lord, 2004).

In addition to a number of not for profit advocacy organizations working towards building an equitable and accessible Canada, federally funded bodies also exist, working to support the needs of those living with disabilities. The Advisory Committee on Assistive Devices (ACAD) provides the Federal Industry Minister with advice on issues that impact on the ATI in Canada and on access issues in general. They have provided suggestions related to work done by the Task Force on Disability Issues and also plan to participate in the development of the National Access Strategy (ADIO, 2007). In 2003, the chair of ACAD spoke out in response to the released Canadian Innovation Agenda (Government of Canada, 2003):

> "I was surprised and profoundly disappointed when I did not find any reference to persons with disabilities or assistive technology in the recent paper by the Government of Canada entitled "Investing in People, Knowledge and Opportunity". After the commitment in the most recent Speech from the Throne and the support indicated by Cabinet for support of Research and Development on Assistive Technology so that Canadians with disabilities could take part and be fully included in the Innovation Agenda, I was shocked that it was not included in that important document...." (Dr. Gary Birch, 2003)

ACAD also suggests that the ATI sector has not been formally recognized by Industry Canada, since its branch office, the ADIO, is not appropriately staffed or funded (ACAD, 2005). The ADIO is mandated to provide advice, support and market intelligence to Canadian AT developers, producers, vendors and service providers, and works to ensure the availability of accessible devices to those who need them. They operate with only three staff members and an annual budget of $74,000. Recommendations put forth by ACAD urge Industry Canada to adequately fund the ADIO so that it may provide support to encourage growth in rehabilitative engineering (ACAD, 2005).

The ADIO aims to support the development and production of affordable communications, informatics devices and systems that help people with disabilities live more independently (ADIO, 2006). Some of their published works have explored the status of the ATI scene in Canada. Finn (1998) stated that since the early 1990's the growth of AT development has accelerated, allowing Canadians to be served by a domestic market. Their office has also identified a number of academic units within Canada whose work is related to AT (see Appendix A).

Geographically, these units span the country and include both colleges and university programs that focus on a wide range of disabilities. Their list provides some baseline information about the nature of academic work being conducted in Canada that focuses on AT, but more in depth information is lacking.

It is hoped that the current research will provide valuable information to agents within the government of Canada – such as the ADIO – who have the potential to facilitate growth and innovation within the ATI. What follows is a description of the research objectives that will help accomplish this task.

RESEARCH OBJECTIVES

This study explores a number of the issues described above to better understand the dynamic between industry and academia as it relates to the ATI. Results from two separate surveys provide the data for this research. By considering the internal and environmental interactions for both the industry and academia, a more thorough understanding of the factors and perceptions that underlie academic-industrial relations is gained, ultimately revealing how these two stakeholders interact and exist within the AT context. The findings provide insight into opportunities for capacity building within both of these arenas. The following set of research questions assist in attaining the study objectives:

- What relationships do academic institutions have with ATI members?
- What kind of research do academic institutions conduct in relation to AT?
- What are the sources of funding for AT research in Industry and Academia?

- What is the nature of the ATI workforce, and what are recruitment procedures?
- How well are company needs for personnel being met?
- How do University/College programs view the ATI?
- How aware are University/College programs of employment within the ATI?

CHAPTER TWO: METHODOLOGY

Literature reviewed in Chapter One has provided sufficient support for approaching the current study with a methodology that reflects the multidisciplinary nature of the ATI. The current study uses two separate and unique surveys as the primary data source to tackle the research questions, targeting two distinct stakeholders of the ATI: members of industry, and members of academia. The research methodology is primarily quantitative, as it seeks to identify a baseline description of these two groups, while aiming to provide a clearer picture of the ATI as a whole. Email contact with an invitation to complete an on-line survey was identified as the most practical and confidential approach to participant recruitment (see Appendices B & C). The use of this approach is further described below. The following section provides an overview of literature that supports the dual survey methodology used to conduct this study. Details about the sample selected and recruited, ethical implications, analysis procedures, and methodological limitations are also discussed below.

METHODS AND ANALYSIS

Rationale for Survey Use

The use of surveys, and online surveys in particular, is supported by research indicating that it provides more economical, timely, and confidential responses (Mehta & Sivada, 1995; Coomber,1997; Sheehan & Grubbs, 1999). Although some research indicates that higher response rates are a benefit of survey methodology, others believe that the evidence is not yet clear (Sheehan & Grubbs, 1999).

A review of existing literature examined research that specifically supports the use of survey methodology to explore dual stakeholder relationships. Studies that address labour issues of supply and demand (Berger, 2002), and industry – university relationships (Santoro & Gopalakrishnan, 2000) have employed methods similar to those used in this study: survey methodology to target both the suppliers (workforce or academia) and demanders (industry) of labour. These studies also have similar goals to this research in that they aim not only to explore the nature and quality of relationships between two different stakeholders in a common field, but also to provide decision makers with information that will assist them in building workforce capacity.

Sample

The population that this study targets includes two groups: (1) ATI members and (2) academic institutions that train the potential workforce for the ATI. The Industry members are those organizations who have self-identified with the Canadian Companies Capabilities Index (CCC) database (Industry Canada, 2006), and others identified through the ADIO database. The CCC includes companies with a range of foci: blindness, deafness/hard of hearing, language and communication, learning/cognitive, low vision, mobility, seniors, research, and academia (Industry Canada, 2006). Industry Canada (2006) also describes the database as:

- A public, centrally maintained, current searchable database of 50,000 Canadian businesses;
- Including hundreds of specialized manufacturing, service and product specific business directories;
- Having directories with powerful advanced search and reporting capacity;

- Containing business profiles with comprehensive information on contacts, products, services, trade experience and technology;
- Providing search results that can be presented and printed in comprehensive, short or custom reports.

The sample for the industry survey was tested against the Health Technology Exchange list of Ontario Assistive Technology companies. This suggests that approximately one half of the ATI was sampled through this survey.

Academic institutions in the target population include all colleges, universities, and Cégeps across Canada. All Universities, Colleges, and Cégeps listed in the Association of Universities and Colleges of Canada and the Association of Canadian Community Colleges databases were included in the study sample. Specifically, department heads (or equivalent) of the top ten programs most commonly identified as areas of study related to the ATI were targeted. These top ten were identified through the Industry survey and they include: Electrical Engineering, Computer Science, Occupational Therapy, Education, Kinesiology, Mechanical Engineering, Physiotherapy, Psychology, Biomedical Engineering and Social Work. These programs were identified via preliminary analysis of the Industry survey.

Data Collection

Data were gathered from two main sources. The first was a survey that targeted Industry: "Assessing the Assistive Devices Industry in Canada". The 27-question survey was designed and distributed by Allison Holland and Dr. Biden at the University of New Brunswick (UNB) in the summer of 2006 (see Appendix B). The survey prototype was reviewed and tested by the ministers Advisory Committee on Assistive Devices. It was

also tested by the institute of biomedical engineering at UNB for completion time, consistency, and readability. The survey was available online and on paper, in both French and English. The questions aimed to fill in previously identified gaps in knowledge about companies in the industry. Questions focused on: the sources and types of technology developed by the companies, the scope of their markets, the availability and appropriateness of personnel, and the facilitators and barriers to organizational advancement. Raw data collected from the survey were made available to the researcher. Data were then transferred from the original Excel file and coded into an SPPS file.

Using some preliminary findings from the Industry survey, a second survey, "Assistive Devices: University – College Survey" was designed and distributed under the guidance of Dr. Biden. It contained 15 questions and was made available in an online format in English and French with the help of the Information Technology group at the University of New Brunswick. The survey was also tested for readability, completion time, and consistency, by the ADIO and a group of students UNB. An email of information and invitation was sent to academic survey recipients identified in the sample mentioned above. Emails were disseminated between December 2006 and January 2007, and included the link with which respondents could access and complete the survey online (see Appendix C). Two weeks after the emails were sent, follow-up reminder emails were sent to recipients who had not completed the survey. Upon receipt of completed surveys, data was recoded and transferred from Excel to SPSS for analysis.

Ethical Considerations

An ethics application was submitted and approved by the University of New Brunswick Ethics Committee. To maintain confidentiality, survey respondents were not asked to identify their institution or name, but only the first three digits of their postal code. This allowed for identification of responses by province and region. As a means of debriefing, respondents were given the opportunity to receive a copy of the final report by indicating an email address where the report could be sent.

Analysis

There are three phases involved in the analysis of data for this study. The first phase involves the examination of the results from the Industry survey, and phase two includes an examination of the data returned from the academic survey. The final phase combines the results from the two surveys to explore the relationship existing between these two major stakeholder groups (see Discussion – Chapter 4), providing a gap analysis using information from both survey sources.

In terms of statistical analysis, a description of the data set is the focus for the first two phases. Descriptive statistics including frequency analysis and cross tabulations will help to identify and describe the major characteristics and practices that can be gathered from both the industry and academic surveys. Specifically, the analysis describes:

- The location and types of academic and industrial institutions who participated in the survey
- The number of students who go on to work in the ATI
- The number and type of academic courses or programs that focus on AT
- The sources of funding that are directed to AT research in Canada

- Challenges faced by the AT Industry members
- The kinds of relationships and connections that exist between academic institutions and ATI members

This data provides a baseline of information from which we can better understand the positions of academia and industry within the field of AT, which then may help us to estimate the potential for further growth and development in the field. Before exploring the results of these surveys further, a few challenges with the data as a result of methodological limitations must be acknowledged.

METHODOLOGICAL LIMITATIONS

Survey Sample and Distribution

The nature of the sampling process proved to be somewhat of a challenge for the academic survey. In order to access the email addresses of the department heads (or equivalent), a search of each university and college website was undertaken. Many websites are not user friendly, or were not intuitively laid-out. College websites were a particular challenge because they did not often subscribe to a common or observable structure (Schools – Faculties – Departments – etc.). Some schools did not list email addresses of all faculty. Also, the rapidly changing nature of the Internet may have resulted in some e-mail addresses being out of date, and therefore undeliverable (Smith, 1997).[3] There is also evidence to suggest that online surveys that are unsolicited may be perceived as aggressive by respondents, and not in keeping with the Internet culture, thereby resulting in a non-response (Mehta and Sivadas, 1995). Also, because the academic survey sample was selected based on the industry survey results (indicating

[3] It is estimated that this happened no more than ten times for the academic survey.

most frequent programs of recruitment) some academic areas that other research has shown to train students in AT, were not included (Jans and Scherer, 2006). Examples of such programs include: Communications, Human Development, Gerontology, Industrial Design, Speech and Hearing Sciences, and Vocational Rehabilitation. For these reasons, there is some concern that key participants may have been excluded from the sample.

The timing of the survey distribution presents another limitation, in particular for the second survey. Although there are several explanations for the low response rate, one of them may be due to the time of year the surveys were sent out. Surveys were sent out between mid-December and early January, which is an extremely busy time of year for academic institutions. Examinations and end of semester activities may have prevented some respondents from taking the time to complete the survey.

Two Surveys

Another methodological limitation results from the fact that two surveys were used. The Industry survey and Academic survey were not designed concurrently compounding the challenge of extrapolating data for analytical purposes. Although the responses from the Industry survey enabled the design of the Academic survey with the intent of providing a gap analysis, identifying trends in the data from the two surveys and being able to compare them realistically was a challenge.

Character of Data

The nature of the academic survey is primarily quantitative and is targeted towards an administrative population. Although this target audience for the most part was able to

inform the questions asked, the data may lack "richness" that would come from a variety of sources. In other words, administrators may be able to say how many students move on to work in the ATI, but without actually asking students why that is, it is impossible to know precisely why the numbers look the way they do. However, to have undertaken this kind of research would have been beyond the scope of this thesis.

CHAPTER THREE: RESULTS

Two parts form this analysis: (1) examination of the results from the Industry survey, and (2) analysis of data returned from the Academic survey. A description of the data set will use frequencies and cross tabulations to identify and describe the nature of the ATI, the relationships existing between ATI and academia, perceptions held about the ATI by academic personnel, and supports and challenges that influence both the ATI itself as well as academia's involvement in the ATI. Some data was analyzed in a way that highlighted cross-provincial comparisons. Provincial, as opposed to regional comparisons were more frequently examined for two reasons: (1) industry data was collected about support and funding at a provincial level, and (2) the low response rate for the academic survey made provincial analysis more practical. However, few trends were observed from this type of analysis. Therefore, some results are presented within this chapter, while others (that are less amenable to discussion) have been included in Appendix D for the interest of the reader.

Although the majority of the questions on the surveys yielded quantitative results, some qualitative information was also gathered through the inclusion of open ended questions. These responses are included within this chapter where applicable. It is hoped that this process will begin to provide some information to help fill a large knowledge gap in this field.

RESPONSE RATE

The Industry survey was sent out via email to 798 individuals and returned a 13% response rate with 105 completed and returned surveys. Statistical analyses revealed that the geographic distribution of the original sample and the response rate are identical. Despite having sent the academic survey to 355 university recipients, and 191 college recipients only 39 completed responses were collected in total. Although this rate is disappointing, the low response can be seen as a meaningful finding in itself and will be discussed further in Chapter 4. It should also be noted that no questions forced responses.

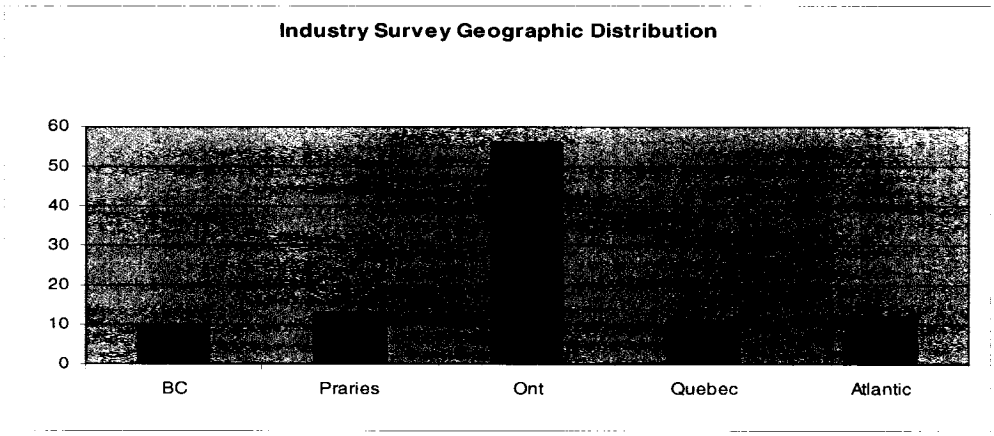
DESCRIPTIVE ANALYSES

Industry Survey

Organizational Demographics

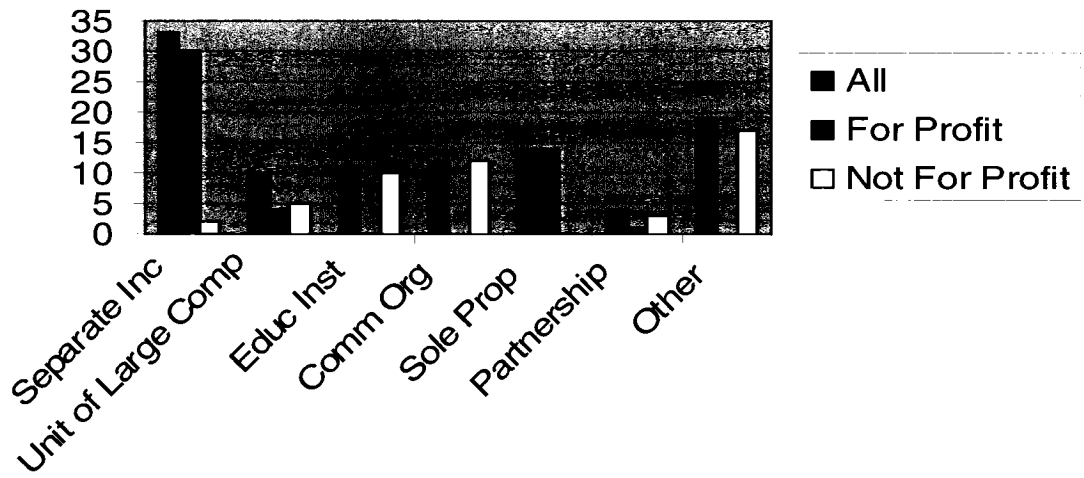
Responses to the industry survey were received from across the country, but an overwhelming majority (n= 56) were from Ontario (see Figure 1). Considering that Ontario has by far the largest provincial population (approximately 12.1 million) their significantly higher response was expected. If responses were proportional to their actual population, Quebec (population 7.7 million) should have had the second highest rate, followed by British Columbia (population 4.3 million), Atlantic Canada (population 2.3 million), and finally the Prairies (population 2 million) (Statistics Canada, 2007). As seen in Figure 1 however, this was not the case. The distribution is examined further in Chapter Four.

Figure 1: Geographic Response Distribution of Industry Respondents



The number of for profit and not for profit institutions that responded to the survey were just about even (n= 49, n=51). Respondents representing separately incorporated companies constituted 31% of the sample, and most of these companies were 'for profit' (n=30). Although two not for profit companies were included in the former category, the remaining forty seven were dispersed among several other categories: units of larger companies, educational institutions, community organizations, sole proprietorships, partnerships, and other (see Figure 2). Within the category 'other' several respondents (n=19) indicated that their organization was a hospital, branch of government, volunteer group, or rehabilitation centre.

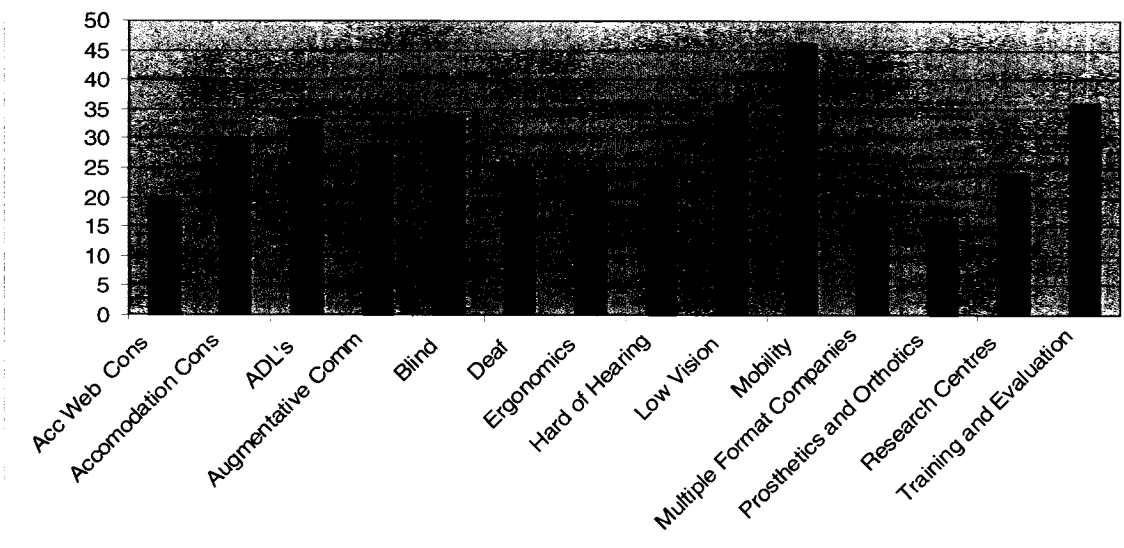
Figure 2: Percent of company categories listed by type



Organizational Type and Activities

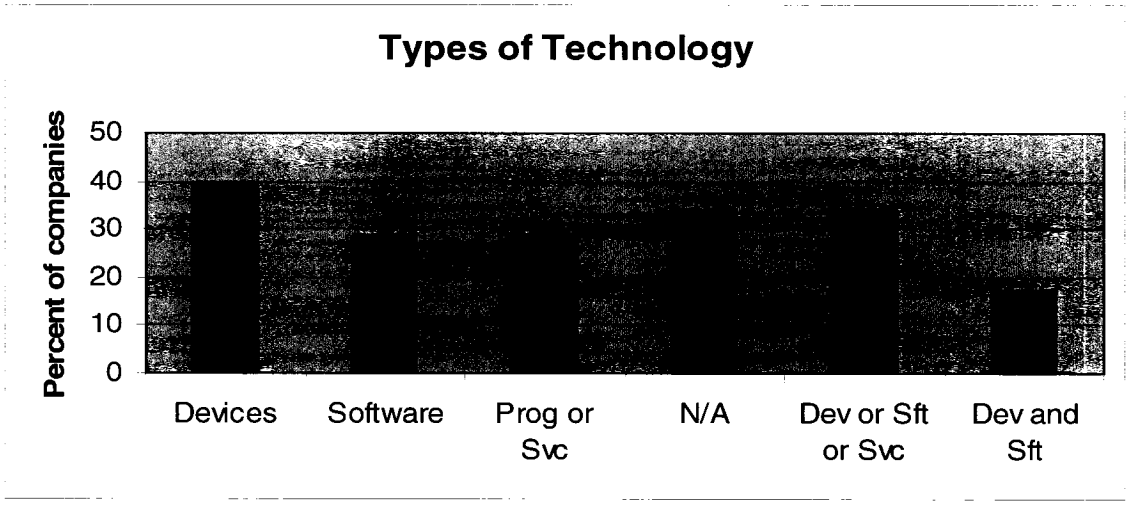
Respondents were asked to select all relevant options from a number of different categories that described the main activities performed by their organization. The most frequently selected category was mobility (n=46), followed by training and evaluation (n=36). The category least selected (n=16) was 'Prosthetics and Orthotics' (see Figure 3).

