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Alberta's Manufacturers: Workforce Challenges and Strategies

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Canadian manufacturers contend with a number of competitive challenges within a rapidly changing global market. Among these are the present and projected shortages of skilled workers who are critical to the success of secondary sector firms that increasingly utilize advanced manufacturing technologies. The recent boom in Alberta's economy has exacerbated an already critical national workforce situation. Evidence from a recent survey of manufacturers suggests that the skilled labour issue is a far more salient problem for manufacturers in Alberta than for most of Canada. The shortage of skilled workers ranks, by far, as the most important competitive concern for Alberta manufacturers. This issue appears to have limited growth for many firms from this province, to a higher degree than seen elsewhere in the country. This paper also explores the extent of the human capital shortage in manufacturing and the strategies that firms are using to address this challenge.

Introduction

Despite the reduced role of manufacturing in most advanced industrialized economies, producers from these countries are faced with current and future shortages of human capital in this sector. This issue portends a critical problem for manufacturers that increasingly demand skilled workers in order to survive competition across domestic and international markets. A 2005 article in the *Globe and Mail* projected a mounting skills shortage for Canadian manufacturers (Sherlock 2005), which is a concern that has serious ramifications for firms that are already challenged with numerous competitive issues that include increased materials costs and a stronger Canadian dollar. While the workforce shortage is impacting the secondary sector across Canada, the situation is particularly dire in Alberta. Due to a resource-driven economic boom, virtually every sector has experienced deep labour shortages (see Nikiforuk 2006), especially in manufacturing. Beyond popular media and government reports on this topic, the importance of human capital for manufacturers has become an important topic for researchers as well. Thornhill (2006), for example, demonstrated that the utilization of human capital was an important element among firm-level strategies for Canadian manufacturers and moreover, this was found across different production environments (i.e. various manufacturing subsectors). Additionally, Deitz and Orr (2006) determined that in the long term, manufacturers in advanced market economies will continue to demand increasingly higher skills levels from workers.

Given this situation, there are several questions to be addressed in this paper. What are the competitive issues of Alberta manufacturers – is the labour shortage really a top competitive issue and is the problem indeed different from the rest of Canada? Second, how are producers impacted by this dearth of workers? Last, if there are indeed issues regarding human capital for manufacturers, how are they addressing this issue? A noteworthy situation exists in Alberta and for that matter, all of Canada: what appears to be a twilight economic sector in supposed decline is now faced with workforce shortages that could impact the long term viability of many industries and high-growth firms. If manufacturing will continue to be a critical component of the Alberta economy and will continue to support the province's extractive industries, the labour shortage could only serve to harm firms that are already confronted with a number of other competitive issues.

Research Background

The background for this paper comprises two distinct areas of research, namely, the study of the evolution of industries, and the meaning of such evolution for the shifting location of manufacturing activities. Accordingly, the review provided below addresses both of these areas in turn.

Industrial Evolution

The manufacturing sectors of most advanced economies are transforming into higher-end production activities in order to retain competitive advantage against a broadening array of worldwide manufacturing sites and firms. Beyond focusing on product innovation and change, most companies are reevaluating their entire operations, including better utilization of resources such as their workforce (Jaikumar 1986; Mahajan 2004). Why is the state of the labour force important for the manufacturing sector? In just two examples, works from Porter (1990) and Porter and Stern (2001) demonstrate that a skilled labour force is an important *factor condition* that is necessary to provide a region with competitive advantage. For manufacturers in a region to remain competitive both nationally and globally, they must have access to a skilled workforce. At the same time, Porter (1990) also discusses labour shortages as a distinct *disadvantage* for regional economic growth. Regions and the firms within them can be thus hindered by human capital deficits.

As suggested by research on the product life cycle (e.g. Hirsch 1967; Vernon 1979; Glass 1997), there are constant changes in the production and demand of manufactured goods as these products evolve. Basically, this cycle entails an initial development phase, a growth period, and a maturation stage. A new product emerges after a development process, most often with a small market demand. If accepted by the market, the product gains a larger number of buyers and the production process becomes standardized. Next, the product reaches full standardization, market demand plateaus and can then stagnate. If a firm wishes to avoid this last stage, it must create new products, or, if it makes a relatively standardized product, it must improve other aspects of its operations, such as increased productivity. Although such life cycle concepts do not fit all businesses, they are particularly well suited to many kinds of manufacturing as studied here (Klepper 1996; Mowery and Nelson 1999; Klepper and Simmons 2000).

