



The Alberta Health Industries Innovation System

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Project Manager: Dr. Peter Josty
Principal Investigator: Dr. Cooper H. Langford
Research Associate: Astrid Jacobson,
Research Assistant: Julie Allati-it

Executive Summary

This study is about Alberta's health industries, an exciting and volatile sector. The sector opens the opportunity for Alberta to participate actively in a growing industry that is projected by knowledgeable observers to generate revenues of more than \$10 billion in Canada alone. The health industries that operate at the level of support to the institutions of care delivery form a diverse group in Alberta. The study below is based on a database of 300 firms, institutions, and government agencies. In this report we divide the industry into nine groups that reflect both the character of products or services and the place in the value chain. These groups are: biotechnology, pharmaceuticals, medical devices, nutraceuticals, health services, suppliers, information technology (IT), consulting, and development. Biotechnology and pharmaceuticals overlap extensively. In depth interviews were conducted with a 10% sample distributed similarly to the numbers of members of each group. Activity in Alberta is not intensive and is distributed widely among these groups. This study found no strong sense of community and that strong industry associations are lacking, with the exception of bio-Alberta, which covers part of this sector and activity in some related sectors.

As might be expected, firms are concentrated in the two major metropolitan areas, Edmonton and Calgary. The two have similar overall firm populations with Edmonton leading in biotechnology and Calgary in IT. The vast majority of firms are small, and large firms are scarce. Most firms are young. A majority of firms have products still in the R&D stage and only a minority have well established products. The majority of revenues are, as expected, derived from sources outside Alberta. Among firms interviewed in this study, nearly 25% had revenues over \$1 million. The overall structure suggests a family of nascent industries (plural). These companies do form alliances within and beyond Alberta. A very significant fraction of firms have connections to one of the poles of strength in the province: the universities and research institutes, or the health regions. Linkages to research institutions (again within and beyond Alberta) are widespread and may be regarded as a driver of development. Linkages to the health regions were found to be problematic.

The key governmental infrastructure organizations identified were the National Research Council's IRAP (industrial research assistance program) and the AHFMR. The agencies for transfer of technology associated with the universities: UTI (U. of Calgary) and TecEdmonton (U. of Alberta) have been engaged with the health industry, as is expected since

biomedical industries are the leading beneficiaries of university licensing and spin-off internationally.

The “Alberta Advantage” was recognized by individuals in terms of low taxes and an ‘entrepreneurial spirit’. Still, much of the attraction to location in Alberta was based on personal factors. However, benefits of tax policy were not seen as applying to firms. The tax climate of BC or Quebec was seen as much more favourable to the health industry. Like smaller young firms in most industries, finance was seen as a major barrier by most. Competition from oil and gas was regularly mentioned. Nevertheless, a few reported that raising money was straightforward, and many that it is important to attract investment from outside Alberta.

The health industries are global, especially in their science base, but there is evidence that we in Alberta find places in the global system where resources of both codified (“know what”) and tacit (“know how”) knowledge are brought together to build a successful niche that integrates well into the global system. At present, these are not focused in any one of the sub-groups. In health industries, secure regional advantage comes with innovations that erect barriers to imitators. This is most readily accomplished in areas of radical innovation. Two striking Alberta examples are found in the “personalized medicine” initiatives of Chenomx in Edmonton and the advanced imaging systems from IDC in Calgary.

Concern for the sustainability of health systems throughout the industrialized world recommends attention to disruptive innovation that simplifies delivery of patient outcomes while reducing the load on health professionals. Important recent Alberta examples come from SagaTech Electronics in Calgary that has simplified diagnosis of Sleep Apnea so that it becomes a home rather than hospital procedure, Litebook of Medicine Hat who produce hand-held light therapy that offers portable treatments to replace office ones, and CV technologies of Edmonton who have shown how to bring to market derivatives of traditional remedies that meet the standards of scientific medicine.