Figure 3: Main organizational activities



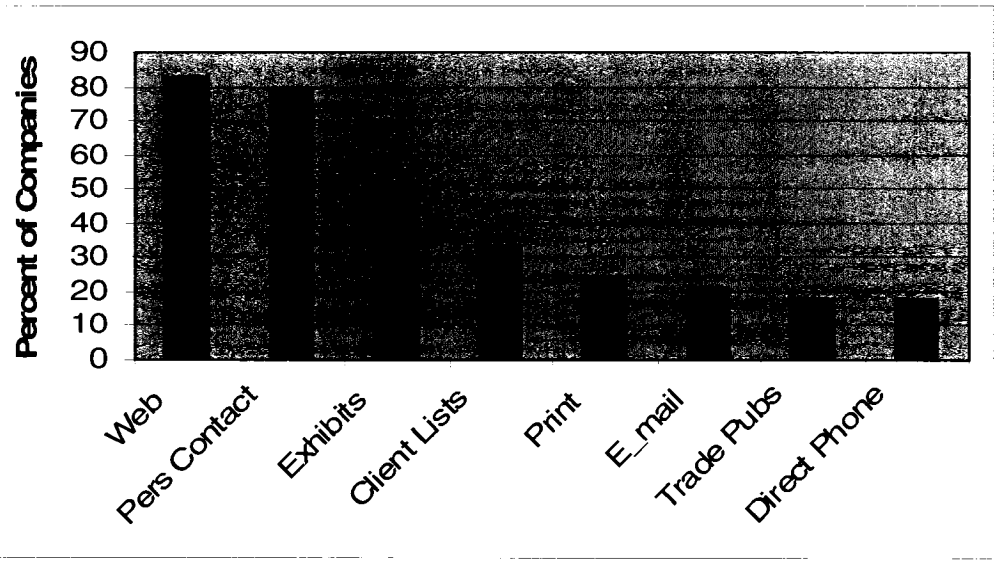
The types of technology produced by organizations varied. While 35% of companies indicate that they do not produce technologies at all, many organizations indicated that they produced more than one type (see Figure 4).

Figure 4: Technology produced by organizations



Respondents were asked to indicate all the ways in which their products or services were marketed to consumers. The method selected by just over 80% of respondents was the use of the World Wide Web. Personal contacts were also highly utilized as a means for informing clients (80%). Figure 5 illustrates some additional examples as well. Several respondents indicated other examples that were not options for selection within the survey. Some of the most common examples included: publications in journals, newsletters, and referrals from clinicians (including physiotherapists, occupational therapists, and physicians) and schools.

Figure 5. Where and how AT organizations market their products



Human Resource Structure

Respondents were asked to identify which category they fell into with regards to the number of employees and volunteers who worked with their organization (3 or fewer, 4 - 10, 11-20, 21-100, 101-400, over 400). Not for profit companies had more volunteers in all categories except the lowest (3 or fewer), and more employees in all categories except the two lowest categories (3 or fewer and 3 -10) (see Figures 6 & 7).

Figure 6: Number of employees by type of organization

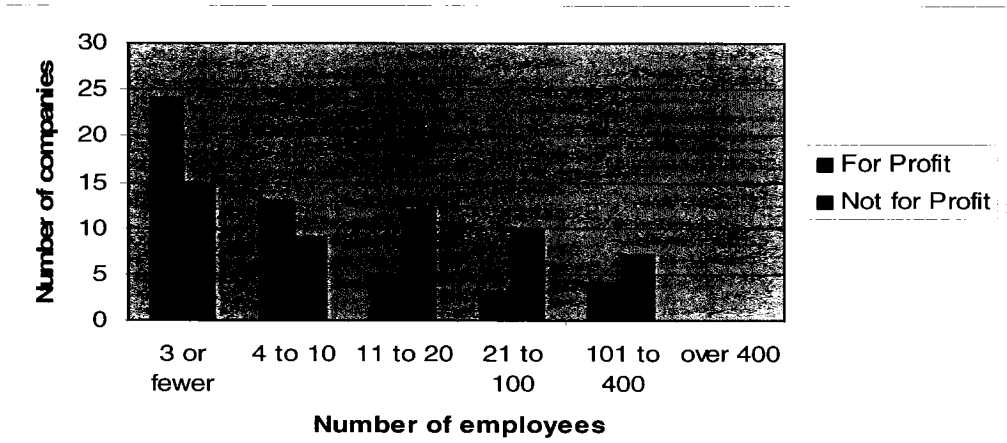
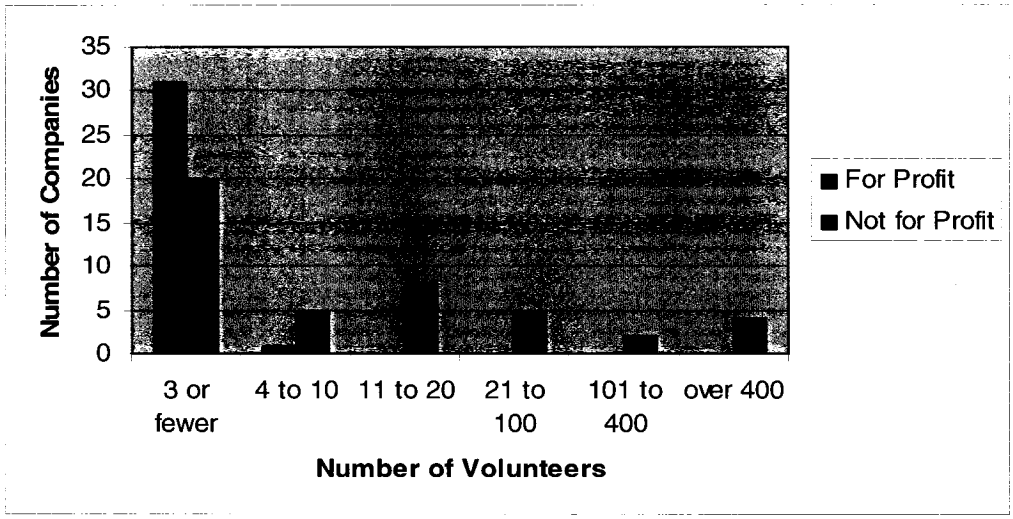


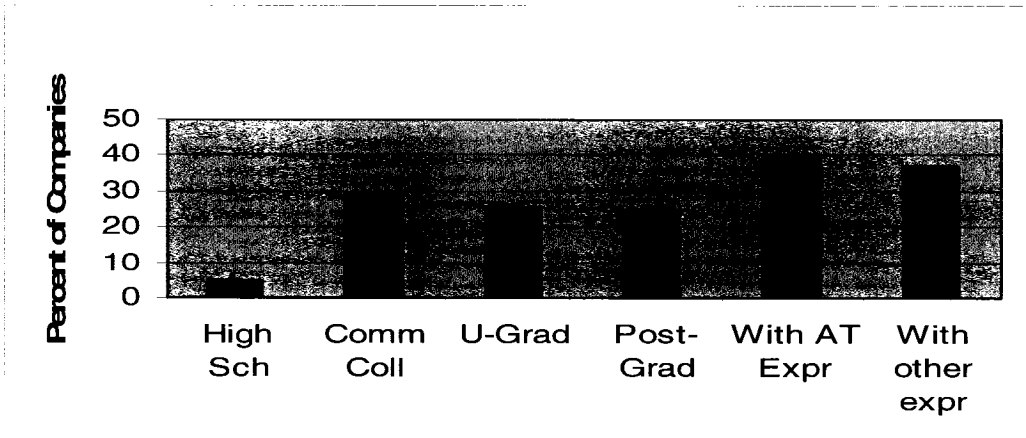
Figure 7: Number of volunteers by type of organization



Recruitment Practices and Challenges

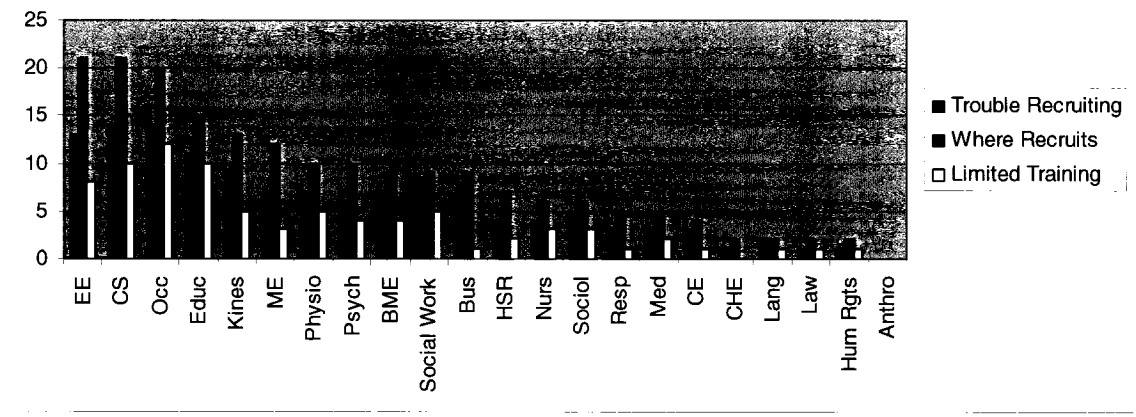
The industry survey asked respondents to identify where their organization usually recruits new employees to work in the field of AT. The most frequent responses indicate recruitment of individuals who have already gained experience either in assistive technology industries (in Figure 8, 'with AT expr') or elsewhere (in Figure 8, 'with other expr'). Community college and university graduates were also recruited by companies between 20% and 30% of the time (see Figure 8).

Figure 8: Areas of Recruitment for Work in the ATI



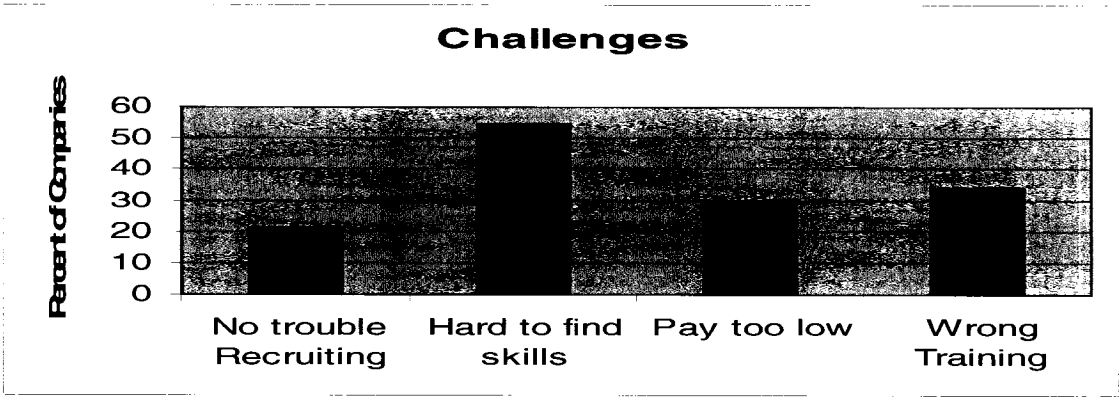
Respondents were asked to identify professional disciplines from which they have been known to recruit staff. They were also asked to indicate (a) whether or not they had difficulties recruiting them and (b) when limited training in each particular discipline was an issue (see Figure 9). The ten most frequently selected disciplines identified here were used as the target areas for the Academic survey participants.

Figure 9: Recruitment Areas and Difficulties



A number of recruitment challenges were identified through the survey, and include: difficulty finding the necessary skills, finding professionals with inadequate training, and not being able to offer competitive pay (see Figure 10).

Figure 10: Recruitment Challenges of the ATI



When respondents were asked to identify their company's current priorities, increasing employee skills, and increasing the number of employees were ranked 5th and 8th respectively out of 10 possible options (see Figure 11). Respondents were asked specifically if they planned to recruit new employees within the next year. Figure 12 outlines their responses by province.

Figure 11: Company indicated priorities

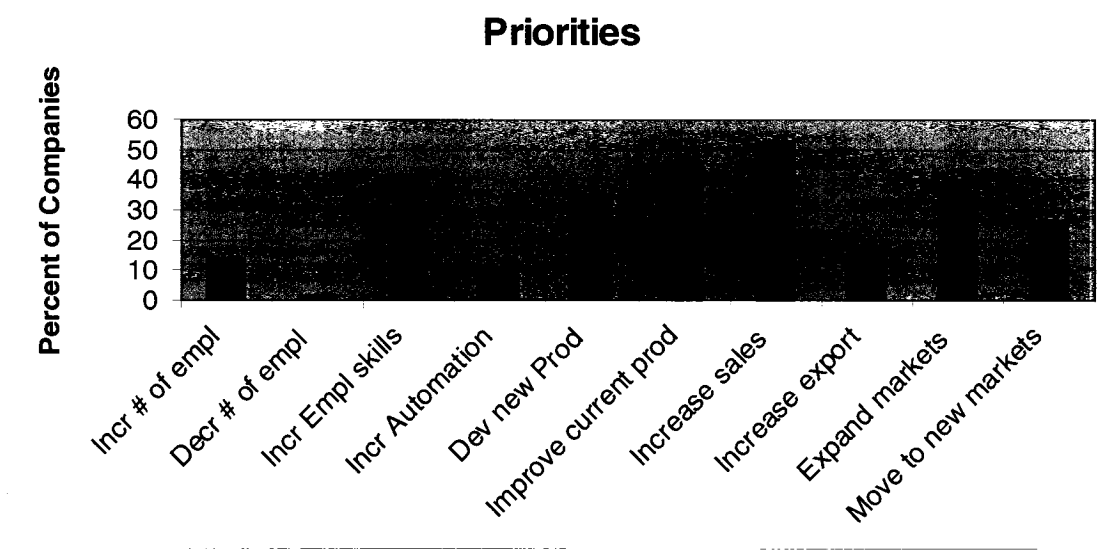
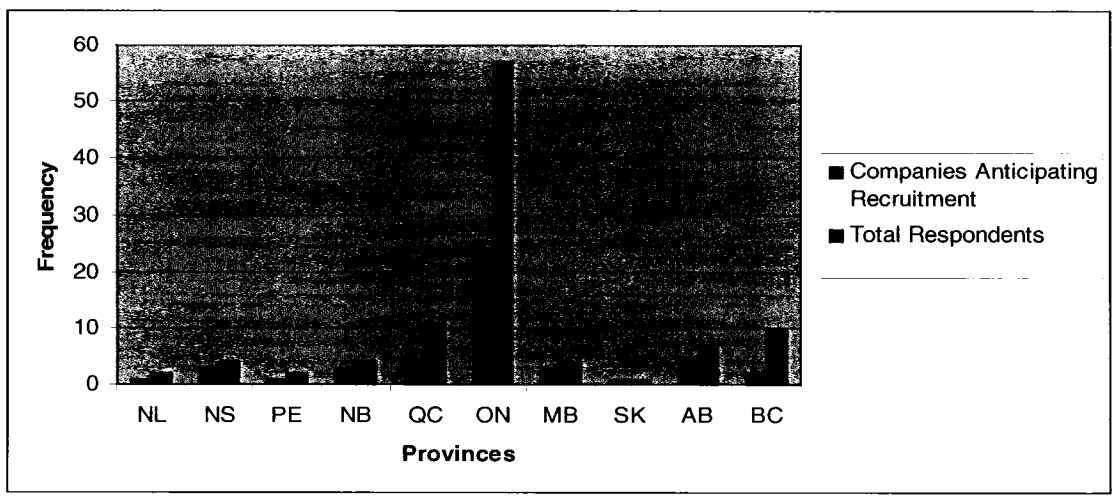


Figure 12: Companies (by province) planning to engage in recruitment activities within the next 12 months, and total respondents per province



Industry - Academia Relations

Industry members were asked to describe how they work with Universities or Colleges. Almost half of the respondents (48%) indicated that when recruiting new employees to work in the area of assistive technology, they made direct contact with colleges, universities or other training and education centres. Excluding recruitment activities, Figure 13 demonstrates additional relationships and activities that AT companies report sharing with academic institutions.

Figure 13: Percent of work activities with academic institutions

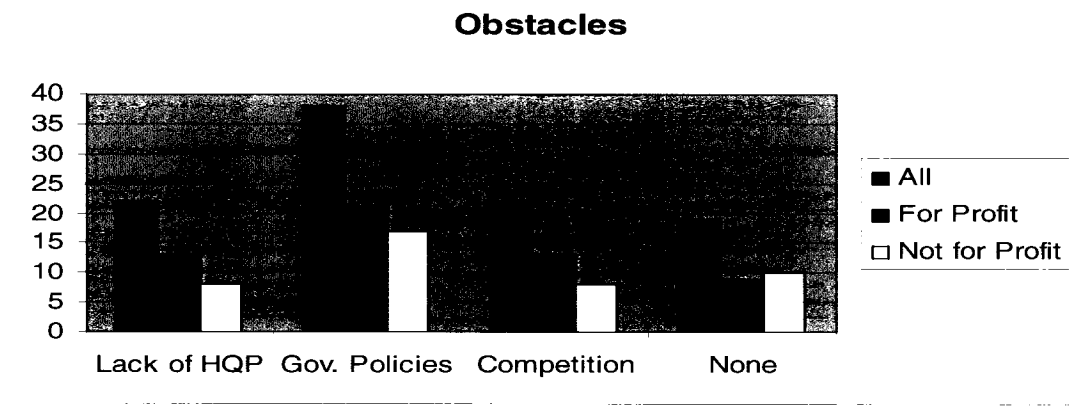
Supports and Barriers to AT Organizations

Although finding the right skills was a challenge specific to recruitment, most organizations do not perceive a lack of highly qualified personnel (HQP) as the main obstacle to overall organizational advancement (see Figure 14). Government policies and regulations were most frequently cited as obstacles (n=37). Important to note is that the second most frequently selected obstacle (n=25) was 'other'. This indicates that a wide range of obstacles – unpredicted by the survey – negatively impact Canadian AT businesses. Of the 'other' responses, over half (n=16) were focused around money.