The important connection to be made here is the link between life cycles and labour. As a firm or industry advances through its life cycle, its skill profile also evolves (Geels 2006). In its initial phase, the labour force of an industry emphasizes a creative and technical skill set, reflecting the developmental position of the industry and its associated technologies and markets. As production increases and the needs of the industry increasingly emphasize functions such as production and distribution, new skill sets are introduced in successive waves of hiring, fundamentally changing the industry's labour force mix. Eventually, when the industry reaches a phase of maturation and a decision-point between product renewal and stagnation, further labour force changes become necessary. At this point, the particular evolutionary path followed by the industry guides the precise nature of its newest hiring initiatives (Markusen 1985). The key point with all of the above is that, although the evolutionary paths followed by firms and industries are complex, the labour force required by an industry at any given time evolves in concert with changes in the industry's broader, competitive context. Thus, it is important for regions to continue to adapt their labour force conditions to meet the needs of their key firms and industries, or risk losing such economic activity to places that offer a better match. In terms of public policy, this means it is crucial for regions and their governments to accurately assess the evolving labour needs of firms and track the ability of their labour force to provide employees with suitable training and skills.

So, what can be said about the evolving economic environment within which manufacturers must compete in Alberta and Western Canada? Although the region has a long tradition of resource-dependent industries (Randall and Ironside 1996), recent years have seen a great diversification of industries and production processes in Western Canada. For example, Calgary has developed a sizeable wireless and global positioning systems technology cluster (Langford et al. 2003), and the region's major universities have spurred on further developments in software development and biotechnology (Ryan and Phillips 2003). Even Western Canada's traditional, resource-based industries have employed new organizational methods and technologies, and have engaged in high levels of research and development, to great advantage (Hayter 1996; Rees and Hayter 1996). Thus, it would be fair to characterize the region's recent development as shifting gradually toward more higher-value-added industries, a trend very much in line with development in the North American economy more broadly.

Indeed, it has become evident that the markets in which North American manufacturers continue to have comparative advantage are found in high-end production, or the positive end of the product life cycle involving new technological development. Essentially, to compete in global markets, firms require a skilled labour force. In a study of US manufacturers, evidence from Deitz and Orr (2006) indicated that the demand for advanced manufacturing labour has increased, while overall manufacturing activities have experienced job losses. The problem is that there is an acute shortage of such workers. The successful implementation of advanced manufacturing technologies (e.g. computer numeric controls) and the often-accompanying processes (e.g. flexible production) demands increasingly higher levels of human capital (Gertler 1995). Further, there is evidence that the use of educated workers in advanced specialized fields can contribute positively to productivity and overall economic growth (Lodde 1999).

Granted, the Canadian (or for that matter, the North American) situation regarding this issue is unique. Two decades ago, Muszysnki and Wolfe (1989) illustrated that the Canadian case is much different from the workforce training schemes seen in an OECD country such as Japan. Given the increasing technical demands of the economy, particular emphasis could be placed on addressing employer training and moreover, that workers need skills that are transferrable and flexible (Muszysnki and Wolfe 1989, 261). Accordingly, research has demonstrated that firms in advanced industries spend more on worker training as they come to realize the importance of this asset to their viability (Bartel and Sicherman, 1998). In their study of small to medium-sized Canadian firms across a number of economic sectors, Baldwin and Johnson (1995) found training to be beneficial to both workers and the companies for which they work. Work from Therrien and Léonard (2003) has also indicated that workforce training encourages innovation and, as Glass (2006) has demonstrated more recently, innovation is vital to avoiding product cycle stagnation. At the same time, firms must be strategic in their expenditures. Investments in human capital can indeed increase firm-level productivity, although it is often a question of exactly how companies should invest in this resource (Black and Lynch 1996). The emphasis on human capital is often seen in more innovative subsectors of manufacturing, such as surgical instruments or advanced cutting tools, as they have already realized the importance of human capital and are working on strategies to address the issue.