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1. Introduction

This study is about Alberta's health industries. This is an exciting and volatile sector. It opens the opportunity for Alberta to participate actively in a growing industry that is projected by knowledgeable observers to generate revenues of more than \$10 billion in Canada alone, and the firms in Alberta are not at all limited to Alberta markets. The predominantly young Alberta firms, mainly founded since 1990 and on average employing about 25 people, still need support from their community to achieve their promise. The elements of support of course include investment, but there are a number of intangibles that make key contributions. These include inputs from research institutions and the health care system, two areas of Alberta strength. Since all of the entrepreneurial executives we have interviewed would report that innovation is much more than invention or discovery, these inputs include sources of knowledge about management, making markets, and techniques of production and manufacture as well as science and technology. Much of this knowledge is of the sort that is carried by experienced practitioners and cannot be, or has not been, written down. Finally, the inputs include the contributions from associations that assist the flow of knowledge, public agencies that support innovators, and a congenial government policy environment. These inputs make up an *innovation system*. When a regional innovation system such as Alberta's is analyzed as it interacts with a particular industrial sector, the term "cluster" is often applied. The Alberta health industries are not yet as mature as most conglomerations called clusters. Our industry is an adolescent, but like our young people it carries the promise of our next generation. It can make a profound contribution to our society and our economy. Like other adolescents who carry our future, it merits active support from all Albertans.

The opportunities that lie ahead are exciting and varied. Profound innovations in health are promised by the integration of IT and nanotechnology into health industries. Such combinations are the source of radical innovation *via* complex new combinations that are both hard to imitate and to provide sustainable advantage. In the area of molecular biology the target is moving from the population average approach to a patient-specific personalized medicine based on understanding individual metabolism. Beyond these the sustainability of the health system depends on many innovations that will not be primarily a matter of technology, but a matter of organizational innovation and ways of doing business.

This study examines the structural characteristics of the Alberta health industries *innovation system*, primarily from the perspective of cluster concepts of spillovers and knowledge flows as stimulants of industrial growth. The focus of the study is on firms and the infrastructure organizations that support industry development. The concept of an *innovation system* recognizes that innovation is a complex process. Industrial innovation has firms at the centre. However, many other factors are important.

- Public institutions prepare human capital and supply research inputs.
- Associations of firms support communication and learning.
- Interactions with customers, suppliers, and competitors are regularly at the top of the list of factors influencing innovation identified by firms.
- Governments provide both direct and indirect support as well as establishing the legal and regulatory framework.
- Specialized services of lawyers, accountants, and other professionals are often industry specific.
- Finally, the social climate in which firms operate is influential.

If we are to understand how to foster innovation and promote growth in Alberta's health industries, we need understanding of the whole system.

The starting point is an inventory of current activity and a database of 300 firm, government agency, association, and research institution actors that has been compiled and updated to 15 07 2006 . An effort has been made to ensure that all organizations listed in the database are active. The second phase has been an analysis of statistical data from Statistics Canada and certain previous studies of the Alberta scene. The final phase has been a qualitative study of more than 10% of the actors in the database via semi-structured in-depth interviews. The interviews are complemented by some statistical information on the firms interviewed. Overall, we gain a picture of a still fragmented young industry with distinct success stories, and major opportunities not yet fully exploited. In particular, the uniquely large regional health authorities in Calgary and the Capital Region, offer a special opportunity for development of industrial activity related to the future structure of health care delivery. As well, the research institutions are strong and provide a source of talent and raw ideas.

The definition of health industries has been chosen so as to focus on the activities that support the direct providers of health services to patients. Thus, physicians, nurses, etc. are generally not included while the

boundary on included firms is set by coverage of activity in support of the formally recognized professional deliverers of health care, with a limited extension into nutraceuticals and non-“Rx&D” pharmaceutical companies. The conception of the scope of the health industries described above roughly follows the guidelines for the role of the private sector recommended by Michael Rachlis in *Prescription for Excellence*¹.

2. Structure

2.1. *The database*

The primary subdivision of actors is into firms, associations, government agencies, universities, and research groups. 86% of the database is comprised of firms. Classification of firms was constructed largely to optimize use of the Statistics Canada data that classifies firms by the North American Industry Standard Code (NAICS). There is no simple mapping of NAICS codes onto the territory of this report but the 9 categories shown in Figure 2.1 were reasonably successful in comparison to alternatives. Firms are assigned to categories in terms of their principal activity, as is the case for NAICS coding. Software firms are included in this database if it is clear that they pursue a major activity related to health care. This is obviously a group that is hard to disaggregate from the larger population of software firms in NAICS categories.