Specifically, lack of funding and subsidies (especially from government), soft funds, low revenues, low salaries, and the value of the Canadian dollar were all cited as barriers. Additional barriers listed under the 'other' category include:

- Lack of awareness
- Lack of industry cooperation
- Small business size
- Human resources
- Lack of client understanding

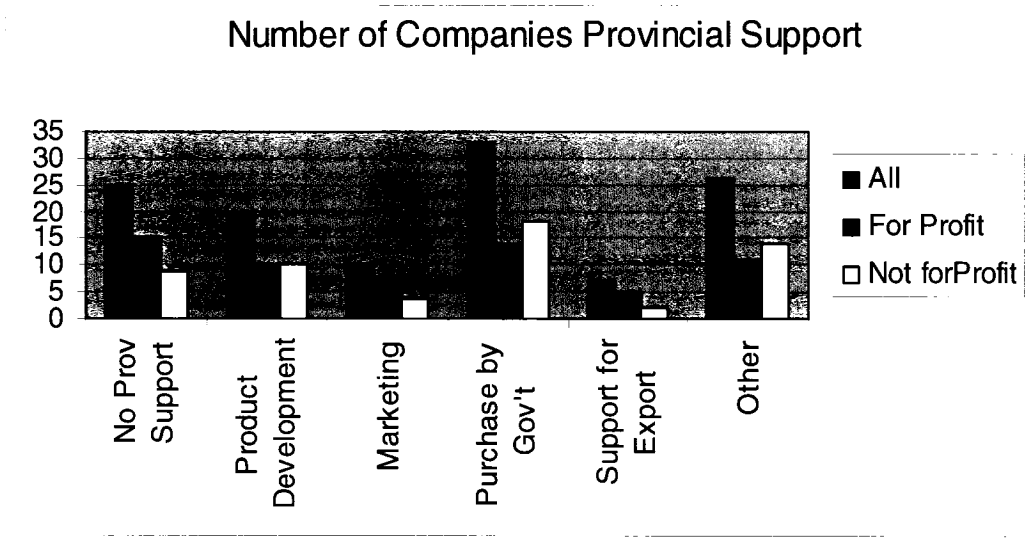
Figure 14: Obstacles preventing advancement of AT organizations



Respondents were asked to indicate ways in which policies and programs in their province support assistive technology (results reported in Figure 15). They were asked to identify all that applied from the following list of options:

- There are no policies/programs in my organization's province that support AT
- Through support for product development
- Through support for marketing
- Through the purchase of products we provide
- Through support for the export of products we provide
- Other

Figure 15: Organizational perspectives of provincial support



For the category 'other', survey respondents listed several examples including: legislation, grants, funding for end users, client consultations, and purchase of services. Although purchasing of products was cited most frequently (n=33), 'no support' was the second most highly selected response (n=25). It is interesting to note also that 50% of respondents from Atlantic Canada indicated that they received no financial support (see Appendix D). On the opposite coast, a similar result finds 45% of respondents from BC also claiming no support. At the opposite end of the spectrum of responses, only 11% of respondents from Ontario claimed to receive no support. Further broken down, the 11% from Ontario come from Eastern Ontario (n=2), Central Ontario (n=4), and Southwestern Ontario (n=1). The implications of these findings and of this apparent perceived lack of support in Canada are highlighted in Chapter Four (see Missing Links).

Academic Survey

Respondent demographics

Of the 39 academic survey respondents, 61% were received from universities (n=24), 33% from colleges (n=13) and 5% (n=2) identified themselves under the category "other" (one was a polytechnique and the other a university-college). Surveys were returned from almost every province, though the response rate was highest in Ontario (n=15). The type of institution within each province is seen in Figure 16. Analysis at a regional level revealed that most responses came from larger cities:

- Nova Scotia: Halifax
- New Brunswick: Fredericton
- Quebec: Montreal, Sherbrooke
- Ontario: Toronto, Ottawa, London,
- Manitoba: Winnipeg
- British Columbia: Vancouver
- Yukon: Whitehorse

Respondents were also asked to identify what type of unit they represented within their institution. The majority of respondents fell into one of the eleven categories listed on the survey, with the most responses coming from education units (19%, n= 8). "Other" categories included: early childhood education, biology, human studies, and ergotherapy/technology. The distribution of the types academic programs (hereafter referred to as units) are illustrated in Figure 17.

Figure 16: Type of academic institution by province

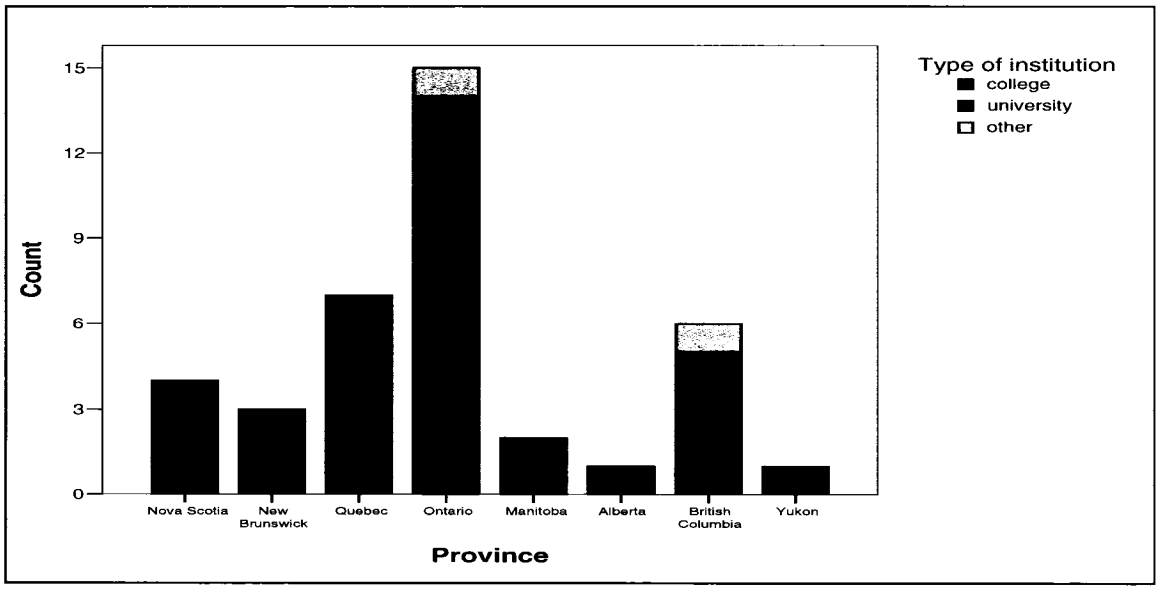
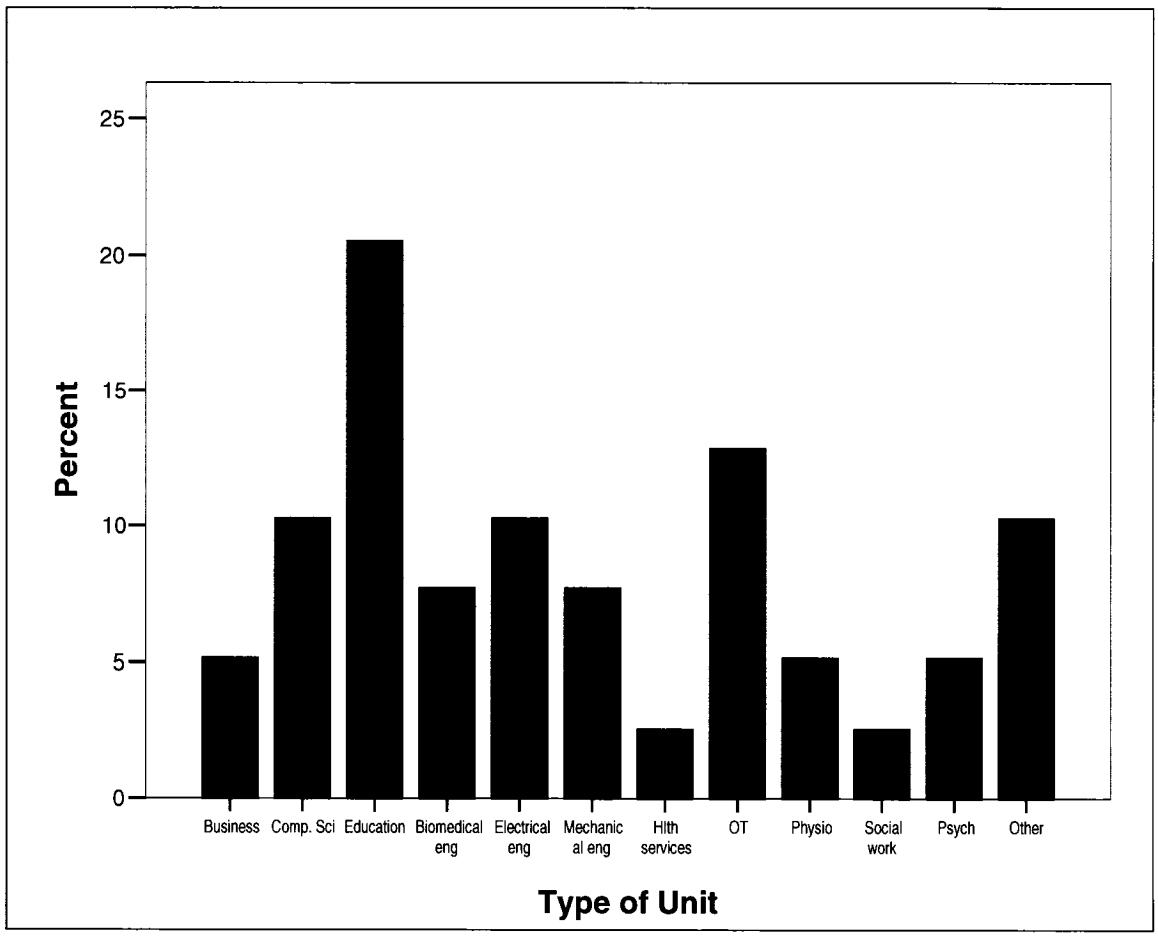


Figure 17: Type of units within academic institutions



Institutional Activities

Another way to understand current relationships between academia and industry is by examining their current involvement in teaching, research, and development in AT related activities. The majority of respondents (57%) indicated that their units do not provide education in assistive technology (n= 22). Of the respondents who indicated that their units do provide education in assistive technology, eleven units provide education that is embedded within different courses, and six units have courses that are specific to assistive technologies. Courses specifically focusing on assistive technologies included:

- Augmented Communication/Assisted Technology
- Advanced Technology
- Using Technology in Schools
- Ergotherapy and Technology
- Ergonomic Design of Biomechanical Devices
- Power Engineering Technology

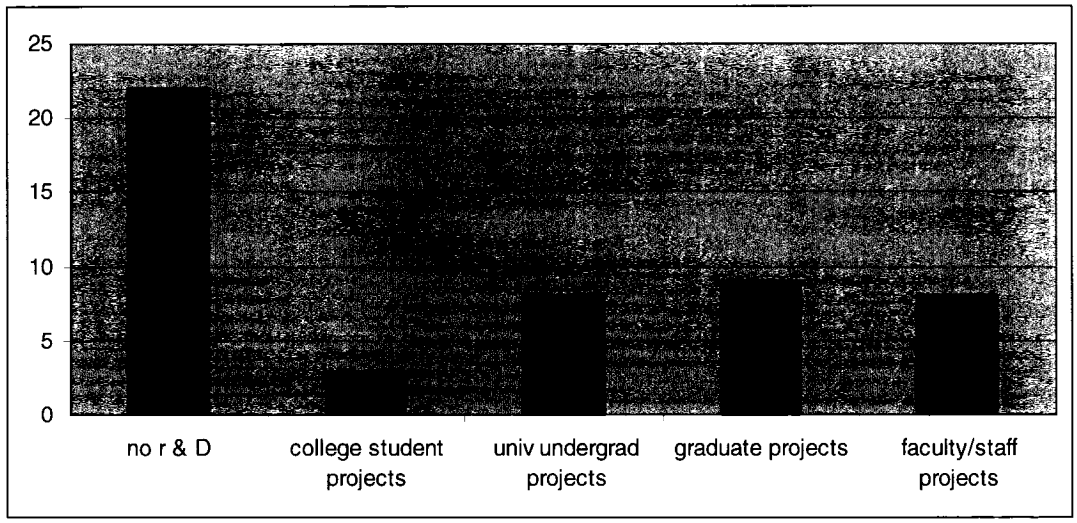
When asked to identify what kind of work in AT that units conduct, almost all respondents (97.4%) indicated participation in at least one of the following activities: training (professional development and students), development (of devices, software, and/or procedures), and assessment (of devices, software, and/or rehabilitation procedures). When looking at these activities across types of institutions, cross tabulations reveal that universities reported activity more frequently than colleges (See Table 2).

Table 2: Activities by type of institution

	College	University	Other	**Total**
Training Students	3	13	1	**17**
Professional Development Training	0	4	1	**5**
Develop Devices	0	5	0	**5**
Develop Software	0	3	0	**3**
Develop Procedures	1	6	0	**7**
Assess Devices	0	4	0	**4**
Assess Procedures	0	7	0	**7**
Other	0	1	0	**1**
Total	**4**	**43**	**2**	

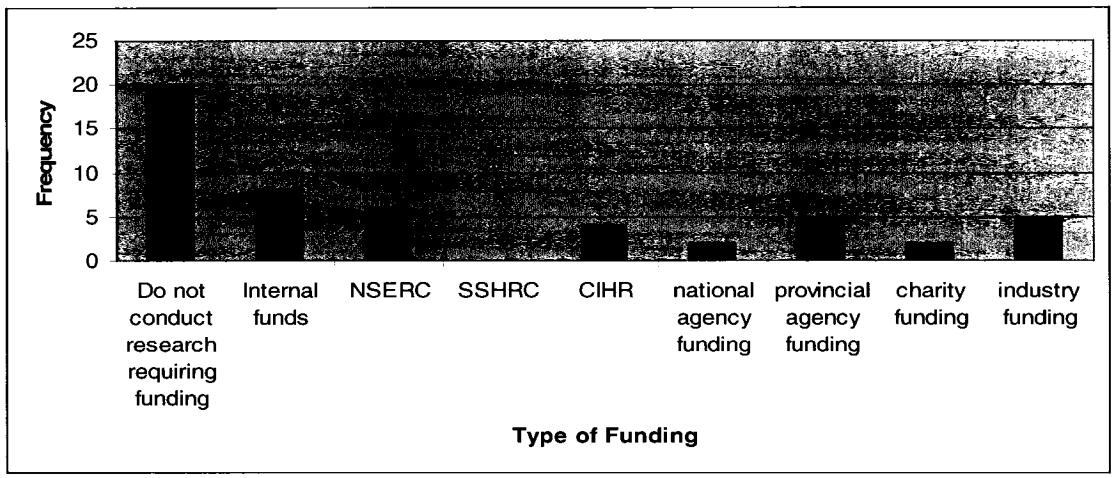
A majority of respondents (56%) indicate that no research and development in AT is conducted within their units. Within the units that do conduct research and development (n=17), activities fall into one or more of the following categories: college student projects, undergraduate projects, graduate student projects, or faculty/staff projects (see Figure 18). Only six of the ten types of units surveyed reported any research activity: engineering (biomedical, mechanical, and electrical), education, occupational therapy, and physiotherapy. Units most frequently indicating involvement in research projects were biomedical engineering (n=7) and occupational therapy (n=7). The implications of limited research capacity will be discussed in Chapter 4 (see page 58).

Figure 18: Frequency of research and development activities by type of project



Most frequently, ideas for research projects originated from staff or students (38.5%). Only 7.7% of respondents indicate that project ideas come from industry. Other sources of ideas for project planning include input from end user associations (17.9%), and project funders (7.7%). However, only half of respondents indicated that they receive research funding. Only five respondents (12.8%) indicated that they receive funding from within the industry. Other funding mentioned includes contracts or grants from provincial or national sources (including NSERC and CIHR), internal departmental or institutional budgets, and charities (see Figure 19).

Figure 19: Funding sources for academic units



Student Attraction to and Employment within AT Industry

Over half of respondents indicated that their students are not attracted to the assistive technology industry, mainly because of a lack of perceived opportunities (n=20). A few respondents also noted a lack of industry presence in their region as a barrier to student attraction (n=5). Just over 10% of respondents indicated that students were attracted to the AT field because of an active regional industry and/or availability of employment opportunities. These respondents were from Ontario (n=3), Quebec (n=1), and British Columbia (n=1). However, a large number of respondents (41%) were unsure whether or not students were attracted to the field. Echoing this sentiment, when asked to describe the importance of the AT industry for providing employment to graduates, the most frequent response selected (n =10) was 'unsure'. Five respondents indicated that the industry was 'important' in providing employment while only one (from an Occupational Therapy unit) indicated that it is 'very important'. Nine respondents indicated that the AT field was 'not at all important' with regards to graduate employment, and within this category were respondents from physiotherapy, computer science, education, and

engineering (biomedical and electrical). Cross-tabulations were run to determine how these results looked depending on type of institution, and type of unit (see Figures 20 & 21).