Connections to Locational Change

Although aspatial, purely organizational considerations are central in the foregoing discussion of industrial evolution, it is clear that geography provides an important context for understanding the implications of such change. Alterations in technologies, processes, and products (as discussed above) often lead to fundamental transformations in firms and industries, with some of the most important resulting changes being in the geographic location and distribution of firms and related elements (MacLachlan 1992). This is seen clearly across Canada, where labour markets are evolving as a result of restructuring occurring across most manufacturing industries. As this restructuring occurs, moreover, there are changing regional differences in the mix of industry and resulting employment patterns (Rutherford 2006).

The emerging literature of *evolutionary economic geography* specifically addresses the geography of change in the economy (Boschma and Martin 2007). Within this relatively recent research movement, the life cycles of firms, industries, business clusters, and regions comprise one of the most important themes (Essletzbichler and Rigby 2007). As with the purely organizational firm developments already reviewed, the economic cycle concept contributes crucial elements to our understanding of the locational shifts impacting businesses and their competitive environments. The early work of Vernon (1966), focused on the development of the product life cycle concept, together with the later advancement by Markusen (1985) in the related profit cycle model, provide a compelling accounting of the nature of the linkages that connect evolutionary change in firms and industries with their shifting geographic orientation. This collective literature shows that firms in different life cycle stages have different locational factors of importance, and thus distinctive geographic patterns. Firms in early cycle stages focused on business development, finance, and other highly-innovative activities have locational needs that are distinct from firms in high-growth phases that are building a high-capacity production system, and are different again from businesses with mature products that are looking to further evolve through cost-cutting. The fact that manufacturing in Alberta, and Canada more generally, is shifting toward higher-end and more technologically-sophisticated production means that Alberta's manufacturing firms are operating within the context of competitive considerations that have seen much change in recent years. This shift leaves open

the question as to whether firms already located in Alberta will find an Alberta location to be suitable for future operations.

The cycle research cited above has framed the geographic study of industrial evolution in its most direct terms, by addressing the shifting geography of firm location. This is arguably the principal area of need related to evolutionary research in geography, but this does not mean that other perspectives cannot provide insights of value. One area where an additional contribution in this area is possible is to examine the evolution of manufacturing from a labour force perspective. Changing labour force conditions are important factors in, and also key reflections of, the overall changes now taking place in Canadian manufacturing. The dual perspectives briefly surveyed above provide a foundation for research in this area, so it is from this foundation that the paper proceeds.

Overall, the research reviewed above suggests that a skilled workforce is integral to the success of most manufacturers. On a larger scale, this body of research provides every indication of being important to the success of Alberta's manufacturing sector in particular. Alberta's manufacturing sector has grown and diversified in recent years, emphasizing more advanced production processes and products. Such developments are of great importance for the Canadian manufacturing sector as a whole, given its historic concentration in Ontario and Quebec and the many efforts made over the years to distribute such activity more widely across the country. However, for Alberta-based manufacturers to continue to develop their competitive advantage and solidify a sustainable industrial community in Western Canada, a skilled workforce is needed. Given the manufacturing change that is occurring across most advanced economies, success in this area is anything but assured. An assessment of workforce conditions in Alberta is important to understanding the competitive landscape for these manufacturers, and developing public policies that can help to ensure their ongoing success. This paper aims to provide empirical evidence on what could amount to a *factor disadvantage* for Alberta's manufacturers, and perhaps for the wider national economy.

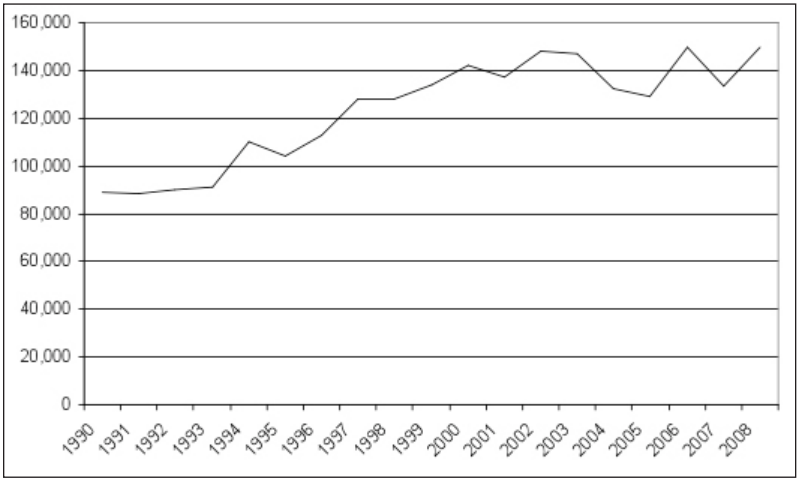
Trends in Canadian Manufacturing Employment