The largest and most diverse category is suppliers. Medical devices, biotechnology, pharmaceuticals and IT are major sectors to which we give extended attention in later sections. There is a strong overlap between biotechnology and pharmaceuticals: 60% of firms that are defined as primarily biotech are also involved with pharmaceuticals, and 72.4% of pharmaceutical firms are involved with biotechnology. As you can see from Figure 2.1 (page 4), together the two make the largest sector. The distribution of firms in the database between the two major centers, Calgary and Edmonton is shown in Figure 2.2 (page 4). It will be seen that activity is distributed fairly evenly between the two. The only differences of real statistical significance are the greater concentration of biotechnology companies in Edmonton and IT companies in Calgary. Nevertheless, both centers are represented significantly in both sectors.

¹ Michael Rachlis. *Prescription for Excellence: How Innovation is Saving Canada's Health Care System*. HarperPerennialCanada, Toronto, 2004.

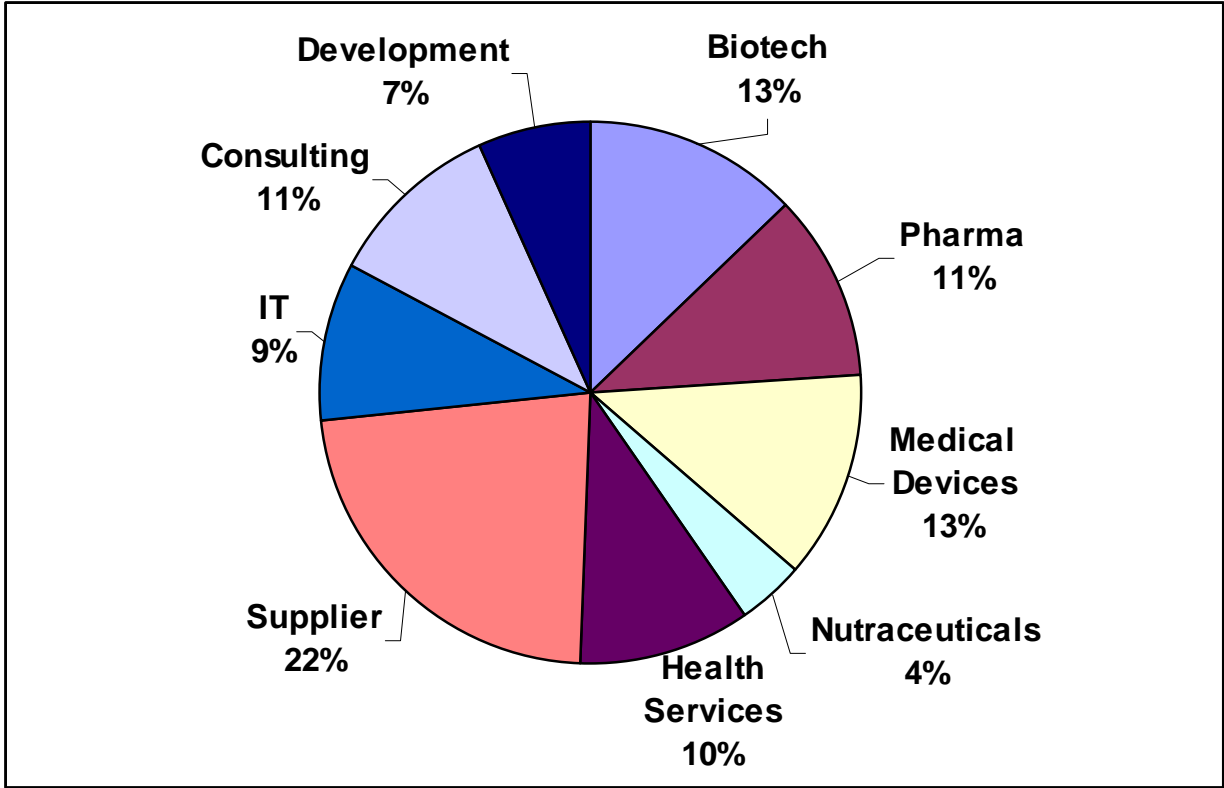


FIGURE 2.1 DISTRIBUTION OF COMPANIES IN THE DATABASE BY THEIR FOCUS.