Figure 20: Perceived importance of AT industry for graduate employment based on academic institution type

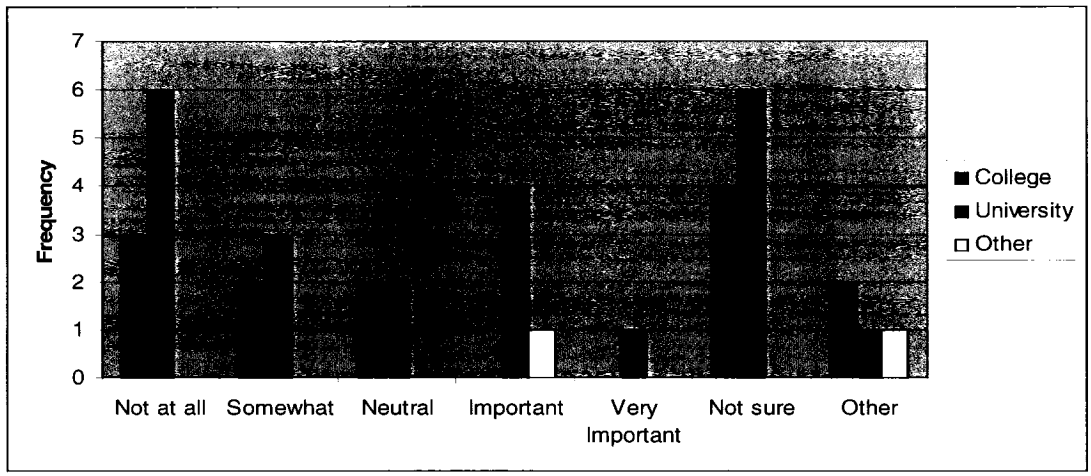
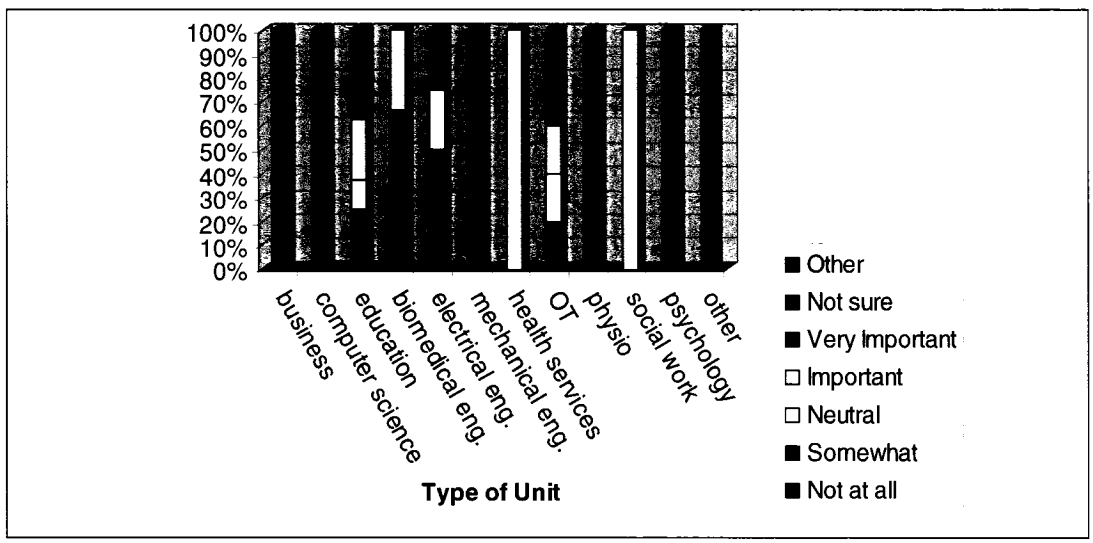


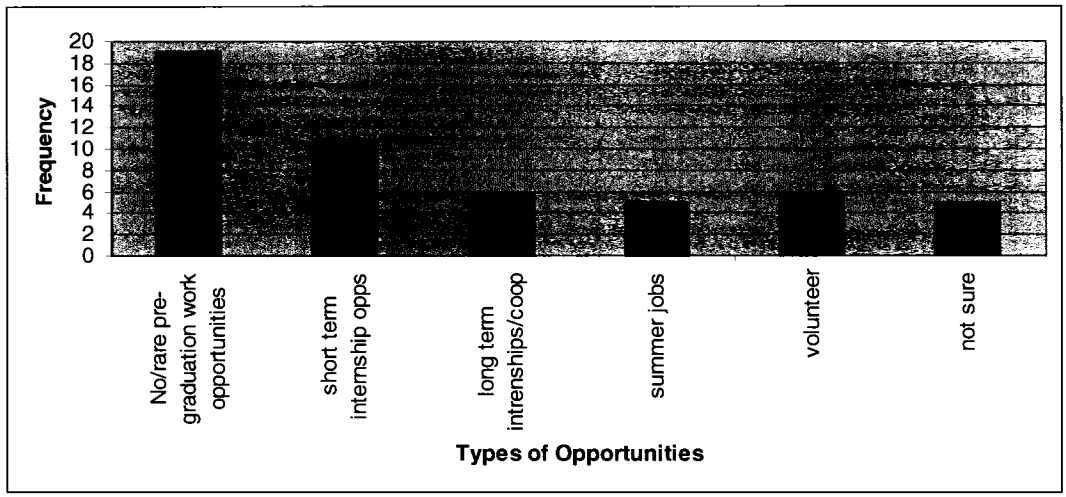
Figure 21: Perceived importance of AT industry for graduate employment based on academic unit type



When asked to estimate the percentage of students who go on to work in AT post graduation, only 33% of respondents provided an answer. Among them, the majority (78%) estimate that 5% or fewer of their graduate students go on to work in AT. When estimating undergraduates who go on to work in the field, over 90% of survey recipients who answered the question estimated the number to be 5% or fewer. The most staggering estimation came from a respondent who estimated that 30% of graduate students and 5% of undergraduate students from his/her unit (occupational therapy) go on to work in AT.

Pre-graduation employment/involvement with AT industry was another topic addressed by the survey. Many respondents (48%) indicated that pre-graduation opportunities were rare. Some respondents did indicate that short term opportunities were available to students. Summer jobs, volunteer positions, and longer term placements (such as co-op) were other examples of pre-graduation opportunities cited by 28% of the respondents (see Figure 22). Those who cited available student work opportunities were predominantly from departments of engineering, education, or occupational therapy. Respondents who indicated they were unaware of what opportunities existed were from departments of business and psychology. As suggested by the results of the industry survey, it appears that these results confirm an overall disconnect, and lack of awareness between academia and the ATI.

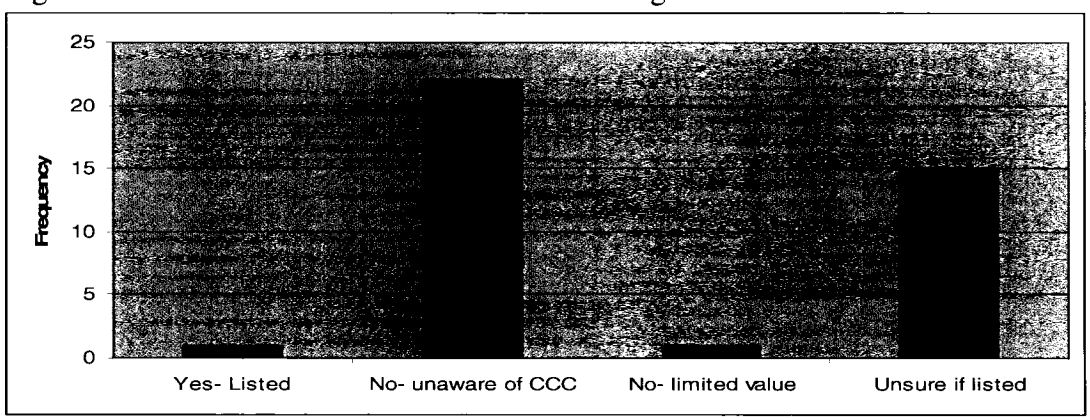
Figure 22: Frequency and kinds of pre-graduation AT opportunities for students



CCC Membership

Academic institutions were asked whether their unit is a member of the CCC. Only one respondent (a Mechanical Engineering unit at a university) responded yes to this question. Many respondents (n= 14) indicated that they were unsure whether or not their unit was a member of the CCC (see Figure 23). Respondents who answered 'no' to membership were asked to explain their answer. The majority of respondents (52.4%) indicated that they were unaware of the CCC. One respondent (a university program in education) indicated that they were aware of the CCC, but did not subscribe to it because the value of doing so was perceived as limited.

Figure 23: Reasons for inclusion/exclusion with regards to CCC database



CHAPTER FOUR: DISCUSSION

The results section provided a descriptive analysis of the survey responses. Although data returned may not constitute a representative sample of the Canadian ATI or all academic institutions across Canada, it still provides a more comprehensive understanding about their demographics, human resource structure, goals, challenges, roles, and activities. From here we are able to interpret and discuss the results observed as they relate to existing literature in the field. The discussion explores trends revealed by the respective surveys with regards to industry and academia respectively, as well as findings that relate to the interactions between them. The final section highlights some 'missing links' that have become apparent throughout the research process. This section specifically identifies other key stakeholders in the ATI that play a role in mediating the success of the industry.

INDUSTRY

Respondent Demographics

The geographic distribution of the Canadian Companies Capabilities Index (CCC) is heavily represented by companies from Ontario (51% of the total). Quebec and British Columbia represent 17% and 15% of the total membership respectively, while Albertan companies provide 8% of the total. The remaining provinces combine to fill the remaining 9% of the sample. Survey results show that the response rate is fairly proportional to the actual population only in the case of Ontario. Over or under-representation of the remaining provinces is an issue with the sample that prevents generalizability. Of the 105 survey respondents, 56 were from Ontario (53%), which is

very close to the representation of Ontario based companies in the CCC. However, in relation to the actual population, Ontario is over-represented (survey representation – 53% vs. percentage of the Canadian population – approximately 37.5%). Quebec (10.5%) and British Columbia (10%) were under-represented in the survey responses compared to the total sample collected from the CCC, and also in relation to their provincial populations. British Columbia represents 13.4% of the total Canadian population, and Quebec 24%. The Prairie and Atlantic provinces – representing 12% and 11% of survey responses are over represented since these groups combined form less than 1% of total CCC companies sampled, and their actual provincial populations contribute only 7% and 6% of the total Canadian population.

Organizational Type

In Canada, the majority of businesses are Small or Medium Sized Enterprises (SMEs), meaning that they employ fewer that 500 employees (see Appendix E). In fact, 95% of businesses in Canada employ less than 50 employees while 75% employ fewer than 5 (Dulipovici & Kahn,1999). The results of the Industry survey are consistent with this trend, as the majority of all respondent organizations have 10 or fewer employees (see Figure 6). The SME categorization is important to consider throughout the discussion of issues affecting the ATI.

Although there is no single commonly accepted definition of SMEs, Table 3 lists some examples of how Western nations define them. Additionally, Canadian definitions specify that companies must be for-profit and incorporated, and that they are not a wholly owned subsidiary of a larger company (CET, 2003). The Canadian Federation of

Independent Businesses also uses the 500-employee mark as their maximum for SMEs. Although half of the survey respondents are not for profit organizations (therefore, not technically falling under the Canadian SME designation), results of the survey support the assumption that they face similar challenges as for profit SMEs due to their equally small size. In fact, for organizations reporting over ten employees, not for profit organizations were more predominant than for profits.

Table 3: SME definitions in Western Nations

Defining Body & Jurisdiction	Defining Characteristics			Reference
	Employees	Annual Turnover (million)	Balance Sheet (million)	
The Companies Act 1985, UK	Small: <50	< $*11.2* (£5.6)	< $*5.6* (£2.8)	(UK 2004)
	Medium: <250	< $*45.7* (£22.8)	< $*22.9* (£11.4)	
European Commission, EU	Micro: <10	< $*2.7* (€2)	< $*2.7* (€2)	(EC 2005)
	Small: <50	< $*13.6* (€10)	< $*13.6* (€10)	
	Medium: <250	< $*67.9* (€50)	< $*58.4* (€43)	
Canada	< 500	< $*50* (annual revenues)		(CET 2003)

Note: italicized sheet figures are in millions of CAD, converted from GBP and EUR (in parentheses) as necessary using XE.com Universal Currency Converter® (available at http://www.xe.com/ucc/).

Organizational Competencies

As described in the results, ATI members appear to be involved in a wide range of activities. It is difficult to generalize core competencies for the population, among the respondents, but the wide range of activity is positive. Work in the area of mobility is dominant, but hearing and vision, ergonomics, augmentative communication, and accommodation consultation are also prevalent. When compared to international activities in ATI, there is reason to believe that we should be proud of the work being

done in Canada. In the UK, there is some concern that the research and development being done in the ATI does not reflect statistics of prevalence of disabilities (Newell, 1998). Newell warns that there is a tendency for hearing impaired and vision impaired populations to be mistakenly thought of as the only ones which need to be considered by researchers and developers. Fortunately, results of this survey show a more even distribution among areas of expertise (refer back to Figure 3).

In the industry survey, 'accommodation consultation' is an area of work with which fewer than 30% of respondents identified. This is an area that has been highlighted as extremely important to build upon in light of population aging. In the UK, experts in the field are urging AT researchers to refocus their energies not on specific disabilities but on building environments for people (seniors in particular) who are more likely to live with a range of mobility, auditory, or visual limitations. Although there has been a great deal of work put into the development of "smart homes", there is concern that it has not been done in partnership with research investigating the special characteristics of elderly disabled people, and the kinds of technological support which is appropriate for them (Newell, 1998).

This trend may also be affected by whether or not an organization falls within for profit or not for profit sectors. In the Industry survey, responses were almost exactly even in their distribution between for profit and not for profit organizations. Some research suggests that the not for profit sector is more tapped into "grass-roots", advocacy type activities that inherently take the needs of end users into consideration (Hutchison et al., 2004). This is seen through affiliations that corporations are building with local

community based organizations, to support the development of research and education to inform public policy (Hutchison et al., 2004). However, the current research indicates few differences existing between for profit and not for profit respondents (specific examples to follow in the discussion below).

Supports and Barriers to Organizational Advancement

Research suggests that programs and policies will better engage SMEs if they address some of the inherent characteristics of the small business context that can act as barriers to organizational advancement (Thompson, 2002; Normie & Gavrish, n.d):

- A lack of resources – SMEs are often short on (1) time, (2) money and (3) human resources. These three issues are explicitly expressed in the survey as real challenges to organizational advancement.
- A lack of exposure – lower public profile means that they have to work harder to market their products and organization to potential employees, clients, and funders. Data from the industry survey suggests that awareness – on the part of end users, government, and academia – is a real issue preventing organizational advancement.
- A reluctance to change – small businesses often have significant inertia; they will not change their familiar practices unless there is an overwhelming reason to do so. This example is manifested in the survey by one respondent in particular who indicated that the only priority his/her company has for the upcoming year is to "maintain status quo".

These issues have also been found in European research focusing on rehabilitation technology. A study by Bueler (2004) noted three main problems hindering the advancement of the field:

1. Lack of information, resulting in the provision of cheap technical aids, where insufficient attention is given to users' needs.
2. Lack of financial resources for research and development.

3. Lack of common European and international standards.

These three trends can also be seen as symptomatic to the issue of lack of exposure and consequently, awareness of the ATI. Lack of awareness was highlighted as a problem perceived by the industry in the current study (see page 37 – Supports and Barriers to AT Organizations). In the United States, the Assistive Technology Industry Association (ATIA) has recognized that a lack of awareness is detrimental to the advancement of the field. To increase awareness about assistive technology and the valuable role it can play in the life of an individual with disabilities the ATIA has commissioned a series of stories from individuals with disabilities whose lives have been changed with assistive technology called "ATIA Triumph Stories" that will be shared in public forums (ATIA, 2007). The stories seek to inspire others with disabilities, as well as inform policy makers of the real every-day value of assistive technology.

In the ATI and in SMEs in general, all of the aforementioned barriers can create a tendency to avoid leading edge issues, because they are thought to be of little practical value, or involve new, expensive and/or untried technologies that are risky to take on (Newell, 1998). This trepidation may also manifest itself as a barrier to organization advancement as it stifles the innovation potential of such organizations (Thomson & Heron, 2006; Shipton, West, Dawson, Birdi, & Patterson, 2006). However, many companies struggle to find the financial means to maximize their innovation potential.

The results of the industry survey indicate that finances act as a barrier to organizational advancement. Specific financial concerns cited were a lack of funding to develop products, a lack of money to pay employees competitive wages, and low revenues. Part of

this problem may stem from a perceived stigma that the ATI carries. Literature suggests that the ATI is often viewed as fragmented with low profitability (Normie & Gavrish, n.d.). The AT market structure is complex (and at times fragmented) as a result of the large number and array of intermediaries involved in product dissemination such as equipment prescribers, procurement, delivery, and sales support agencies (European Commission, 2000). Although these perceptions may be true, this kind of stigmatization can result in low corporate investment in AT product development, making it difficult for organizations to maximize the potential of their outputs (European Commission, 2000).

Similar issues echoed in the research by Hutchison et al (2004), explain that not for profit organizations in the ATI (in particular those with an advocacy role) are particularly dependant on government funding to support their work: funding, according to the results of the current industry survey, as well as the work of Hutchison et al (2004), which is insufficient. Interestingly, not for profit agencies reported barriers less frequently in the current survey across all categories than for profit organizations. Although this was not explained explicitly through the survey, this may be because not for profit organizations are more eligible and likely to receive funding and donations than for profits. One finding to support this assumption is indicated in Figure 15, where it appears that for profit organizations report less provincial support than not for profit organizations.

Although all of the barriers mentioned above do not apply equally to all SMEs or companies within the ATI, these examples provide a selection of issues that policy makers may want to consider as they work to support organizations within the ATI.

Human Resources

There is a growing body of research claiming that Human Resource Management (HRM) is one of the most important factors in determining the success of an organization. Several studies from the UK have linked effective HRM in SMEs with higher financial success, and increased innovation (Veldhoven, 2005 ;Thomson & Heron, 2006; Shipton et al., 2006). Organizational performance (or success) can be improved when specific HR practices are employed: human resource planning (Koch & McGrath, 1996), selectivity in staffing, training, and incentive compensation (Delaney & Huselid, 1996). According to the strategies listed here, results of the Industry survey suggest that AT organizations may be at a disadvantage when trying to maximize organizational performance. This is due to the fact that many organizations reported difficulties in finding employees with appropriate skills and adequate training. Almost half of the industry survey respondents were not for profit organizations that relied more heavily on volunteer services than for profit organizations (see Figure 7). Although volunteers are often highly motivated and dedicated workers, high turnover rate may challenge HRM planning, and limit opportunities for training and incentive compensation that have been linked with organizational performance (Delaney & Huselid, 1996). Not for profits are also challenged by limited resources designated to development of leadership recruitment and strategies (Hutchison et al, 2004). Fifield and Fifield (1997) also acknowledge the challenge of recruiting young talent to the field of AT but have hope that the situation will be partially improved when academic training programs become more standardized. They suggest that in the meantime, 'AT hackers' should be encouraged to join the field: individuals who are not specifically trained in AT but who have outstanding technical and

problem solving skills. This also seems to be a strategy of the Canadian ATI as data from the Industry survey reveals that a number of organizations target recruitment activities to relevant areas that are outside the AT field.

Organizational weaknesses in HRM create a tangible barrier to maximizing the potential of this industry. However, some Canadian organizations are recognizing this obstacle and rising to the challenge through the creation of youth leadership development training events where they can build interest among youth in the field of disability (Hutchison et al, 2004). Interest and awareness of the ATI is discussed in more detail below (see ACADEMIA - Awareness of ATI).

Results from the Industry survey indicate that competition acts as yet another barrier to organizational success in the ATI for about 40% of respondents (see Figure 14). This manifests itself through the recruitment process in a couple of ways. The first way is that companies indicate that they prefer to recruit individuals who already have training in the field of AT, or in their field of expertise (see Figure 8). When recruiting people who are already or have already been employed, the onus is often on the organization to sell themselves to the potential candidate. With some companies citing that they are unable to offer competitive salaries, recruitment efforts are a challenge. This proves to be exceptionally difficult when companies are trying to recruit staff from outside the ATI. The challenge is likely to be more pronounced depending on the profession of employment. In the case of engineers for example, there are a number of markets for which their skill set can be applied, and so the ATI, which has been traditionally viewed

as a low-profit, niche business, must compete with a larger number of related but different, and more lucrative industries (Leifer et al., 2005).

Although recruitment was cited as a challenge by many Industry survey respondents, it is also important to note that just over than half of them (54%) plan to recruit within the next 12 months. They rank 'increasing the number of employees' 5th out of 10 organizational priorities for the upcoming year. Research in the UK has revealed similar trends with regards to recruitment intentions in the field of technology. In the spring of 2005, the Recruitment Confidence Index (RCI) was used to survey recruitment intentions among UK businesses. Results indicated that although one out of two companies planned to recruit employees in the next six months, 45% of companies predicted it would be difficult to find IT people with the skills they need. Shaun Tyson, professor of human resources at the Cranfield School of Management commented on these results indicating that part of the reason for this skill shortage is because organizations generally do not invest enough in the training or development of their employees (Anonymous, 2005).

Manpower's Employment Outlook Survey – also forecasting for spring 2005 – indicated that SMEs in the UK were more likely to increase recruitment activities than larger enterprises. This is important for the UK economy because as in Canada, SMEs make up 99% of British business. The challenge noted here however is that SMEs suffer from the same problems as the rest of the market (lack of skilled labour) but are more severely affected than larger business. This is due to the fact that SMEs are less likely to have internal training structures, and therefore are more reliant on hiring people with the right skills at the outset (Anonymous, 2005). This provides further support for the need to

develop relevant educational training programs in Canada so that companies can recruit graduates with appropriate skills and training from the outset. However, a number of challenges act as barriers to the development of these programs. For example, AT training programs are vulnerable to fluctuations in funding, and staffing, affecting their ability to retain the qualified faculty they need to run such programs (Grey & Colman, 1996; Lenker, 1996; Jans & Scherer, 2006). It is suggested that these and other issues can be ameliorated through partnerships with industry. Collaborative ventures of this sort will be explored later in the chapter, but first, a discussion of how academia is placed within the ATI in Canada and abroad.