The Canadian manufacturing sector has, in general, differed from many of its OECD counterparts. Manufacturing employment in the US has for example, declined by over twenty percent in the

past decade, and similar decreases have been seen in locations as varied as Japan and Germany. As seen in Figure 1, manufacturing employment in Alberta has actually risen since 1990, in contrast to the trend seen throughout most industrialized economies, lending credence to the westward move in manufacturing activities described by Kowaluk (2006). Even on a national scale, and in contrast to most advanced economies, Canadian manufacturing in general has been relatively stable, reaching peak employment levels, roughly 2.29 million, as late as 2004. So, by and large, the manufacturing sector remains a relatively robust part of the overall Alberta economy and an important element of the Canadian economy. The composition of manufacturing in Alberta, of course, is different from Canada as a whole, as seen in Table 1. The manufacturing sectors lean heavily toward the processing of natural resources. These processing activities fall within commonly-used definitions of manufacturing activities and are therefore included here. These industries, furthermore, are highly capital intensive and require an increasingly skilled workforce.

Figure 2 illustrates the evolving nature of Canadian manufacturing. After adjustments for inflation, the data show that manufacturers have made steady increases per worker, and hence have increased productivity. This might suggest that manufacturing in both Alberta and the rest of Canada is evolving into higher value-added activities.

Figure 1. Manufacturing Employment in Alberta, 1990-2008

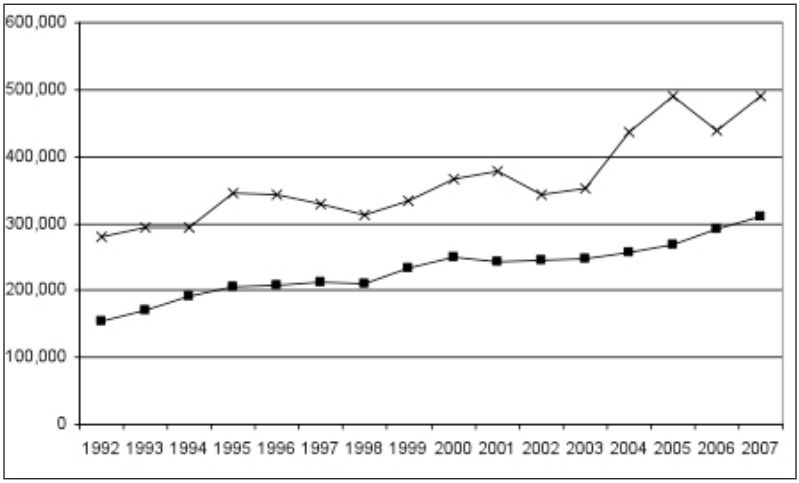


Source: Statistics Canada, www.statcan.gc.ca, last accessed 1-May-2009

Table 1. Composition of Manufacturing in Alberta versus Canada (in CDN Billions)

Rank	Alberta	Value	Rank	Canada	Value
1	Petroleum/coal products	17.05	1	Transportation equipment	97.25
2	Chemicals	13.26	2	Petroleum/coal products	81.47
3	Food	10.92	3	Food	78.13
4	Machinery	6.48	4	Primary metals	55.24
5	Fabricated metal products	5.85	5	Chemicals	51.13

Figure 2: Manufactured Goods: Shipments per Worker (in Canadian Dollars)



Note: Adjusted for inflation in 2007 dollars
Source: Statistics Canada, www.statcan.gc.ca, last accessed 8-May-2009

At the very least, productivity improvements that come from the implementation of new processes and the introduction of advanced capital equipment underscore the need to pay attention to issues of enhanced workforce skill levels.