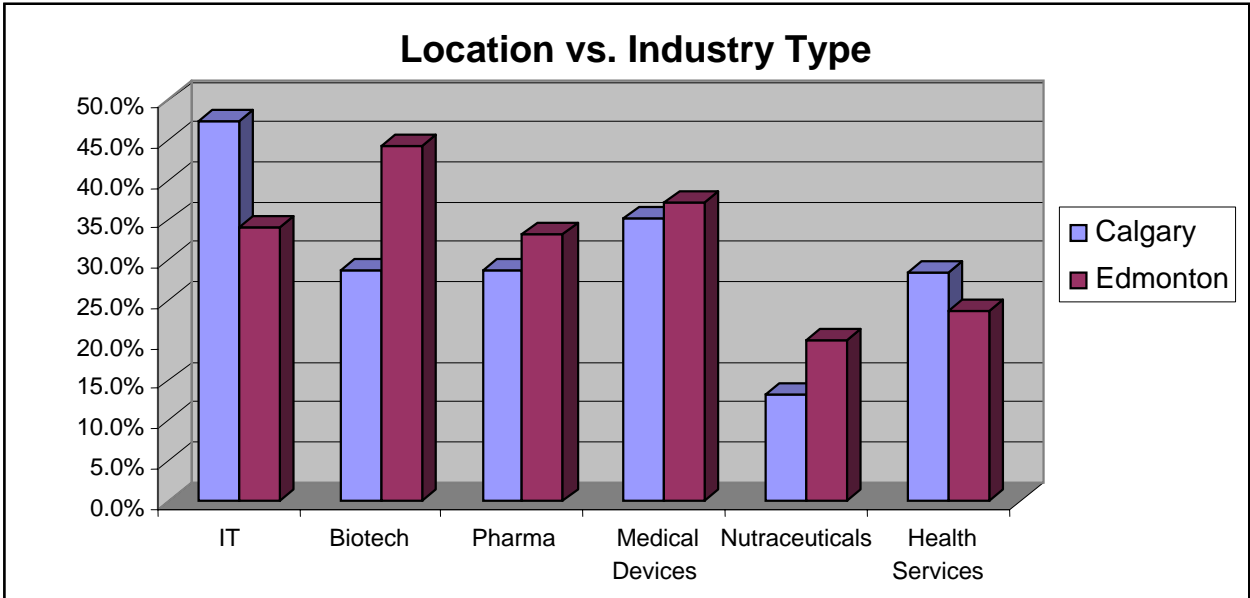


FIGURE 2.2 DISTRIBUTION BETWEEN THE TWO MAJOR CENTERS OF FIRMS IN THE DATABASE.

2.2. Statistics Canada data

Statistics Canada collects data across the full spectrum of activities related to health industries. The advantage is the most complete data, the consequence of its procedures, reputation, and statutory authority. The disadvantages are the ambiguities with many NAICS codes even at 5-digit² level.

Figure 2.3 shows the distribution of companies at the 5-digit NAICS code level across the province. The data reveal significant activity distributed over the province, but do omit biotechnology since it is not an “industry” category in the NAICS system. Biotechnology firms are grouped by the nature of their products. The category of scientific R&D services no doubt counts firms not in the health industries, but may still be relevant in that there is no doubt possible talent flow into health related activity from firms in this category but currently outside health related work. (Experience of Litebook, see below, illustrates this). One suggestion the figures offer is that there is a level of activity in biotechnology and medical devices that may have reached the scale that can support mutual learning.