ACADEMIA

The role of academia as it relates to training professionals who will go on to work in the ATI is a topic that appears infrequently in published literature (Fifield & Fifield, 1997). However, some of the existing research has been helpful in examining and interpreting results of this research. A discussion of respondent demographics and institutional activities helps to frame the programs that have been identified through the survey and compare them to academia in other countries. Awareness of the ATI is also discussed through the exploration of perceptions held by respondents to the academic survey.

Respondent Demographics and Institutional Activities

The geographic distribution of respondents for the academic survey included representation from almost every province. Although the response rate overall was quite low, responses were highest in Ontario, which is congruent with results from the Industry survey. As reported in Chapter Three, most responses came from larger cities within

provinces. This is likely due to the fact that colleges and universities are often concentrated in more metropolitan areas. In terms of representation within academia, respondents self identified with a range of programs and departments: engineering, occupational therapy, education, physiotherapy, social work, psychology, computer science, ergo-therapy, and business. However, it is important to note that 57% of respondents indicated that their units did not provide specific training in AT. Those who did were primarily based in departments of engineering, education and occupational therapy. Results from the current study are not incongruent with trends noted in a US study which surveyed academic and community based programmes that train professionals in assistive technology (AT). Jans and Scherer (2006) surveyed 55 programmes in 27 states concerning their courses, curricula, and training audiences as they related to AT. Analysis of their survey results indicate that AT training includes multidisciplinary audiences (Jans & Scherer, 2006). Similar to our survey, education, and occupational therapy programs were among those most highly involved in AT training (Jans & Scherer, 2006).

Results from the current survey point to a lack of training in AT among all programs surveyed. The majority of respondents (57%) indicated that their units do not provide education in assistive technology. In the cases of those who do, the majority provide education that is embedded within different courses. This finding is congruent with US education trends revealing that AT is generally taught as a component of another course (Fifield & Fifield, 1997).

The National Center for Education Statistics in the US found that the two most frequently cited barriers to children's use of AT were inadequately trained special education teachers and insufficient evaluation and support staff (Wahl, 2002). Further, a study in California reports that AT training is not sufficiently addressed in professional training curricula for speech and language pathologists, occupational therapists, and other specialists, and that some programs offering certificates or degrees in assistive technology are not producing capable practitioners (ATA, 1999). This problem may be due to the fact that most special and regular education personnel are credentialed without any AT experience. Any training they do receive is through short term in service placements (Wahl, 2002; Fifield & Fifield, 1997).

Also interesting to note is that there is not an especially strong representation on the survey of programs offering training specific to AT like rehabilitation engineering, biomedical engineering, or rehabilitation counseling (see Figure 19). Although these programs do exist in Canada and other nations, this kind of specialized training is the least common of those that focus on AT (Fifield & Fifield, 1997) despite the fact that they have the potential to be major educational contributors to the field (Cooper, 2006); (Peterson & Murray, 2006).

In the current study, it appears that the majority of respondents indicate research and development activities are from Universities as opposed to Colleges (see Table 2). This finding is similar to that of Jans and Scherer (2006), who also noted more predominant activity in AT at the graduate student level. However, the academic survey indicates that an overall paucity of research is being conducted across most programs highlighted in the

survey (see Figure 18). Research from the field of rehabilitative medicine confirms this trend. Frontera et al (2006) explain that in order to enhance clinical practice, research must be supported by a critical mass of investigators working as teams, and that this kind of research capacity is rare in rehabilitation medicine. They fear that sustaining a future for the field will be difficult unless this situation improves. Poor research capacity not only affects academic units and the students in these programs, but also limits general capacity for innovation, thereby affecting the industry as a whole.

A study by Hutchison et al (2004) asked several Canadian consumer driven disability organizations in the not-for profit sector to describe some of the challenges they face in operations. One of their case studies revealed that national consumer organizations emphasize the importance of good research to support their work, but that many organizations struggle to build that capacity internally (Hutchison, et al., 2004). A lack of research experience and training at the university and college level may partially explain the results of the industry survey that indicate that companies have trouble recruiting employees with the skills they need. As more organizations move towards the practice of "evidence based decision making", the value of staffing organizations with employees who understand, and can work within such frameworks is indispensable (CHSRF, 2003). Moreover, if future employees of the ATI are not well trained in research, it will be difficult for them to build research capacity within AT organizations. Therefore, research capacity within academia should be explored in more detail to determine the competencies of Canadian students in this field. The following suggests ways to build such research capacity in the field of rehabilitation.

A summit for rehabilitative medicine organized by the Foundation for Physical Medicine and Rehabilitation, the American Academy of Physical Medicine and Rehabilitation, the American Congress of Rehabilitation Medicine, and the Association of Academic Physiatrists was held in Boston in 2006. During the summit, a framework to guide and develop rehabilitation research capacity was built. Although the content of the summit was specific to the needs of rehabilitative medicine, the principles underlying recommendations developed may be of value to additional AT disciplines. The main components and goals of the framework included the following five strategies, while Figure 24 illustrates a framework to help evaluate the uptake of these strategies:

1. Building a coalition of professional groups and consumer organizations to create a national agenda addressing the issues of funding, capacity-building needs, and public education and awareness

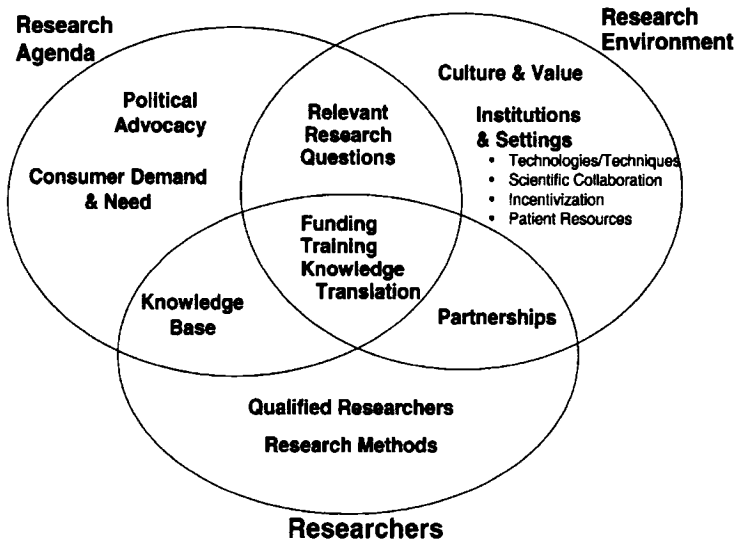
2. Developing training programs in multiple disciplines and multiple levels, ensuring to include women, minorities and students with disabilities.

3. Enhancing funding opportunities for researchers at all stages of their careers

4. Building partnerships and collaboration among researchers of different scientific and professional disciplines, individuals with disabilities and their families, and also practitioners.

5. Building infrastructure by establishing new rehabilitation research programs or strengthening ongoing ones through the sharing of resources within and across institutions and disciplines.

Figure 24. A guide created to help measure research capacity for rehabilitative medicine



(Frontera et al, 2006)

Awareness of ATI

A number of responses to the Academic survey questionnaire indicate that academia generally lacks awareness about the function and potential of the ATI (see Figures 20-23). The majority of respondents were unsure about (1) whether or not their students were attracted to work in the ATI, (2) whether or not their unit or institution subscribed to the CCC/ knew what the CCC was, and (3) whether or not the ATI played an important role in providing graduates with employment opportunities[4]. Limited awareness may be a reflection of the lack of educational training that is specific to AT. As indicated above, training is often limited to on the job training or short workshops, resulting in a lack of clinicians and faculty members who are skilled enough to be able to offer comprehensive

[4] The only unit that indicated the ATI was 'very important' for the employment of graduates was occupational therapy. This is not surprising because although many engineers and computer scientists go on to work in the ATI, there are a number of other industries that compete for their skills. In the case of occupational therapy, the career path is more directed towards work in this industry.

training to students and users of AT (Fifield & Fifield, 1997). Fifield and Fifield (1997) suggest a number of requirements for training and awareness in AT that address the multidisciplinary nature of the audience requiring training (Table 4 outlines the model's major components). Their model covers a continuum of training needs, from that which is very specific and technical to training that is more accessible to the general population.

Table 4: The need for training and awareness in assistive technology

Training Level	Content	Population
AT Practitioners	Professional concentration in AT through interdisciplinary experience Expertise in training, research, development, evaluation and assessment of consumer and environmental needs	Clinical Technology Specialists - OT & PT - special education - rehabilitation
Technical Specialization	Training and experiences in AT design, research, fabrication, software development and customization, testing and evaluation, repair and adaptation.	Technological Specialists - engineers - computer specialists - industrial technologists
Technology Literacy	Competencies to use and apply the technology of one's discipline. Evaluate consumer needs with available technology and familiarity with AT of other disciplines.	Special Disability Providers - OT & PT - special education - rehabilitation
Technology Familiarity	Familiarity with field specific technology: education, communication, employment, recreation etc. Familiarity with sources of information for financing, and customization.	Primary Providers - teachers - counselors - transportation - nurses - administrators
Technology Awareness	Awareness of technology that is available, and where services and information can be obtained. Recognition of the use of technology to circumvent barriers and the benefits of the use of assistive technology.	General Population - family members - public - legislators - business people

Also interesting to note is that 20 of the 39 respondents from the academic survey indicated that their students were not attracted to the ATI because of a perceived lack of opportunities (see page 43). It is unclear whether or not this perception is accurate. The industry survey indicated that many organizations are recruiting but are experiencing difficulties in doing so (see Figures 9 & 10). Academia's perception of a lack of opportunities may simply be a reflection of a general lack of awareness of the ATI on their part, or a symptom of an overall disconnect between these two groups. Whatever the reason, there is ample motivation to bridge this gap. As indicated by the literature reviewed in Chapter One, industry-academia relations are a crucial component of maximizing the innovation potential of the ATI. The current state of their relations revealed through both surveys is discussed below.

INDUSTRY AND ACADEMIA

Industry - Academia Relations

Results from both surveys show that there are some connections and relationships that exist between academia and industry. However, opportunities for students to interact with the industry prior to graduation occurred in less than 50% of the sample. Further, results from both surveys show that joint research and development ventures – found by the literature to be so critical to maximizing the potential of the ATI – are not commonplace. Due to the high proportion of respondents from the academic survey that indicate they do not engage in research and development activities at all, it is difficult to gauge whether the problem may be primarily based in academia. However, trends revealed in the industry survey show that involvement in research and development is on

the low side as well (see Figure 3). This finding has been confirmed by one expert in the field of vision research (Precarn, 2006):

> "What has been lacking in the assistive devices research community is a coordinated effort to bring together researchers from different national and international organizations to benefit from each other's progresses and focus on delivering products to the market faster"
> (John Tsotsos, Director of the Centre for Vision Research, York University)

However, recent events paint a more promising picture for a collaborative Canadian ATI than the one the data presents. 'Intelligent Computational Assistive Science and Technology' (ICAST) was a national symposium on assistive devices jointly hosted by York University and Precarn Inc.. Held in Toronto in October 2006, the purpose of the symposium was to bring together leading Canadian experts in the field of AT to review recent developments in the field and accelerate R&D initiatives to improve the lives of Canadians living with disabilities (Precarn, 2007). Also in Toronto in June 2007, the Festival of International Conferences on Caregiving, Disability, Aging and Technology (FICCDAT) was an event presenting five separate conferences, each focused on enhancing the lives of seniors, persons with disabilities and their family caregivers (Spindel & Fernie, 2007).[5] The conference brings together healthcare professionals, government policy makers, researchers, family caregivers, students, seniors and persons with disabilities to share their research and experience on issues facing aging populations, including the use of assistive technologies (Spindel & Fernie, 2007). A number of key stakeholders involved in these networks were not addressed by the current research.

[5] Results from this overall project were presented at both ICAST and FICCDAT. Results from this thesis were also presented at a conference at the Canadian Association for Health Services and Policy Research conference in Toronto (June 2007): Leading, Linking and Listening: Knowledge Exchange at the Frontiers of Health Services and Policy Research.

However, their roles within the ATI are linked to and affect both industry and academia, and as such they are important to include in any dialogue involving the ATI. The following section ties these missing links to the previous discussion.

MISSING LINKS

In addition to industry and academia, the roles of other players in the ATI are also important to acknowledge not only when trying to facilitate collaboration, but also when building capacity in the ATI in general. Some respondents from the industry survey indicated concern about being misunderstood by academia, end users, and even their own peers (see Chapter Three - Supports and Barriers to AT Organizations). As described above, collaboration is one way to enhance awareness and build capacity in the ATI. Enhancing inter-sectoral collaboration at all levels of community may facilitate this outcome.

Jans and Scherer (2006) cite examples from the United States where community-based, non-profit organizations have offered formal college credit for their AT training by affiliating with a university or college and/or by fulfilling the standards of national or state-credentialing programmes. Many of these organizations were funded under the Assistive Technology Act of 1998 or are members of the Alliance for Technology Access (ATA). The ATA is a network of community-based resource centres, developers, and vendors of AT that provide information and support services to people with disabilities to increase their use of technologies (Jans & Scherer, 2006).

Engaging government in collaborative processes is also highlighted by some literature as being critical to this industry. Results from the industry survey suggest that there is a perceived disconnect between industry needs and government support. Although this perception varied across provinces, results demonstrated that fewer respondents in Ontario perceived lack of provincial support as an issue. This appears to indicate that Ontario companies receive more support than their provincial counterparts. One reason for this may be that Federal organizations supporting the ATI (such as the ADIO) are based in Ottawa, perhaps resulting in a stronger link between provincial and federal efforts, and making support more accessible to Ontarians. However, the feeling of disconnect that prevails in the rest of Canada has been noted in other countries as well. An independent evaluation of the European Commission's Technology Initiative for Disabled and Elderly People also found that government support and involvement in ATI programmes was lacking. They went on to recommend the implementation of a new funding mechanism instituted by the UK government to support product and service flow from academia to industry to the consumer (Normie & Gavrish, n.d). Also reflecting the importance of government involvement in the ATI, research from China provides a conceptual framework for guiding efforts in the technology sector. It uses what is referred to as a 'triple helix of collaboration'.

Miao, Jun and Junrui (2002) explain that a closer interaction among government, industry and academia, has been shown to be more effective at building capacity in science and technology than previous bilateral relationships between academia and government, industry and government, and academia and industry. Although this triple helix exists with high degree of functional differentiation among the partners, collaborative

exchanges are cited as key to success (Miao, Jun, & Junrui, 2003). Industry members must succeed at engaging both government and academia in order to support their work. The concept of the 'triple helix' model can be applied to development of appropriate programming in schools to support the needs of the ATI. If a push for enrollment in educational programs that train individuals for careers that support the ATI is needed, the government could be involved in providing some kind of financing to support recruitment into and development of these programs. By working with stakeholders from industry, academia, and government to achieve a common goal, efforts can be concentrated and monitored more efficiently.

Funding organizations – both governmental and non governmental – are another important piece of the AT puzzle. In the Journal of Technology Transfer, Russell Bessette (2003) explains that twenty-first century, university-based research – especially that which involves high technology – is getting more and more expensive. This requires academic institutions to rely on funding agencies, both private and public, for support. Despite the challenges in measuring economic output, several benefits for investors involved in university based research have been noted (Bessette, 2003):

1. Outputs benefiting *private* investors (including for profit and not for profit companies):

- New products and license agreements resulting in revenues
- Manufacturing improvements leading to cost savings
- Trained graduates hired by investor company
- Knowledge spillover – enhanced innovation by bridging academia and industry

2. Outputs benefiting *public* investors (including government):

- New jobs created (average annual salary per job)
- Retained jobs (average annual salary per job)
- Tax revenues
- Secondary impact of worker's spending to local economy

Although benefits may differ for different types of investors, there appears to be ample reason to invest in high tech academic research. However, research areas that are perhaps less profitable (such as education) also require funding to support research and training. In the current academic survey, approximately one half of respondents indicated that they receive no research funding (see Figure 19). Indeed, Bessette (2003) argues that good science plus good business equals wealth and opportunity for all citizens, but the value of research that maximizes stakeholder investments cannot be understated. Although some academic institutions received funding from NSERC or CIHR, a different kind of funder, which was not listed on the survey, may provide a new approach to research that builds in a high potential for collaboration. Below, a case example of this type of organization is described.

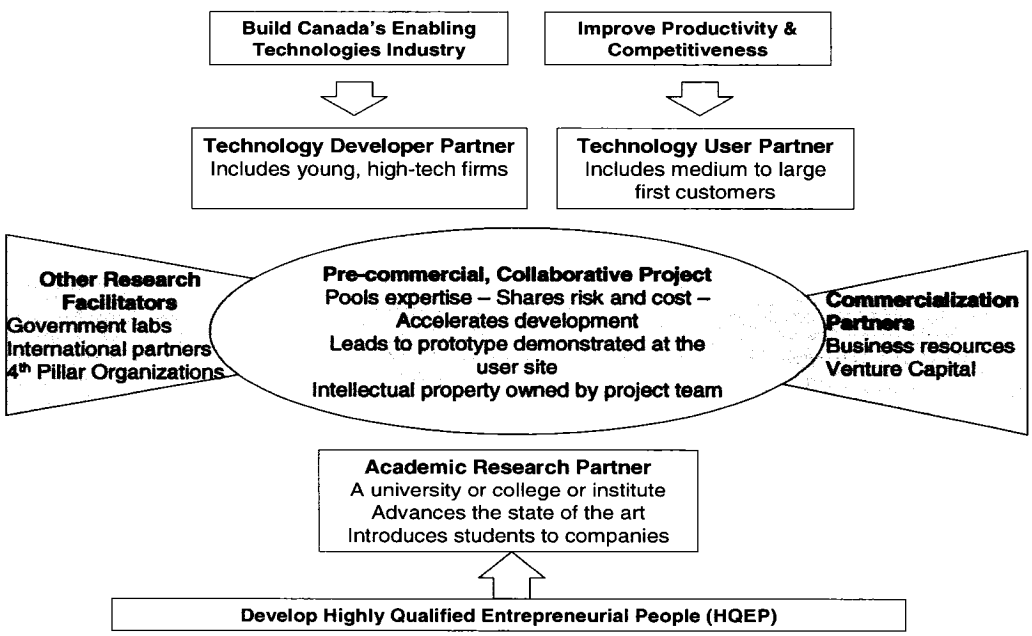
Bridging the Gaps

Precarn Inc. describes themselves as a "4th pillar" organization, which means that they facilitate collaboration among the three traditional pillars in our economy: industry, academia, and government (Precarn, 2007). Their focus is on the growth of the intelligent systems industry in Canada (including AT), with particular focus on SMEs, and they accomplish this through several mechanisms:

- Creating networks of industry and university leaders
- Building partnerships and collaborations to undertake research and development
- Creating a national, cross-sectoral vision for research and development excellence
- Developing, attracting and retaining highly qualified people

Precarn (2007), a not for profit organization based in Ottawa, has developed a model to help collaborative teams undertake high-risk research on technical challenges associated with new market opportunities. The model fosters collaboration and innovation (see Figure 25) in an attempt to help Canadian companies commercialize their new ideas to get an edge in global markets. This model – intended to boost productivity and innovation – might be a valuable addition to AT organizations (either academic, or commercial) looking to enhance their own capacities for collaboration and/or commercialization.

Figure 25: The Precarn model of research and development collaboration



(Adapted from Precarn, 2007)

A key component of this model is its inclusion of government, end users and academia in research projects. The involvement of end users adds value to the research process by acting as built in market tests. Seale, McCreadie, Turner- Smith, and Tinker (2002) explain that older adults – very capable, critical and active consumers of AT – are more frequently being involved in its design and evaluation. Including end users in focus groups gives them the opportunity to describe the difficulties they encounter, and suggest practical ideas that can be addressed by more scientific and design research. The inclusion of academia in industry based research allows students the opportunity to bring their knowledge to Canadian employers, thereby facilitating what is known as 'technology transfer'. The principles and value of technology transfer will be discussed in the following chapter that explores recommendations for future research.