Human Capital Challenges in Manufacturing

To better understand the performance, challenges, and trajectories of manufacturers, Canadian Manufacturers and Exporters (CME) conducted a postal survey of CME members across Canada during the summer of 2006. The survey instrument encompassed many aspects of concern to the manufacturing sector, including recent performance, problems, exports, human capital, and productivity enhancement strategies. The 2006 survey produced 986 valid responses (nationally, a response rate of slightly less than 10%), 103 of which were from Alberta. A series of chi-square tests were run, comparing this sample (both provincial and national) against the manufacturer population in terms of measures such as firm size, revenue, and line of business[1]. These tests confirmed that the sample is statistically representative at the 95% level. It should be noted that the survey answers were largely categorical responses or Likert-style scales, which limits the types of statistical tests that can be run. Yet at the same time, the survey results are still useful for exploring the dynamics in labour shortages for Canadian manufacturers. Further supplemental evidence comes from informal, follow-up conversations held with over 40 representatives of manufacturing firms attending the Fifth Western Canada Conference on Best Practices in Lean Excellence sponsored by CME in Calgary during October 2006. These conversations served largely as a follow-up to the survey results and additionally, were used to explore potential issues for manufacturers that may have occurred since the time of the survey.

What is the current employment growth status for Alberta's manufacturers? Table 2 presents the survey responses for two time periods: 2005 to 2006 and 2006 to 2007. Over half of the firms indicated that they grew or expected to grow their workforces in each period. Moreover, far fewer manufacturers expected to reduce employment levels at their firms. Given the survey results and what was seen in Figure 1, these trends are unique, since in most OECD

[1] The Alberta sample was too small for a rigorous statistical comparison between manufacturing subsectors. However, a series of chi-square tests confirmed no significant differences in the severity of the labour shortage between industries.

countries manufacturers instead continue to drastically reduce their workforces. The situation is also complicated given the booming Alberta economy, pointing to added demands on an already shrinking pool of workers available to manufacturers.

Is the human capital shortage really important to manufacturers, given the numerous other problems that they face? A survey question asked firms to rate how 25 competitive challenges had influenced their operations during the past year, with 'significantly worse' being the most negative response. Table 3 provides a breakdown of some of the leading responses, with over 95% of the manufacturers rating the labour shortage issue as getting much worse. Perhaps a more noteworthy finding was that only one firm in the Alberta sample saw an improvement in the situation in the availability of skilled workers. Also ranking high were materials, energy, and labour costs. On a regional comparison, note that the two leading issues for the national sample of surveyed firms were energy costs, materials costs, and the strong dollar. So, the respondent reactions suggest that the labour shortage is indeed a real issue for Alberta producers.

The problems related to the costs of energy, materials, and the dollar are competitive issues are, in many ways, out of the hands

Table 2. Alberta Manufacturer Employment Trends

Time Period	Shrink	Remain Same	Grow
2006 vs. 2005	22.8%	17.8%	59.4%
2007 vs. 2006	14.8%	33.7%	51.5%

Table 3. Percentage of Firms Indicating Selected Problem Worsened Significantly

Problem	Alberta firms	All surveyed firms
Availability of qualified personnel	95.6	54.5
Materials costs	79.2	73.2
Energy costs	74.5	81.2
Labour costs	72.8	45.2
Strong Canadian dollar	53.5	66.0
Capital costs	47.5	33.6
Domestic competition	28.3	23.4

of Alberta's manufacturers and often have influences well outside of the provincial or national economy. Materials costs have been largely driven by burgeoning demand for raw materials across the globe, especially from China (Kaplinsky 2006). This challenge hits Canadian manufacturers hard, particularly those involved in subsectors such as metalworking and advanced materials industries. Further, the strong Canadian dollar is also outside the purview of Alberta manufacturers and is more a product of international economic situations and currency movements. Of course this problem hits exporters the hardest, as many firms ship significant amounts of products to the United States and elsewhere. Ironically, a once-strong US dollar enabled strong exports of Canadian manufactured goods to the US. On a final note, the rise in energy costs have led to the boom in the Alberta economy and therefore in many ways created the labour shortage.

The ranking of the labour shortage issue gives every impression of being a salient challenge for Alberta manufacturers and one that needs to be addressed within the foreseeable future. This, however, is one manufacturer problem that could perhaps be attended to by individual firms or on an industry-wide basis. It is apparent that the labour shortage is a challenge, but is it simply a short-term concern? As mentioned earlier, the popular media and trade groups across North America have sounded an alarm regarding this problem (see NAM 2003) and, for over a decade, many researchers have shown that skilled labour shortages could have potential impacts on manufacturers and their competitive positions (e.g. Knudsen, et al. 1994; Fasenfest and Jacobs 2002).