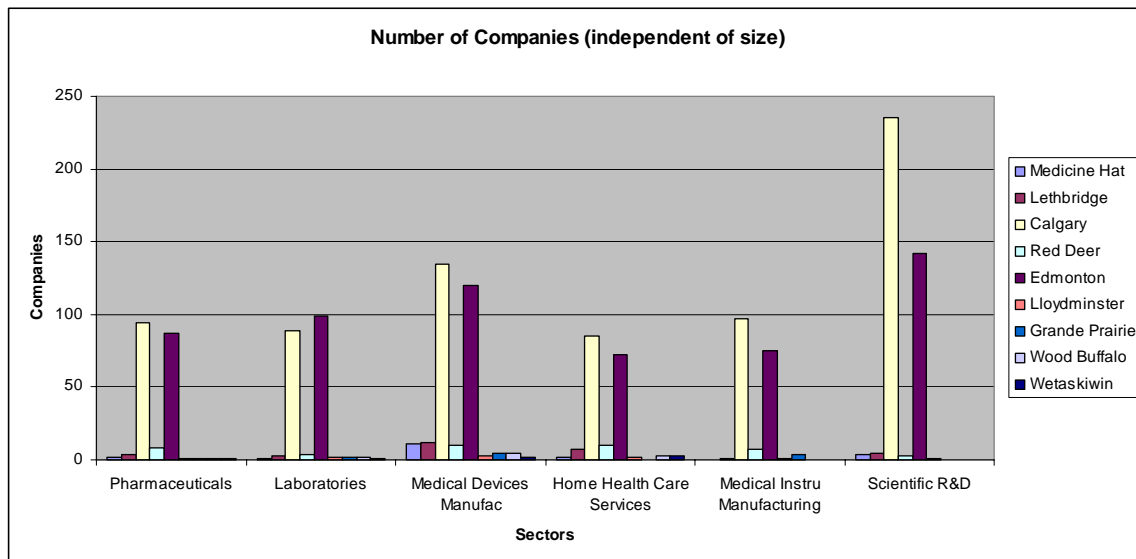


FIGURE 2.3 DISTRIBUTION OF FIRMS (BY NUMBER) ACROSS ALBERTA (2007).

The size distribution of firms in the medical supplies and equipment manufacturing, measured by employment, is shown in Figure 2. 4. Firm distribution in this category follows a typical “power law”. That is, there is a

²In the NAICS code, the first two digits designate the sector, the third digit designates the sub-sector, the fourth digit designates the industry group and the fifth digit designates specific industries.

very large number of very small firms and a very small number of large firms. None of the firms in the province exceed 500 employees. (This size distribution is approximately characteristic of the other categories as well.)

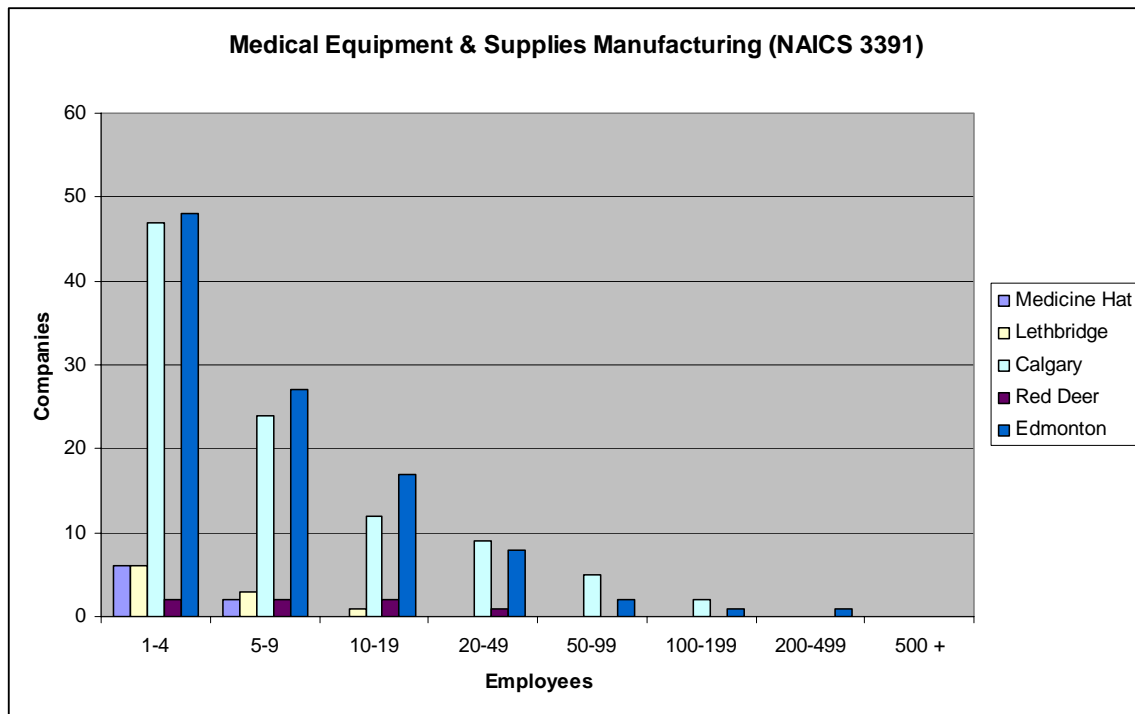


FIGURE 2.4 APPROXIMATE “POWER LAW” DISTRIBUTION OF SIZE OF FIRMS IN MEDICAL EQUIPMENT AND SUPPLIES MANUFACTURING (2007)