This chapter has explored results from two original surveys and paired findings with existing literature to form a more comprehensive image of the Canadian ATI. The discussion has also brought to light some new concepts that were not necessarily included in the research objectives but that tie in well with the themes discussed. It has also provided some applied and practical examples of how work in the ATI can successfully engage all relevant stakeholders in the field. The following chapter will highlight some of these areas, making recommendations for the direction of future research.

CHAPTER FIVE: CONCLUSION

Based on the information collected through the survey analyses and the review of relevant literature in the field, this chapter summarizes insights gathered about two major stakeholders in the Canadian ATI: academia and industry. The chapter concludes by highlighting recommendations for further research, as well as a number of potential implications for relevant stakeholders.

KEY FINDINGS

Three key messages interpreted from the current study are listed below. They are supported by additional facts drawn from the current research and literature reviewed.

1) Academia is not meeting the needs of the Canadian ATI by producing the skilled labour required for the field:
   - AT organizations have difficulty recruiting staff members with adequate training
   - Universities have more programs related to training in the ATI than do colleges, but overall, there are few programs and courses at either level offering training that is at all specific to AT.
   - Programs providing the most training are education, rehabilitation sciences (occupational therapy in particular), and applied sciences (electrical engineering and computer science in particular). Other programs (with high innovation potential) like biomedical or rehabilitation engineering, are present but not yet prominent.

- Training for AT within academia is limited and is mainly embedded within other course material
- Research related to AT appears infrequently in academia, and occurs mostly at the university graduate student or faculty level

2) An overall disconnect currently exists between academia and industry acting as a barrier to innovation:
   - Joint research and development ventures – found by the literature to be so critical to maximizing the potential of the ATI – are scarce
   - Awareness of the ATI on the part of academia is low, restricting the potential for student involvement
   - Pre-graduation opportunities for students to gain practical knowledge and exposure to the ATI are rare

3) The ATI is vulnerable to a number of external influences and key players:
   - Industry members perceive that the main barriers to their advancement are related to federal and provincial government policies and regulations, and a lack of funding
   - Small and Medium Sized Enterprises are the predominant business type, and are therefore susceptible to a lack of resources, human resource management challenges and low exposure

The impact of these findings on the ATI in terms of both policy and practice are significant. The apparently fragmented and inconsistent nature of the training and research related to the ATI results in an industry with limited capabilities. The current

research paints a picture of AT related work that has been mainstreamed throughout our education system: there are bits and pieces of it covered in a variety of courses, but not in a way that provides justice to the importance of the subject itself. Stephen Lewis warns of the danger of this trend, as he believes that once you mainstream an issue it becomes "everybody's business and nobody's business. Everyone's accountable and no one's accountable" (Lewis, 2005:124). He further explains that mainstreaming might work if a general platform of equality already existed, but since it does not, spreading good intentions too thinly simply results in greater entrenchment of inequalities (Lewis, 2005). A lack of strong governance for the ATI is likely part of the problem.

Some might argue that the ADIO is accountable in this case. Although the ADIO works tirelessly to support the needs of this industry, it is unreasonable to expect that with their limited budget and staffing they will be able to support a truly comprehensive effort to guide the needs of this complex industry into the future, especially given an anticipated growth in demand. Thus, maximizing the potential of the ATI will take a comprehensive effort that involves a number or stakeholders in a strategic way.

One reason that may explain the apparent lack of dedicated resources and interest in the industry is because of its reputation, or lack thereof. Although the industry carries out a vast range of activities, it must not be forgotten that a significant proportion of the industry is devoted to improving the health of others through the application and distribution of technology. In many cases (and depending on the province) the industry provides services and products that simply aren't covered by provincial health plans, despite the fact that they may bring great benefit those who use them. Therefore, the ATI

should be viewed as more than just an industry who is out to turn a profit – but as a diverse and skilled group of organizations that are providing essential services to the population. Instead of remaining as they are - a neglected area in the spectrum of health services - provincial and federal policies and programs should acknowledge the key role they play in maintaining and improving the health of millions of Canadians. A number of suggestions presented below address these and other issues. It is hoped that they might be considered when planning future research projects or programmes related to the ATI in Canada.

FUTURE RESEARCH

Results from the current surveys have provided valuable information with regards to how academia and industry exist within the ATI. However, like most research, the process has also unearthed additional questions that were beyond the scope of the current study. This section presents strategies and areas that should be considered in future research in order to answer some of the questions not addressed by the current study, while also addressing the three key findings identified above.

Motivation and Type

To begin, it should be acknowledged that the motivation for replicating or building upon the current study is compelling, especially due to the low response rate in the academic arena. Although this presented challenges for analysis and generalizability of the data, it must be viewed as an important finding in itself. The reason for the low response rate may have been due to the methodological limitations of the survey administration acknowledged in Chapter 2. Alternatively, it may simply be the result of respondents

choosing not to respond to a survey on a topic with which they could not identify. One early response from the Academic survey supports this assumption. One respondent replied to the invitation email explaining that they did not complete the survey because it was completely irrelevant to them. Although we will never know why the survey was irrelevant to them, this type of response is still very informative. Awareness of the ATI was raised as an issue on the part of academia, but may also be due to the overall disconnect between a number of stakeholders in this industry. These issues need to be explored in more detail by a study with the means to engage academia at a more direct level. This will help to begin to explain and resolve the issues identified in the first key finding noted above, which highlights the role of academia in training future employees of the ATI.

Another consideration that might be taken into account when developing future research is related to temporal relationships to address the second key finding of the study: the disconnect between academia and industry. The current research is cross sectional, and as such, it captures only a static image of the existing relationships between the ATI and academia. Some research has suggested that due to the evolving nature of industry there is tremendous value in monitoring the temporal aspects of professional partnerships (Santoro & Gopalakrishnan, 2000). Targeting and monitoring specific collaborative ventures between academia and industry longitudinally might be a template for future studies. In the field of technology new discoveries and advances are being made at such alarming rates that AT rarely becomes publicly available before newer models are already in development (Fifield & Fifield, 1997). Although this sometimes acts as a barrier to developing training programs for AT, the temporal nature of learning in this

field would be beneficial to consider in future studies. Along these lines, one thing not distinguished in the current study is whether AT training focused on building awareness or competencies. Some suggest that fear and avoidance of technology increases when training focuses on competencies rather than awareness (Thorkildsen, 1993). Especially considering the low response rate to the current academic survey, further studies that explore AT training in Canada are not only warranted, but overdue. Now that broader aspects of future studies have been addressed, more specific recommendations related to the focus of future research will be presented.

Focus

The recommendations that follow respond to the issues identified in the third key finding of this study – external influences and stakeholders that impact the ATI. This overall project focused only on three of the major stakeholders in the ATI: industry, academia and end users. Federal and provincial government agencies (although important stakeholders in the ATI) were purposely excluded from the current study. Through the research process, additional key players have been identified. Of particular note are the employees/potential employees of the ATI and the professional associations by which they are represented. Described below are ideas about how each of these stakeholders could be involved in future research contributing to the dialogue on the ATI.

Employees and Professional Associations

When asking questions related to the supply and demand of labour within a given industry, surveying the current and potential workforce is critical. Surveying students and employees of the ATI would provide a more accurate understanding about factors

influencing their decision to pursue or avoid engagement in the ATI, such as salary expectations and employment goals. Especially as a large segment of the current workforce approaches retirement, some organizations feel that recruitment of their future leaders should be top priority as they recognize that the goals and needs of these future employees may be different than those of the past:

> "Maybe our organizations have to find new ways of being attractive to young people. My sense is that many of the younger people are interested, do have passion... but their commitment is probably shorter term and their focus is much more specific. They're not taking a twenty-year view, they're taking a two or three year view" (Hutchison et al, 2004: Focus Group with Consumer Organization 1).

One way to learn more about the employees and students of the ATI is by engaging the professional associations that represent them. Professional associations of the 'disability disciplines' include rehabilitation, occupational therapy, physiotherapy, special education, speech and hearing, and some kinds of engineering. Some of these associations (e.g. American Occupational Therapy Association, American Speech, Language and Hearing Association) have paired with the Rehabilitation Engineering and Assistive technology Society of North America to develop new curricula for students and professionals already employed within the ATI. The Canadian Association for Occupational Therapy (2006) also has a number of resources designed to help educators meet a variety of professional development and education needs. Work like this should increase opportunities for in service training that result in increased teaching competencies at the pre service level.

Government Agencies

Government was another stakeholder group that is identified through the current research as a key contributor to the competencies of the ATI. Many respondents indicated that a lack of government support through financial contributions and policies acted as barriers to organizational advancement (see Figure 14). Research from the United States indicates that training opportunities and awareness of the ATI in general has been stimulated by the enactment of AT related legislation like the 'Technolgy Related Assistance for Individuals with Disabilities Act' (Fifield & Fifield, 1997). It would be beneficial to gain a more in depth look at government activities and policies that facilitate or inhibit the growth potential of the ATI in Canada. With financial support from the Green Shield Canada Foundation, a consortium of Atlantic Canadian Universities is exploring some of these issues through a three phase programme of research. The first phase seeks to map AT related services in Atlantic Canada. Specifically they will look to Departments of Health, community services, workers compensation boards, charities and non-governmental organizations to see what services are provided, and how they are accessed. The second phase of the research will explore the feasibility of creating single entry access to AT services, similar to the framework currently in place for home care services. The third phase will involve the development of AT related educational materials for health professionals.

Research of this nature might not only look at the role of policy in mediating the development of AT in general, but also of universal design, and the interactions between them. Universal design differs from AT because the approach creates products and/or environments that are designed, from the outset, to accommodate individuals with a

wider range of abilities and disabilities than can be accommodated by traditional applications (Story, Mueller & Mace, 1998). A comment made on the industry survey by one respondent highlights an issue related to universal design that may value more in depth exploration:

> "There is no incentive for manufacturers to meet the needs for persons who are differently able because policies do not encourage universal design. Funding for appropriate products is not offered..."

Although its role is highly valuable, a word of caution is offered to policy makers entering the realm of universal design: as stated earlier in this chapter, mainstreaming of AT and accessibility issues must not take place without the presence of a strong unit that is solely committed to the surveillance and advanced development of this industry. If not, the risk is run of accessibility becoming everyone's concern but no one's responsibility (Lewis, 2005). Due to the complex nature of this industry, there are undoubtedly countless challenges associated with streamlining and refining it to maximize its potential, and these challenges cannot be overcome without a concerted effort and involvement by government departments at provincial and federal levels. Of particular note are Human Resources and Social Development Canada (housing the Office for Disability Issues), Industry Canada (housing the Assistive Devices Industry Office), and provincial/territorial ministries of Education. It is recommended that these units review the strength and nature of their shared interactions and also their relationships with the other two stakeholders explored here. By combining the results of this overall research project – integrating the results from the end user study with the current study – these agencies should have a better idea where there work should begin.

This next section highlights an area which may offer some hope in meeting this challenge. It is a practice or discipline that attempts to bridge all of the stakeholders involved in research – government, academia, industry, end users, and communities is known in the literature as technology transfer. It is a topic beyond the scope of the current project, but its theories and practices would be valuable to consider when embarking upon future research endeavors in this field.

Technology Transfer

Technology transfer, if applied correctly, could help the ATI maximize its potential by instilling a more comprehensive and applied approach to research and development of innovative technologies. The previous chapter highlighted the Precarn model, a framework for collaboration from which technology transfer can be successfully launched. Although it has no single agreed upon definition, some say that technology transfer is a process that encompasses a continuum of related activities from laboratory innovation through market consumption (Lane, 2003b). Operationally, Lane (2003b) defines technology transfer as:

- What: the novel application of existing technologies or prototype devices,
- Who: by members of multiple stakeholder groups,
- Where: operating through research and development facilities,
- When: collectively viewing transfer as a feasible and attractive option,
- Why: to commercialize an innovation or address an unmet need,
- How: through the synergistic matching of capabilities to needs.

The value of successful technology transfer can be especially beneficial in AT for both academics and industry members. Academia benefits from technology transfer when their

research and design succeeds at reaching the industry members who can develop and market innovations to those who benefit from its use. Lane (2003b) highlights some of the challenges associated with successful transfer in an academic setting:

- Defining the institution's role and focus in technology-based innovations.
- Maintaining academic independence while affiliating with corporate interests;
- Balancing faculty involvement in commercial endeavors with their university responsibilities;
- Reconciling a low yield from an internal supply of early stage technologies, with high institutional and State government expectations; and
- Developing the knowledge base underlying technology transfer as a discipline.

Despite the value of technology transfer in an academic setting, Lane (2003b) argues that it is private organizations that truly have the most at stake in the transfer process because they have the capabilities to transform a technology into a product and sustain its presence in a competitive marketplace. Corporate technology transfer issues include: formalizing authority for, and rewarding participation in, transfer activities; establishing methods and metrics for business planning and implementation; and, identifying and internalizing industry examples of successful transfers. The discipline (though not the practice) of technology transfer is still young, but is a component that is more commonly being built into research proposals and programmes (Lane 2003b). Despite the challenges of technology transfer in the ATI because of the size and diversity of the market, its successful application can bring together mainstream science and technology with AT, resulting in close collaboration with a range of stakeholders in the field (Stone, 2003; European Commission, 2000). Therefore, frameworks for and examples of successful

technology transfer should be included in future research examining the competencies and potential of the ATI in Canada.

Summary

The above recommendations provide suggested directions that future AT research may take. It is evident that in order to maximize the potential of the ATI, a range of issues must be taken into consideration from a variety of perspectives (i.e. design/technology, socio-economic/policy, health/human service). The discussion and recommendations have suggested a number of strategies and frameworks that can be used as models to address the gaps in this growing field. Whichever recommendations, if any, are adopted, the hope is that by continuing work in this field, lines of communication will be opened among all stakeholders, resulting in (1) an academic system that engages students in multiple disciplines to work towards applying technical and creative skills to solve social and environmental barriers to accessibility; (2) a research environment that is engaged and in touch with industrial needs and activities, maintaining relevance to society as a whole; (3) provincial and federal governments that are informed and dedicated to maximizing the potential of this industry by supporting and engaging all stakeholders in strategic dialogue and action. Most importantly, as Peterson and Murray (2006) reflect, innovative and original research in this field can be used as a vehicle to help achieve more noble goals including skill and competency development, full participation in society, and integration into local communities, thereby resulting in increased quality of life for people using AT services.

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APPENDIX A: THE ADIO LIST OF ACADEMIC PROGRAMS AND PROJECTS IN CANADA

ADAPTECH PROJECT

Dawson College
3040 Sherbrooke West
Montreal, Quebec
H3Z 1A4

Organizational Notes:

The Adaptech Research Network consists of a team of academics, students and consumers. We conduct bilingual research on the use of computer, information, and adaptive technologies by Canadian college and university students with disabilities. We are based at Dawson College and are funded by both federal and provincial grants. Our work is guided by an active and enthusiastic cross-Canada bilingual Advisory Board.

Our goal is to provide empirically based information to assist in decision making that ensures that new policies, software and hardware reflect the needs and concerns of a variety of individuals: college and university students with disabilities, professors who teach them, and service providers who make technological, adaptive, and other supports available to the higher education community.

http://www.adaptech.org

ADAPTIVE TECHNOLOGY RESOURCE CENTRE

Faculty of Information Studies 140 St. George Street
Toronto, Ontario
M5S 3G6
http://www.utoronto.ca/atrc

CAMBRIAN COLLEGE

The Glenn Crombie Centre for Disability Services
Room 2517A
1400 Barrydowne Road
Sudbury, Ontario
P3A 3V8
http://homepages.cambrianc.on.ca/pathways

CONCORDIA UNIVERSITY

Department of Computer Science
1455 de Maisonneuve West
LB 901
Montreal, Quebec
H3G 1M8

Organizational Notes:

Affiliation: Concordia University, Computer Science Department. About 30 full time professors engaged in research. Two of them are directly interested in research areas relevant to the physically handicapped: Dr. T. Radhakrishnan and Dr. C. Y. Suen. The Chairman of the Department is Professor G. Martin.

1. Speech based software and hardware systems to assist the visually handicapped and the learning disabled. Research is focused on User Interface aspects and in providing seamless interaction with displayed objects;
2. Braille display (soft Braille) and the design of affordable personal braille embossers based on the microprocessor technology;
3. Time-sharing a single (set of) system for simultaneous use in classroom teaching for visually handicapped children in developing countries. This is in the direction of technology transfer;
4. Application of AI techniques and knowledge based systems approaches to present multimedia documents to the visually handicapped;
5. Interaction aids for the motor handicapped using speech recognizers and dialogue controllers;
6. Concordia has set up a Centre for the Services of Disabled Students which has all the modern equipment and offers some (non-credit) training courses. It also employs some physically disabled individuals. Director, Leo Bissonette.

http://encs.concordia.ca

DISABILITY RESOURCE CENTRE

University of British Columbia
1860 East Mall, Room 1874
Vancouver, British Columbia
V6T 1Z1

Organizational Notes:
All areas of access to post-secondary education by persons with disabilities.
http://www.students.ubc.ca/access/drc.cfm

McGILL UNIVERSITY

School of Communication Sciences and Disorders
Beatty Hall
1266 Pine Avenue West
Montreal, Quebec
H3G 1A8

Organizational Notes:

Faculty research interests include the study of normal and disordered speech, language and hearing processes in children and adults, and the clinical applications of that knowledge to assessment and intervention.

http://www.mcgill.ca/scsd

NATIONAL CENTRE FOR AUDIOLOGY

The University of Western Ontario
Elborn College - Room 2300
London, Ontario
N6G 1H1

Organizational Notes:

The National Centre for Audiology (NCA) was created in 1999, by The University of Western Ontario, with support from the Canadian Foundation for Innovation (CFI), the Ontario Research and Development Challenge Fund, and private donors. A comprehensive, research, teaching and clinical centre, the NCA focuses on the evaluation and the improvement of hearing health care services. The NCA's assistive technology projects include

1. the Desired Sensation Level (DSL) Method for selecting amplification characteristics for personal hearing aids
2. Listen-Hear, a software system for helping children who wear hearing aids or have a cochlear implant to develop spoken language
3. HATS, a novel hearing aid test and measurement system for use with modern DSP hearing aids; and
4. IVANS, a system for the analysis of vocal function and the diagnosis of voice disorders.

Previous work in NCA labs also lead to the development of CSRE - a software system for speech sampling, editing, playback, measurement, analysis, synthesis, and testing using PCs which is used in more than 50 countries. NCA projects are undertaken in collaboration with specific industrial and clinical partners, to ensure that the technology developed is applied rapidly to the benefit of consumers. Three NCA researchers (D. Jamieson, R. Seewald and V. Parsa) are also members of the Hearing Team of ORTC,

described in a separate entry. The focus of the ORTC Hearing Team is the development, evaluation and production of improved technologies to assist hard of hearing person communicate with others.

http://www.uwo.ca/nca

ST. MARY'S UNIVERSITY

Atlantic Centre of Research, Access and Support for Disabled Students
923 Robie Street
Halifax, Nova Scotia
B3H 3C3

Organizational Notes:

The Atlantic Centre of Research, Access and Support for Disabled Students is university-affiliated agency networking provincially, nationally and internationally. The staff is responsible for assisting students with disabilities successfully complete their post-secondary education. Centre is involved in the support of persons with disabilities in higher education and the economic integration of those persons.

http://www.smu.ca/administration/atlcentre/welcome.html

UNIVERSITÉ DE MONTRÉAL

Groupe d'acoustique de l'Université de Montréal
Ecole d'orthophonie et d'audiologie
PO Box 6128 - Succursale Centre-ville
Montreal, Quebec
H3C 3J7

Organizational Notes:

Development and implementation of a rehabilitation program for persons affected by occupational deafness: psycho-social intervention within a public health perspective. Adaptation of work stations to the constraints imposed by hearing loss: development of clinical procedures for measuring ability to hear; development of a computerized model to predict ability to detect sound from noise with hearing loss. Assessment of the efficiency of alarms in noisy environments; development of the software to design or adjust signals to suit the constraints of the sound environment. Assessment of hearing disabilities and psycho-social disadvantages associated with deafness: development of a trans-cultural questionnaire.