In order to gauge the projected competitive challenges for manufacturers, respondents where asked to select the top-five issues that will challenge their operations over the next five years. Twenty possible responses could be selected, ranging from workforce issues to supplier concerns. As seen in Table 4, the 'availability of skilled and experienced personnel' ranked first overall in the survey, with over three-quarters of the Alberta respondents indicating that this was indeed an important issue. This percentage varied widely across Canada. The national survey average was just under 48% while fewer than 40% of firms in both Ontario and Quebec deemed this to be a serious issue. This is surprising given that both provinces could be viewed as manufacturing-intensive relative to the rest of the country. Given the recent employment demands of the extractive industries (and supporting firms) involved in the oil sands of Alberta, it is understandable that manufacturers are

Table 4. Problems that will Impact Manufacturers over the Next Five Years

Issue	Alberta firms	All surveyed firms
Availability of skilled and experienced personnel	76.7	47.9
Increasing costs of doing business	61.2	57.9
Stronger Canadian dollar	42.7	54.9
Managing business growth	42.7	22.7
Changing patterns of customer demand	41.7	39.4
An ageing workforce	24.3	25.7
Technological change	23.3	26.0
Introducing new or improved processes	23.3	24.7
Bringing new/improved products/svcs to market	17.5	31.2
Increasing competition from other countries	15.5	23.3

feeling a labour crunch. Across Canada overall, the responses to the question indicate that a substantial number of manufacturing firms see workforce issues as a challenge well into the future.

The manufacturing workforce shortage has been established as a leading concern for Alberta producers, a useful follow-up question could be: how are firms impacted? The results from such a question are shown in Table 5, which also compares the Alberta responses against those of the larger national sample. Note that across every measure (the top-five were shared by both groups), Alberta manufacturers indicated that they were negatively impacted at a much higher rate. Given the current situation, it is understandable that the labour shortage has held back firm level growth and has lead to increased costs. Competing with other sectors for workers can only serve to further increase labour costs. The fifth-rated issue regarding efficiency improvements provides a dilemma for firms: how can efficiency improve without skilled workers?

What is being done to address current and projected shortages for the manufacturing labour force? Table 6 provides the responses to this question on the survey. On this question, manufacturers could choose as many options as needed. Given that the market is extremely tight, virtually all of the surveyed firms are making concerted efforts at upgrading the skills of current employees and moreover, making efforts to retain these workers. How are firms retaining employees? One way is through increased wages, but given

Table 5. How the Labour Shortage is Impacting Manufacturers

Impact	Alberta firms	All surveyed firms
Specific skills shortages constraining growth	41.7	26.2
Significant increase in labour costs	41.7	22.9
Competing for labour with other businesses or sectors	37.9	21.3
Experiencing skills shortages but no constraint	37.9	18.7
Skills/labour shortages require efficiency improvements	28.2	16.4

Table 6. Strategies to Address Current and Future Workforce Shortages (for Alberta Manufacturers*)

Strategy	% of firms
Upgrade skills of current employees	94.6
Increase retention efforts	94.4
Increase recruitment efforts	91.5
Hire recent immigrants	90.0
Hire younger people	89.3
Hire personnel away from other firms	76.0
Simplify processes	73.9
Increase automation	65.2
Change job descriptions	53.6
Form alliances	44.9
Outsource work domestically	42.0
Recruit directly from abroad	39.7
Outsource abroad	23.2

** for the 103 Alberta-based survey respondents*

the margins in manufacturing, this is difficult. Also, as mentioned in Nikiforuk (2006) and during conversations at the CME-sponsored conference, turnover is extremely high as workers jump from firm to firm looking for the "next best thing." So, it appears the firms need to retain workers. Two retention-related conversations from the CME conference merit further mention. A director at a motor vehicle components producer explained that his firm offered a two-dollar per hour bonus if workers showed up for work on time for just two weeks. Thus far, only a third of the workforce was able

to qualify for this. Additionally, a manager from a leading pipe manufacturer explained that his firm even provides pizza parties in an effort to retain valuable workers on second, third, and weekend shifts and to fulfill backlogged orders.