Thus, there are not yet any firms of a scale to achieve global recognition except perhaps in a very highly specialized area. There is one firm in each of Calgary and Edmonton in the medical devices (Edmonton) and medical instrument manufacturing (Calgary) sectors with employment over 200 and two firms in each city in these sectors with employment above 100.

2.3. The HABIT study

A survey was published in 2004 by the “HABIT team” (Health and Bio Industry Sector Team). This was organized by Alberta Economic Development, and Alberta Innovation and Science, with assistance from BioAlberta³. The survey was conducted in the summer and fall of 2003. Eighty-six companies from a database of approximately 250 responded to the survey, although, in many cases, the respondents did not respond to all

³ Alberta Economic Development, “The Alberta Health and Bio-industry Survey”, AED, Edmonton (2004).

questions. The response rate on individual questions ranged from ~6% to ~42% of respondents with a median near 23%. With omitted questions taken into account, the sampling is similar to our semi-structured interviews sampling. The database does not overlap ours 100% because some “bio” firms were not in health industries, but the profiles of the firms in the two studies are very similar.

Revenues reported in the HABIT study were 52% derived from outside Alberta, as expected. Royalties, license fees and contracts were significant contributors to revenue. The revenue distribution is shown in Figure 2.5. Thirty percent of the firms reported producing 100% of their products in Alberta, 15% reported producing 50 to 99% in Alberta, and 13% reported producing no products in Alberta. N/A (called “don’t know”) was the response of 36%.

Product stages reported ranged from established product to R&D. Only 18% reported an established product in the market and 23% reported a new product in the market. Products awaiting regulatory approval accounted for 16% and pre-clinical and clinical trials accounted for 15% each. Over 61% of respondents reported products in the R&D stage. N/A drew 16%. (The percentages exceed 100% since more than one response per respondent was appropriate.) The relative youth of firms in the database is clearly an important factor.

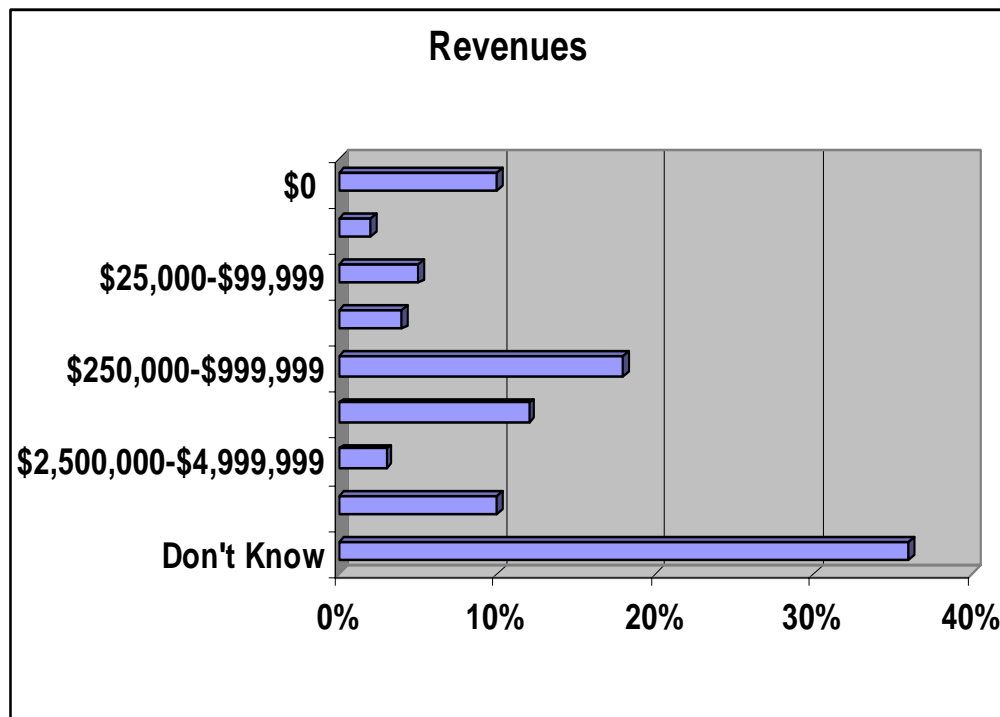


FIGURE 2.5. DISTRIBUTION OF REVENUE REPORTED BY FIRMS RESPONDING TO THE HABIT SURVEY IN 2003.