UNIVERSITÉ DE SHERBROOKE

Department of physiology and biophysics
Faculty of Medicine
3001 - 12e Ave. Nord
Sherbrooke, Québec
J1H 5N4

Organizational Notes:

Production of tactile illustrations for the visually impaired. Computer editing of black and white photographs to retain only dimensional information, an original procedure which correctly translates the levels of grey in an image by elevations that can be felt by the fingers. This means elimination of all tones which do not express variation of illumination according to the distance of the objects in the image.

UNIVERSITÉ DU QUÉBEC À MONTRÉAL

Groupe de recherche sur la langue des signes québecoise
PO Box 8888, Stn Centre-Ville,
Montreal, Quebec
H3C 3P8

Organizational Notes:

1. Description of "langue des signes québécoise" (LSQ).
2. Study of deaf persons' written French, to assist in the teaching of language to deaf students. This will also help in developing teaching strategies to improve written French skills among deaf students.
3. "Conception d'un système expert d'aide à l'écriture à l'intention des personnes ayant une déficience auditive" project, aimed at creating workshops that use an expert system to assist in the improvement of the quality of written language.

http://www.unites.uqam.ca/langues

UNIVERSITY OF ALBERTA

Department of Educational Psychology
6-102 Education North
Edmonton, Alberta
T6G 2G5

Organizational Notes:

Focus is specifically on hearing impairment. Research priorities are mental health, demography, language and cognition. The three main objectives for the centre were to establish an endowed chair of Deafness Studies; to develop and test models for postsecondary programs for the hearing impaired; and to establish a consortium of postsecondary agencies providing deaf and hard of hearing students with improved opportunities to participate in postsecondary education. The networking and advocacy aspects are, perhaps, unique. They represent a formal and cooperative venture between consumer group organizations and the University. Mental health and deafness has been identified as a research priority at the University of Alberta for the next decade. Language, communication and interpreter research is multifaced and wide ranging. Research into educational practice is a key part of the research program, and many of the MEd and PhD theses focus on such topics. An adjunct professor is using computer-based technology to teach lip reading skills to both students and adults.

http://www.uofaweb.ualberta.ca/edpsychology

UNIVERSITY OF ALBERTA

Developmental Disabilities Centre
6-123 Education North
Edmonton, Alberta
T6G 2G5

Organizational Notes:

Its current activities are: research, student training, publications, and limited clinical services related to learning disabilities, mild and severe mental retardation. Its recent research topics have included:

1. The nature of cognitive processes
2. Assessment of cognitive abilities as an alternative to intelligence assessment
3. The nature and measurement of reading and writing disabilities
4. Decline in intellectual functions of individuals with Down's Syndrome due to aging
5. Attention and attention deficit

6. Cognitive assessment of blind persons
7. Sexual abuse of persons with mental handicap
8. Cross-cultural research especially on planning and decision making
9. Remediation and cognitive re-education of reading-disabled children.

http://www.ualberta.ca/~jpdasddc/index.html

UNIVERSITY OF BRITISH COLUMBIA

School of Rehabilitation Sciences
T-325 Third Floor Koemer Pavilion
2211 Wesbrook Mall
Vancouver, British Columbia
V6T 2B5

Organizational Notes:

University offers bachelor's programs in occupational therapy and physical therapy and a masters program in rehabilitation sciences.

Basic and applied research related to:

1. Disability, Rehabilitation, and Society
2. Exercise Science and Rehabilitation; and
3. Neurorehabilitation and Motor Control. Sample projects include work tolerance and functional capacity of people with chronic lung disease. Experiences of immigrant women with accessing health services; screening test for infants in fetal alcohol syndrome clinic; long term follow-up of rehab experience with people who have had a stroke; efficacy of devices to prevent decubiti; community living experiences of people with spinal cord injuries; etc.

http://www.rehab.ubc.ca

UNIVERSITY OF NEW BRUNSWICK

Institute of Biomedical Engineering
P.O. Box 4400
Fredericton, New Brunswick
E3B 5A3

Organizational Notes:

The Institute of Biomedical Engineering is involved in a broad range of research activities related to biomedical engineering. These activities range from basic research in biomedical engineering to the design and development of myoelectric control systems for artificial arms. The Institute operates a clinical facility which fits amputees with myoelectric arms. Other research at the Institute includes the following: gait analysis, biomedical instrumentation, signal processing, spinal cord monitoring, ergonomics, psychological development in limb deficient children, voice recognition and communication, exercise physiology, and mobility.

http://www.unbf.ca/eng/ME

UNIVERSITY OF TORONTO

The McLuhan Program in Culture and Technology
39A Queen's Park Crescent East
Toronto, Ontario
M5S 2C3

Organizational Notes:

The McLuhan Program's mandate is to encourage understanding of the effects of technology on culture and society from theoretical and practical perspectives, and thus to continue the ground-breaking work initiated by Marshall McLuhan. To this end, the Program offers courses, conducts and supports research, and draws together members of the University community whose interests lie in the inter- and trans-disciplinary studies of communications, culture and technology. Through its research, course offerings, publications, speaking engagements, and experimentation in new and old media, the Program serves as an enabling connective force among the University of Toronto, other academic institutions throughout the world, governments, industry, artists of all types and the general public.

http://www.mcluhan.utoronto.ca

UNIVERSITY OF WESTERN ONTARIO

Department of Computer Science
Middlesex College
London, Ontario
N6A 5B7

Organizational Notes:

The main theme is computer-facilitated information access for the blind or visually impaired individuals. Special emphasis is placed on access to scientific and engineering documents involving complicated notations and graphics. Group experiments with combinations of various interactive media including tactile graphics, voice input and output, and gesture input. Group also focuses on developing a teaching environment for blind students of computer science

http://www.csd.uwo.ca

APPENDIX B: INVITATION LETTER TO PARTICIPANTS AND INDUSTRY SURVEY

The Assistive Devices Industry Office (ADIO) of Industry Canada and the University of New Brunswick are conducting a research project to assess the current status of the assistive devices Industry (ADI) in Canada. We invite you to participate in the first part of this project - a survey designed for organizations working within the ADI. Your participation is completely voluntary. However, as a representative of your organization your input is important and will help Industry Canada better support assistive technology organizations. It will also contribute to a comprehensive assessment of the industry that will be of interest to assistive technology organizations. At the end of the survey you will have the option to provide a mailing address or an email address where a summary of the results of this project can be sent.

As an alternative, you may complete this survey on line at:
http://www.unb.ca/survey/index.php?sid=145
Or by using an accessibility setting at:
https://www.unb.ca/sweb/parser/luci.cgi/http://www.unb.ca/survey/index.php?sid=145

Thank you for taking the time to complete this survey. All information

provided will be treated confidentially.

E. N. Biden
Professor
Biden@unb.ca
506-458-7762

Assessing the Assistive Devices Industry in Canada

1. Please check the classifications that describe the main activities within your assistive technology organization.

Please choose all that apply:

__ Accessible Web Consulting
__ Accommodation Consulting
__ Activities of Daily Living (ADL)
__ Augmentative Communication
__ Blind
__ Deaf
__ Ergonomics
__ Hard of Hearing
__ Low Vision
__ Mobility
__ Multiple Formats
__ Prosthetics and Orthotics
__ Research Centre
__ Training and Evaluation
__ Other: _____

2. Which of the following best describes your assistive technology organization?

Please choose only one of the following:

__ For profit
__ Not for profit

3. Which of the following best describes your assistive technology organization?

Please choose only one of the following:

__ A separately incorporated company
__ A unit of a larger company
__ An educational organization
__ A community organization
__ A sole proprietorship
__ A partnership
__ Other: _____

4. Approximately how many employees in your organization are involved in assistive technology?

Please choose only one of the following:

__ 3 or fewer
__ 4 to 10
__ 11 to 20
__ 21 to 100
__ 101 to 400
__ More than 400

5. Approximately how many volunteers in your organization are involved in assistive technology?

Please choose only one of the following:

__ 3 or fewer
__ 4 to 10
__ 11 to 20
__ 21 to 100
__ 101 to 400
__ More than 400

6. Indicate approximately the percentage of your organization's assistive technology market that falls into each market category.

Provincial/Regional ____%
Rest of Canada ___%
United States ___%
Europe ___%
China ___%
Other Asian Markets ___%
India ___%
Brazil ___%
Other South American Markets ___%
Africa ___%
Other ___%

7. What are the target age groups for your organization's assistive technology products or services?

Please choose all that apply:

__ Infant (Birth to 2)
__ Child (3 to 12)
__ Adolescent (13 to 19)
__ Young Adult (20 to 39)
__ Middle Adult (40 to 64)
__ Late Adult (65 and over)

8. What is the purpose of the assistive technology products and/or services provided by your organization?

Please choose all that apply:

__ Educational
__ Recreational/Leisure
__ Sport
__ Home Use
__ Work Use
__ Activities of Daily Living (ADL)
__ Other: _____

9. Indicate approximately the percentage of your organization's assistive technology activities that fall into each category.

Research and Development ___%
Manufacturing ___%
Wholesale ___%
Resale ___%
Consulting ___%
Other ___%

10. If your organization manufactures assistive technology, are these products:

Please choose only one of the following:

__ Designed by your organization
__ Designed by others outside of your organization
__ Both
__ N/A

11. If your organization develops assistive technology, what type of technology is it?

Please choose all that apply:

__ Devices
__ Software
__ Programs or services
__ N/A
__ Other: _____

12. If your organization is involved in the wholesale of assistive technology, do you mainly distribute products:

Please choose all that apply:

__ Your organization has designed
__ Your organization has manufactured
__ Designed by others
__ Manufactured by others
__ N/A

13. If your organization provides services in assistive technology, are they services to:

Please choose all that apply:

__ Other organizations
__ Therapists or other clinicians
__ Final consumers/users
__ N/A
__ Other: _____

14. Does your assistive technology organization use the Canadian Company Capabilities web site to make consumers/end users aware of your products or services?

Please choose only one of the following:

__ Yes
__ No

15. Through what other means does your assistive technology organization make consumers/end users aware of your products or services?

Please choose all that apply:

__ Organization's website
__ Advertisements in newspapers, magazines or other consumer publications
__ Advertisements in trade publications
__ Exhibits at conferences and/or tradeshows
__ Personal contacts
__ Direct telephone sales
__ Email advertisements
__ Client lists
__ Other: _____

16. Does your organization anticipate recruiting new employees to work in the area of assistive technology within the next 12 months?

Please choose only one of the following:

__ Yes
__ No

17. From where does your organization usually recruit new employees to work in the area of assistive technology?

Please choose all that apply:

__ Direct from high school
__ Direct from community college
__ Direct from university – after undergraduate degrees
__ Direct from university – after graduate degrees
__ After gaining experience in related assistive technology industries
__ After gaining experience elsewhere
__ Other: _____

18. When recruiting new employees to work in the area of assistive technology, what difficulties does your organization confront?

Please choose all that apply:

__ Our organization does not experience difficulties recruiting new employees
__ It is difficult to find people with appropriate skills
__ Pay rates in other industries draw people away
__ Universities/colleges do not provide appropriate training
__ Other: _____

19. When recruiting new employees to work in the area of assistive technology, does your organization interact with colleges, universities or other training and education centres?

Please choose only one of the following:

__ Yes
__ No

20. When your organization is recruiting new employees from colleges, universities or other training facilities to work in the area of assistive technology, what departmental areas do they represent?

Please choose all that apply:

__ Physiotherapy
__ Occupational therapy
__ Respiratory therapy
__ Nursing
__ Psychology
__ Medicine
__ Electrical/Electronic engineering/technology
__ Chemical engineering/technology
__ Mechanical engineering/technology
__ Computer Science/Information technology
__ Kinesiology
__ Social work
__ Sociology
__ Anthropology
__ Languages
__ Law
__ Human Rights
__ Education
__ Health Services Research

__ Business/Commerce
__ Other: _____
__ N/A

21. Aside from recruiting new employees, how else does your assistive technology organization work with universities or colleges?

Please choose all that apply:

__ To conduct research
__ To develop technology
__ To assess technology
__ Our organization does not work with universities or colleges
__ Other: _____

22. What are the current priorities of your assistive technology organization?

Please choose all that apply:

__ Increase number of employees
__ Decrease number of employees
__ Increase employee skills
__ Increase automation
__ Develop new products
__ Improve existing products
__ Increase sales
__ Increase export
__ Expand markets
__ Move into new markets
__ Other: _____

23. What are the main obstacles to advancement currently facing your assistive technology organization?

Please choose all that apply:

__ Lack of highly qualified personnel
__ Government policies/regulations
__ Competition from similar organizations
__ We are not facing obstacles to advancement
__ Other: _____

24. In what ways do policies/programs within your organization's province support assistive technology?

Please choose all that apply:

__ There are no policies/programs in my organization's province that support assisitive technology
__ Through support for product development
__ Through support for marketing
__ Through the purchase of products we provide
__ Through support for the export of products we provide
__ Other: _____

25. Please indicate the first three characters of your organization's postal code.
_____

26. If you would like to be provided with a summary of the results generated by this survey please indicate a mailing address or email address where this can be sent.

_____
_____
_____
_____
_____

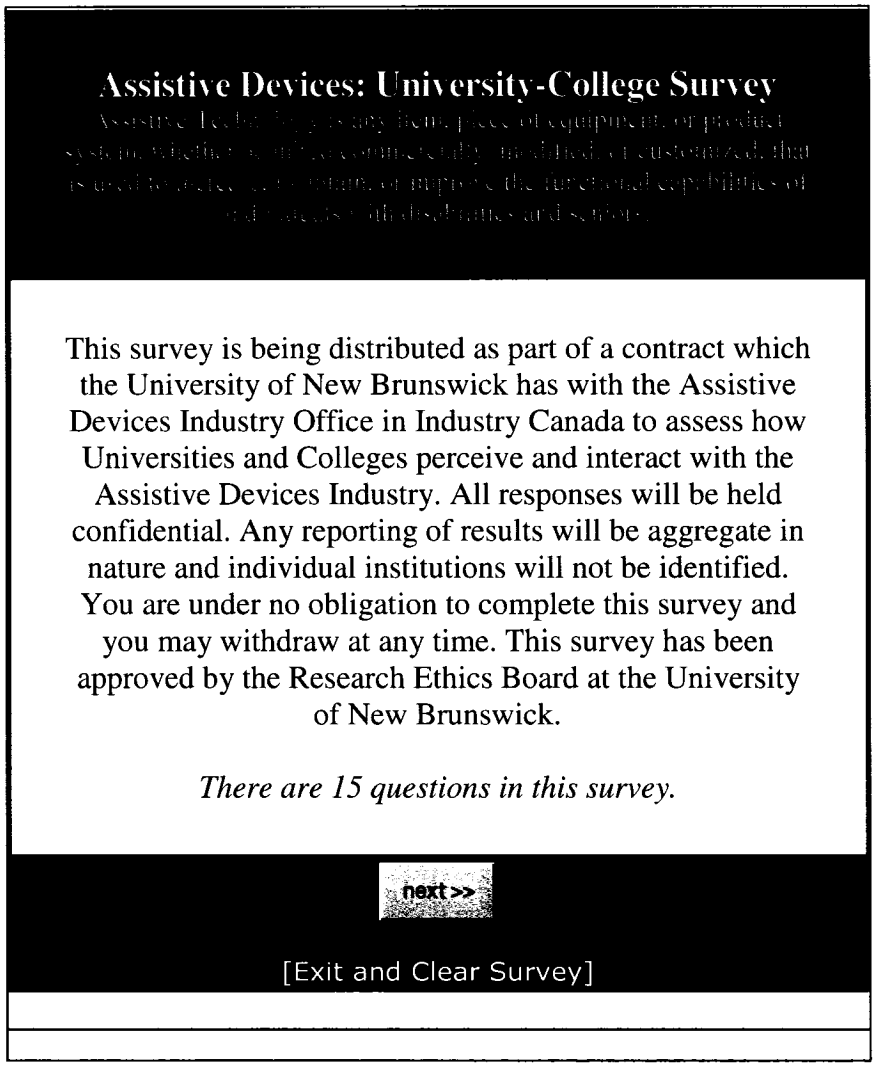
27. If you have any further comments to make about your organization, assistive technology or any of the questions on this survey, please state them here:

_____
_____
_____
_____

Please return complete survey in the envelope provided by September 30, 2006.

Thank you for taking the time to complete this survey.

APPENDIX C: NOTE OF INVITATION AND ACADEMIC SURVEY



Assistive Devices: University-College Survey

Assistive Technology is any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities and seniors.

This survey is being distributed as part of a contract which the University of New Brunswick has with the Assistive Devices Industry Office in Industry Canada to assess how Universities and Colleges perceive and interact with the Assistive Devices Industry. All responses will be held confidential. Any reporting of results will be aggregate in nature and individual institutions will not be identified. You are under no obligation to complete this survey and you may withdraw at any time. This survey has been approved by the Research Ethics Board at the University of New Brunswick.

There are 15 questions in this survey.

next >>

[Exit and Clear Survey]

Q1: 1. Which of the following best describes your institution:

Please choose **only one** of the following:

- ☐ Community College
- ☐ University
- ☐ Other

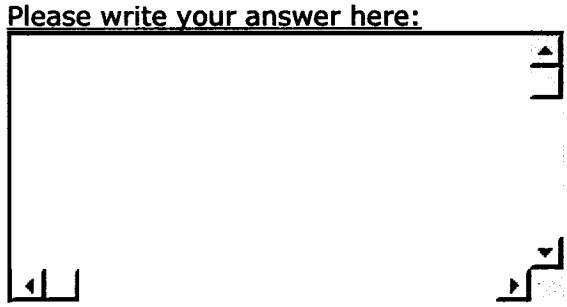
Q2: 2. Please indicate in which category your individual unit falls:

Please choose **only one** of the following:

- ☐ Business
- ☐ Computer Science
- ☐ Education
- ☐ Biomedical engineering/technology
- ☐ Electrical/Electronic engineering/technology
- ☐ Mechanical engineering/technology
- ☐ Health Services
- ☐ Occupational therapy
- ☐ Physiotherapy
- ☐ Social Work
- ☐ Kinesiology
- ☐ Psychology
- ☐ Other

Q3: 3. If your unit provides education in assistive technology as defined above, please list the programs or courses:

Please write your answer here:



Q4: 4. What type of work in assistive technology does your unit conduct?

Please choose **all** that apply:

- ☐ Training of students
- ☐ Professional development training
- ☐ Development of devices
- ☐ Development of software
- ☐ Development of procedures for assessment or treatment
- ☐ Assessment of devices or software
- ☐ Assessment of rehabilitation procedures

Other:

Q5: 5. Does your unit conduct research and/or development in assistive technology or related areas?

Please choose **all** that apply:

- ☐ No
- ☐ Yes - College Student Projects
- ☐ Yes - University undergraduate projects
- ☐ Yes - Graduate Student Projects
- ☐ Yes - Projects done by faculty and/or staff

Other:

Q6: 6. What sources of funding support assistive technology projects in your unit?