In spite of retention difficulties mentioned above, firms still see training as a way to address the manufacturing workforce shortage. Thornhill (2006) concluded that training was important for producers, especially for firms involved in industries that are not considered to be advanced manufacturers. In other words, many manufacturing firms (even in basic production) could potentially remain competitive if they invested in their workforces. Such instruction can take the form of additional machinery skills training, flexible manufacturing education, or training on 'lean' manufacturing procedures. On the survey instruments, firms were asked to indicate their training budgets in terms of a percentage of sales; the results are shown in Table 7. Note that almost 80% of firms invest less than three percent of sales on formalized workforce training; this is not unusual among manufacturers or indeed most firms. It should be mentioned however, that as seen in Table 8, almost half of the manufacturers expected to increase their training budgets for both time periods under study. For the rest of the Canadian manufacturers taking part in the survey, this number did not exceed 35%.

With this said, how do training expenditures actually relate to other firm-level measures? Table 9 presents the results of tests measuring relationships between formal training expenditures and selected variables. The percentage that manufacturers spend on training correlates positively with two other measures of firm-level investments: informal training and process engineering expenditures (both at $p \leq 0.01$). This would suggest that firms that spend relatively higher sums on formal training also tend to be the same firms to implement informal training programs as well.

Table 7. Formal Training Budgets of Alberta Manufacturers

Training budget	% of firms
0%	5.3
0 to 0.9%	24.0
1.0% to 2.9%	49.3
3.0% to 4.9%	10.7
5.0% to 9.9%	5.3
10.0% and above	5.3

Table 8. Current and Planned Training Budget Expenditures for Alberta Manufacturers

Time Period	Shrink	Remain Same	Grow
2006 vs. 2005	2.7%	52.0%	45.3%
2007 vs. 2006	0.0%	53.3%	46.7%

Table 9. Relationships between Training Budgets and Selected Measures for Alberta Manufacturers. (Gamma Statistics)

Measure	Training budget
R&D intensity	*0.512
Informal training expenditures	*0.861
Process engineering expenditures	*0.488
New product intensity	0.219
Firm size	0.133
Export intensity	-0.056

$^{*}\ p \leq 0.01$

These also tend to be the same firms investing in forward-leaning activities such as the improvement of manufacturing processes. Two measures of innovation included on the survey were R&D intensity and new product intensity[2]. An additional variable, export intensity[3], was included to test whether there was a relationship between training budget and those firms that are active on international markets. Training budget expenditures do not show significant statistical correlation with export intensity, indicating that training budgets are not higher among firms with more of an international orientation and indeed, the overall survey indicated that Alberta firms were concentrated largely on domestic markets. Training budget expenditures do correlate significantly with R&D intensity at 99%, but not with new product intensity (p = 0.09). While no causal relationship can be inferred from these tests, at the least, these findings point to a statistical relationship between the proportions of revenue accorded to worker training and one measure of innovation within the firm. In sum, the firms that are devoting considerable funds to research activities tend to be the

[2] Respectively, the percentage of sales spent on R&D and percentage of sales derived from products three or fewer years old.

[3] Exports as a percentage of a firm's total sales.

same firms that accord sizeable percentages of firm-level income to formal worker training programs. The significant relationships seen in this table are important in that they suggest that firms are not merely choosing one type of training over another. Rather, the manufacturers who spend on formal training also tend to spend on informal training activities, a relationship that is not always the case with many firms. Additionally, the data provide some indication of forward-looking firms, given the relationships with research and engineering expenditures.

Discussion and Summary

The survey responses suggest that the labour shortage for Alberta manufacturers is a competitive challenge of substantial importance to these firms, and moreover, is anticipated to be a concern well into the future. Over three-quarters of the Alberta-located survey participants viewed the labour shortage as a problem that could significantly impact their operations over the next five years. This finding is paired with the results indicating that over half of the responding manufacturers planned to expand employment. Or put another way, relatively few firms provided any indication of decreasing employment. This stands in contrast to trends in manufacturing employment seen in industrialized states such as Great Britain, the US, Japan, and Germany. This demand coupled with changing population demographics (e.g. aging workforce and stable or shrinking national populations) suggests that human capital shortages will remain among the most pressing competitive issues for manufacturers into the foreseeable future.