The distribution of reported clients of firms responding to the HABIT team survey is shown in Table 2.1. Percentages exceed 100% because most firms serve more than one type of client.

TABLE 2.1 DISTRIBUTION OF CLIENTS OF HABIT SURVEY RESPONDENTS.

Companies	55%
Hospitals/Clinics	30%
Retailers/Consumers	28%
Health authorities	26%
Other professionals	26%
Governments	19%
Physicians	19%
Universities	19%
Other	9%

An important aspect of the study was the frequency with which alliances were reported. Alliances for R&D were the most frequently reported at 34%. Marketing alliances were reported by 20% of respondents. Both manufacturing and investment/finance alliances were both reported by 16%. Clinical trials were the basis of 8% of alliances and 12% fell into an “other” category. The distribution of alliance partners is shown in Figure 2. 6. The striking feature is the prominence of universities and other research institutions. This close linkage is not found outside of the biomedical industries (Mowery et al,⁴). The “none” response at only 7% is also quite striking and not reproduced in surveys of other industries.

⁴ D.C. Mowery, R.R. Nelson, B.N. Sampat, and A.A. Ziedonis, “Ivory Tower and Industrial Innovation”, Stanford Business Books, Stanford, CA, 2004.

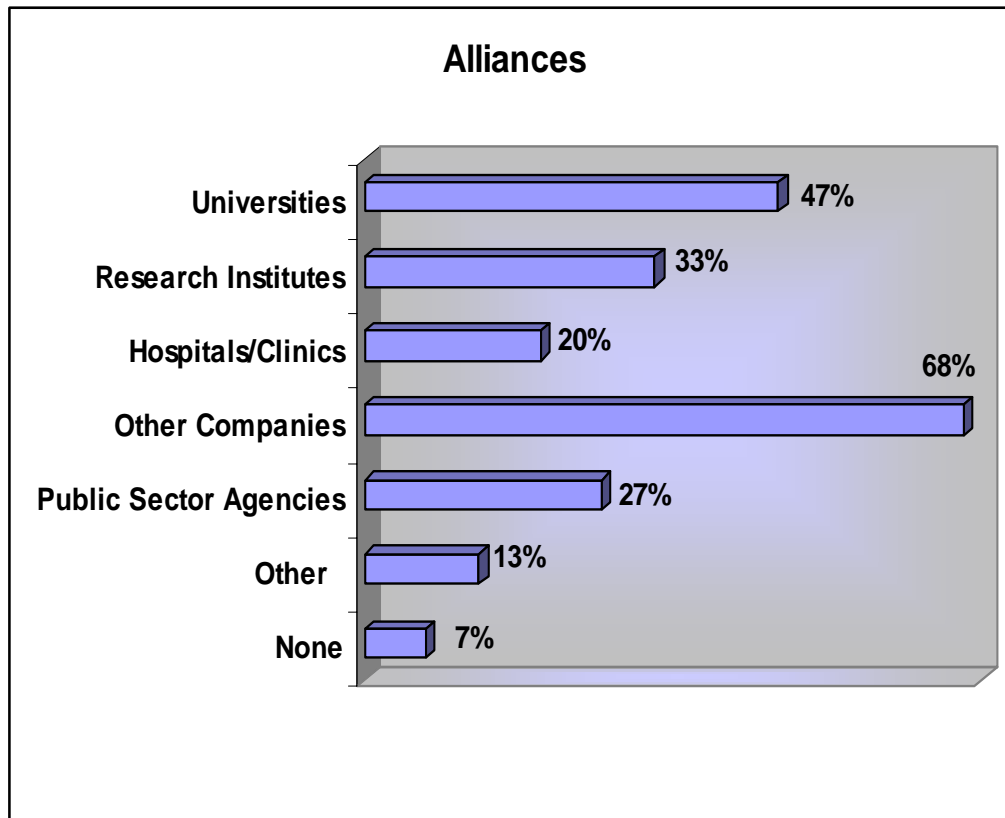


FIGURE 2.6. ALLIANCE PARTNERS OF RESPONDENTS TO THE HABILIT SURVEY.