Please choose **all** that apply:

- ☐ We do not conduct such projects
- ☐ Internal department or university funds
- ☐ Grants from NSERC
- ☐ Grants from SSHRC
- ☐ Grants from CIHR
- ☐ Grants from other national agencies
- ☐ Grants or contracts from provincial agencies
- ☐ Grants or contracts from charities
- ☐ Grants or contracts from industry

Other: _____

Q7: 7. From where do assistive technology projects in your unit originate?

Please choose **all** that apply:

- ☐ Requests for proposals from granting agencies
- ☐ Ideas from faculty or students
- ☐ Ideas from industrial contacts
- ☐ Ideas from end user groups or agencies

Other: _____

Q8: 8. Is the assistive technology industry one to which your students are attracted?

Please choose **all** that apply:

- ☐ Yes - opportunities for employment exist for our students
- ☐ Yes - links to AT companies are common in our setting
- ☐ Yes - the Industry is active in our region
- ☐ No - students don't see many opportunities
- ☐ No - AT companies are rare in our region
- ☐ Not Sure

Other: _____

Q9: 9. Which of the following best describes how important the assisitive technology industry is for your students' employment after graduation.

Please choose **all** that apply:

- ☐ Not at all important
- ☐ Somewhat important
- ☐ Neutral
- ☐ Important
- ☐ Very important
- ☐ Not Sure

Other: _____

Q10: 10. Please indicate the approximate percentage of your students who would enter the assisitve technology industry:

Please choose all that apply and provide a comment:

- ☐ Undergraduates _____
- ☐ Grad-Students _____

Q11: 11. Are there pre-graduation opportunities for your students to gain experience in the assistive technology industry?

Please choose **all** that apply:

- ☐ No - such opportunities are rare
- ☐ Yes - through short term internships or jobs
- ☐ Yes - through long term internships, Coop, etc.
- ☐ Yes - through summer jobs
- ☐ Yes - through volunteer opportunities
- ☐ Not Sure

Other: _____

Q 12: 12. Very few universities or colleges self identify with databases such as the "Canadian Companies Capabilities" database which is maintained by Industry Canada. Is your organization/unit identified on CCC or similar listings?

Please choose **all** that apply:

- ☐ Yes
- ☐ No - didn't know of them
- ☐ No - listings are of limited value to us
- ☐ Not Sure

Other:

Q13: 13. Please provide the first three characters for your postal code.

Please write your answer here:

Q14: 14. Please add any other comments you have about this survey or the Assisitve Technology Industry:

Please write your answer here:

Q15: 15. If you would like to receive a copy of the report from this project please provide an e-mail or postal address to which it can be sent.

Please write your answer here:

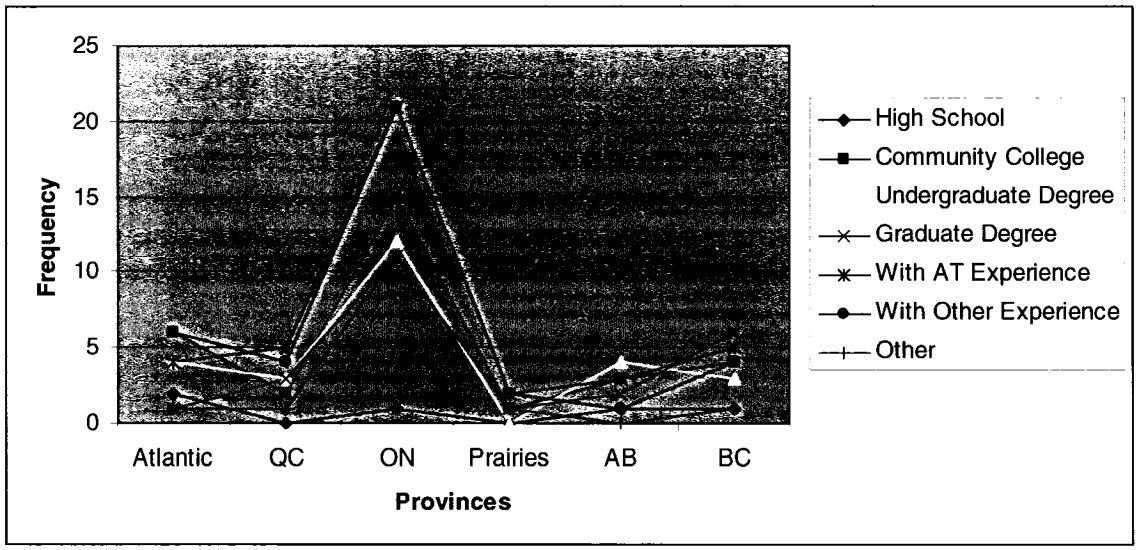
Submit Your Survey.

Thank you for completing this survey.

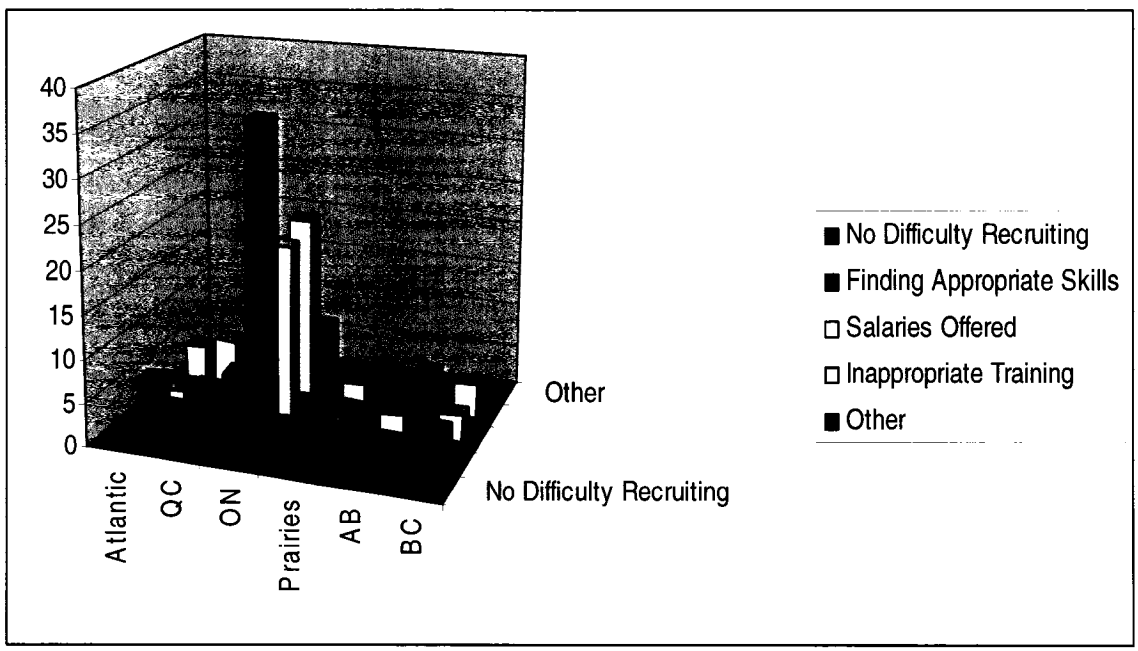
APPENDIX D: PROVINCIAL COMPARISONS

RECRUITMENT

Recruitment Areas

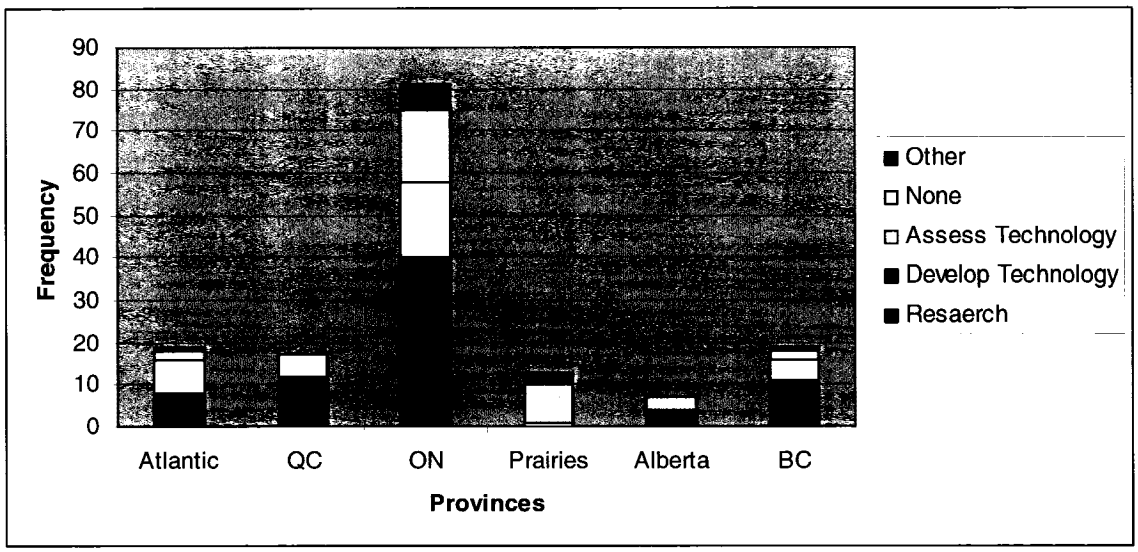


Recruitment Challenges

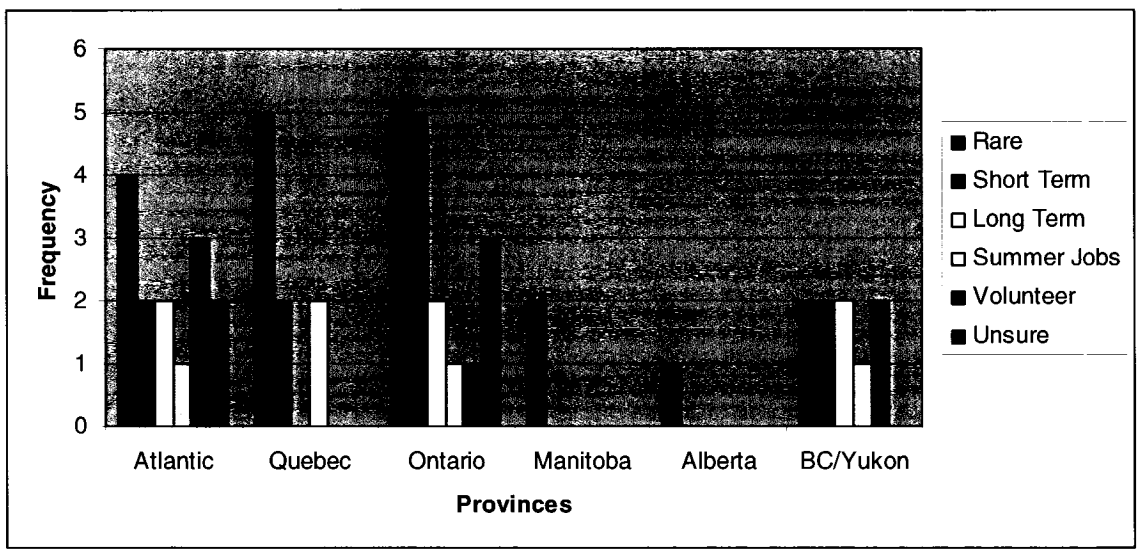


INDUSTRY AND ACADEMIA

Industry Activities with Academia (Excluding Recruitment)

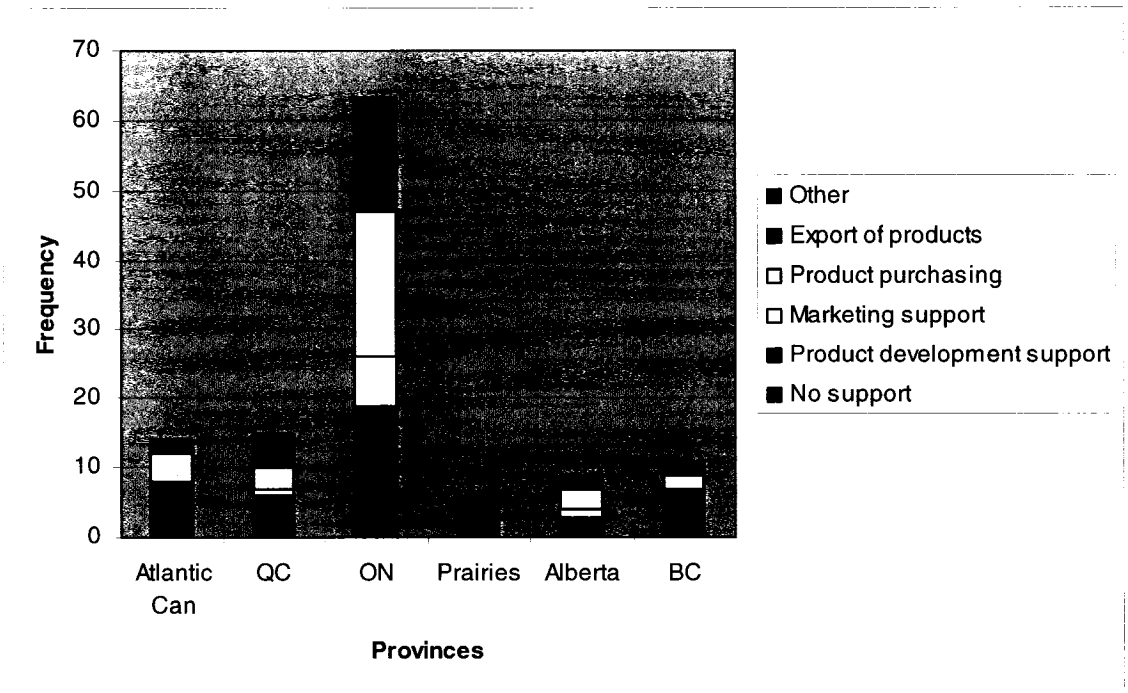


Pre-Graduation Opportunities for Students to Work in the ATI

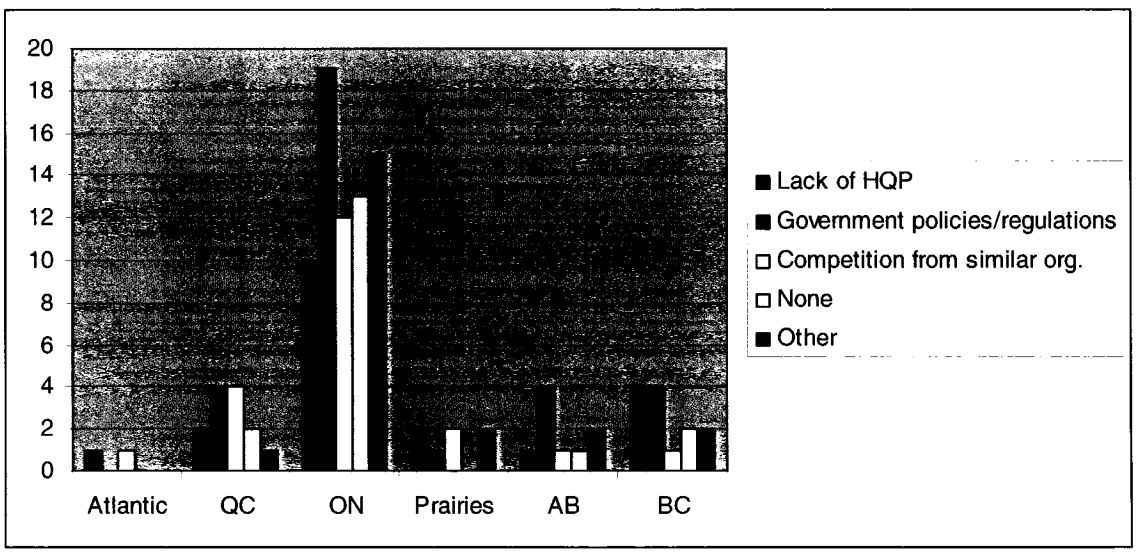


INDUSTRIAL SUPPORTS AND BARRIERS

Types of Provincial Support Perceived



Barriers to Organizational Advancement by Province



APPENDIX E: SMES IN CANADA

A)

Number of Employees	Cumulative Percent of Employer Businesses	No. of Business Establishments		
		Total	Goods-producing Sector[2]	Service-producing Sector[2]
Indeterminate[1]		1 334 791	351 202	983 589
Employer Business Total	*100.0*	*1 042 316*	*240 537*	*801 779*
1–4	56.6	589 777	**146 065**	**443 712**
5–9	73.9	180 345	**35 551**	**144 794**
10–19	85.9	125 561	**24 483**	**101 078**
20–49	94.6	90 436	**19 363**	**71 073**
50–99	97.6	31 323	**8 060**	**23 263**
100–199	99.0	14 791	4 247	10 544
200–499	99.7	7 223	2 159	5 064
500+	100.0	2 860	609	2 251
Grand Total		**2 377 107**	**591 739**	**1 785 368**

Source: Statistics Canada, Business Register, December 2004.

Note 1: The "indeterminate" category consists of incorporated or unincorporated businesses that do not have a CRA payroll deductions account. The workforce of such businesses may consist of contract workers, family members and/or owners.

Note 2: By conventional Statistics Canada definition, the goods-producing sector consists of North American Industry Classification System (NAICS) codes 11 to 31–33, while NAICS codes 41 to 91 define the service-producing sector.

B)

Provinces/Territories	Employer Businesses										
	Total	Percent of Total									
		1–4	5–9	10–19	20–49	50–99	***Small* <100**	100–199	200–499	***Medium* 100–499**	Large 500+
Newfoundland and Labrador	17 127	60.1	18.1	10.5	7.1	2.3	*98.0*	1.1	0.6	*1.6*	0.3
Prince Edward Island	6 516	55.3	18.9	13.0	8.7	2.6	*98.4*	1.0	0.5	*1.5*	0.2
Nova Scotia	30 201	55.4	17.8	12.5	8.8	3.1	*97.7*	1.5	0.6	*2.1*	0.3
New Brunswick	26 371	58.4	17.3	11.6	8.2	2.6	*98.0*	1.2	0.6	*1.7*	0.2
Quebec	237 234	62.4	16.2	9.9	7.1	2.5	*98.0*	1.2	0.6	*1.7*	0.3
Ontario	347 265	52.8	17.4	13.1	10.0	3.6	*97.0*	1.8	0.9	*2.7*	0.3
Manitoba	35 622	51.4	18.4	14.1	10.1	3.5	*97.4*	1.5	0.8	*2.3*	0.3
Saskatchewan	39 199	56.8	18.5	12.5	8.1	2.3	*98.3*	1.0	0.5	*1.6*	0.2
Alberta	140 407	56.6	17.4	12.3	8.5	2.9	*97.8*	1.4	0.6	*2.0*	0.2
British Columbia	158 421	57.2	17.8	12.2	8.2	2.7	*98.0*	1.2	0.6	*1.8*	0.2
Yukon Territory	1 580	51.5	19.2	14.1	10.4	2.7	*97.9*	1.2	0.8	*2.0*	0.1
Northwest Territories	1 735	39.2	20.1	18.5	14.3	4.7	*96.8*	2.2	0.9	*3.1*	0.1
Nunavut	638	29.9	22.3	20.4	18.3	6.0	*96.9*	2.2	0.8	*3.0*	0.2
Canada Total	**1 042 316**	**56.6**	**17.3**	**12.0**	**8.7**	**3.0**	***97.6***	**1.4**	**0.7**	***2.1***	**0.3**

Source: Statistics Canada, Business Register, December 2004.

Table A) shows the number of SMEs in Canada broken down by size and by general sector; B) shows the distribution of SMEs in Canada by province. Both are from: Industry Canada. 2005. Key Small Business Statistics – July 2005. http://strategis.ic.gc.ca/epic/internet/insbrp-rppe.nsf/vwapj/KSBS_July2005_Eng.pdf/$FILE/KSBS_July2005_Eng.pdf