The literature of industrial evolution and locational change suggests that these findings are of great importance to the future competitiveness of the Alberta manufacturing sector. From this perspective, firms that are not able to meet their labour force needs in their current locations must respond. One option in this situation would be to hire new employees from other regions and assist in their relocation. Such an option is particularly realistic when a small number of position shortages are involved. However, when a region as a whole is impacted by a broad labour shortage, relocation of an industry's operations becomes a much greater risk. How to avoid such relocations, and how to identify firms at particular risk of relocation (or alternately those at low risk of relocation) are questions of great importance.

The survey responses provide support for a relationship between training budgets and R&D spending. While further firm-level research must be done, these initial explorations would indicate that manufacturers such as the ones considered here are innovators and perhaps best understand the need for workforce investments in order to remain competitive. These are the very firms that appear to be poised to remain competitive within both domestic and across international markets. Again, from an industrial evolution perspective, these firms are most likely be early in their life cycles and have the potential for many years of profitable operation – precisely the kind of firms an emerging industrial region such as Alberta should be most concerned about losing. From a policy standpoint, one possible solution to this dilemma would be to strengthen manufacturing-related programs at educational institutions, thus helping firms address their problem in their current locations. Another point worth mentioning concerns worker retraining. Many declining manufacturing subsectors across Canada have experienced recent workforce layoffs. Could these workers be retrained for other advanced manufacturing operations? Granted, large-scale relocation of the manufacturing workforce would be a complex issue, but the pronounced downturn of secondary sector activities in traditional locations such as Ontario and Quebec may spur this movement.

While the signs of increased hiring in the secondary sector are also encouraging, the lack of skilled workforces potentially supports Porter's (1990) findings on particular disadvantages of regions. That is, manufacturers in Alberta are at a competitive disadvantage given the shortages of both skilled and unskilled workers. Some firms are addressing this issue through some combinations of increased wages and increased training levels. Given the high turnover rates discussed earlier, however, many manufacturers fear and expect high turnover. This particularly impacts producers utilizing advanced manufacturing technologies. Some manufacturers indicated during the CME conference that they are now looking to 'outsource' production to other parts of Canada. A recent CME initiative, *icosmo* (Innovative Canadian Oil Sands Manufacturing Opportunities), attempts to link manufacturers from the rest of Canada to Alberta manufacturers involved in oil sands extraction activities.

The demand from all economic sectors has led to another problem that could have long-term implications for the competitiveness of Alberta manufacturers and for the regional economy in general. Bowlby (2005), the CME, and others have noted the high school

dropout rate in Alberta, as opportunities in the private sector become attractive due to the labour shortage and accompanying high wages. While this behaviour represents a short-term solution to the labour shortage problem, especially in low-paying and low-skill entry-level positions, this of course has long term ramifications, especially when resource (especially oil and natural gas) prices fall in a boom-and-bust cycle. Declining resource prices impact the lowest-level jobs the most, as basic production activities are scaled back rapidly in response to diminishing demand. In sum, what happens to the workforce during the next bust cycle?

The categorical and ordinal nature of the survey questions provided for a user-friendly survey but limited the types of statistical tests that could be run. Further examinations are in order on this issue, starting with a series of firm-level interviews in order to determine individual company responses to the shortage in skilled labour in Canada. With nearly all of the respondents indicating that the labour shortage is an ongoing and over three quarters viewing this as an impending problem, the issue will be explored in greater detail via further interviews. Given these upward swings and demands for labour from other sectors of Canada's economy (e.g., extractive activities, services), manufacturers indicated that the shortage of qualified, skilled workers is both a current and pending competitive issue, one that at times impacts their operations. The results of this research portend the makings of an ongoing shortage of workers for high value-added manufacturing. The response of Canadian firms to this situation, including the possibility of locational shifts, will make for many interesting research possibilities for geographers and other business researchers in the years to come.

It should be emphasized that this research was completed before the economic downturn of 2008-09. While it is all but certain that this worldwide economic crisis is having an important impact on Alberta's manufacturers, it should be noted that Western Canada's industrial and resource mix appears to have made the crisis less pronounced in Alberta than in many other North American regions. Thus, although it should be anticipated that the study results would be considerably more negative if it were to be completed again in 2009, it could be anticipated that labour shortages, especially in specific highly-skilled occupations, would still be much more of an issue for Alberta than for other established manufacturing regions elsewhere in Canada and the United States.

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