2.4. *The Bio-Alberta “State of the Industry 2005” survey*⁵

The Bio-Alberta 2005 survey significantly extends the information from the HABILIT survey. Eighty-eight of 106 members of Bio-Alberta responded. Over 10% of the member firms are in our interview sample. 37% of employment reported falls within the present categories of health industries including 24% in health biotechnology and 10% in medical devices. More than 3300 Albertans were employed in the bio-industry firms. The survey reports over \$160 million in health biotechnology revenues from reports about revenue by only 38% of the respondents. Overall, bio-industry revenues are reported to have risen 15% compared to the previous year.

It is noteworthy that 13 firms reported entering into new alliances in 2004. Of these, 5 were for R&D, 3 for marketing and 2 each for

⁵ <http://www.bioalberta.com>, accessed 4 12 2006.

manufacturing, distribution, and clinical trials. The stages of product development are summarized in Table 2.2.

TABLE 2.2 STAGE OF DEVELOPMENT OF PRODUCTS

Stage of product development	Number of companies*
R&D	44
Pre-clinical	24
Clinical trials phase 1	10
Phase 2	6
Phase 3	7
Established product	30
Other	5

* Number of companies exceeds number of respondents because respondents could indicate more than one category.

2.5. Profiles of the firms interviewed

For comparison with the above information, the in-depth semi-structured interviews covered just over 10% of the firms in the database and approximately 13% of the infrastructure and governmental organizations. The activity of firms was distributed as follows: 29% pharmaceuticals and/or biotechnology, 27% IT, 19% medical devices, 13% services, and 4% nutraceuticals. The revenue distribution for these firms was: 17% little to none, 13% less than \$500,000, 41% \$1- 10 million, 8% greater than \$10 million, and 8% not reporting. R&D expenditures were as follows: 16% little to none, 36% less than \$500,000, 24% \$500,000 to \$1 million, 20% \$1 to 10 million, and 4% over \$10 million. Data on distribution of customers is consistent with the HABIT study conclusion that the majority are outside Alberta.

2.6. Summary

The structure revealed by the statistical information is of an industry group with a number of distinct components. In this analysis we have grouped the firms into nine sectors. None of them is a truly dominant sector; the distribution is more nearly one of a set of sectors of similar weight. None of the sectors has a firm with more than 500 employees, yet several of the sectors work with the health system that includes some of the province's largest employers, and many of the firms also gain credibility and stability from proximate university relationships. A few firms have achieved international reputations. The sectors typically display a "power law" type firm size distribution with a few larger firms and very many small firms. The firms are young and a large fraction of them have little or no

revenue and many products in the R&D stage. This suggests that the best short description would be of a family of nascent industries (plural). An important point is the evidence that these companies do form alliances and a significant fraction have connections to one of the poles of strength in the province: the health systems or the universities and research institutes.

3. Networking

In some of Alberta's strong industries a network climate exists⁶ where personnel move among firms, meetings occur in which "war stories" of the business are exchanged, new developments reported, and opportunities for collaboration are identified. Such a learning environment encourages entrepreneurship and innovation among people working in the sector, and offers the image of an attractive location to businesses considering expansion or a new initiative. Little in our interviews suggested that this is the environment that firms in the health industries in Alberta perceive. More commonly, the sense expressed was one of isolation. In the interviews, non-local associations were rated significantly higher than Alberta ones in influencing the firms' innovative capacity.

*We feel very lonely. There's not that many people out there. I'm desperately trying to hire someone just now for regulatory affairs, someone who knows medical devices. I'm actually flying a guy in... I'm having to use very expensive consultants. There's just no pool of people in medical devices in this area. If they are out there I'm just not finding them.... There's a few, but there's not much. We're diversifying in this city but it's still oil and gas.*⁷

The sub-sectors in health tend to form distinct communities and two of the stronger communities, in IT and in biotechnology, find a natural network with firms outside the health field. In IT, and to a lesser extent biotechnology, the strongest firms can be outside health and many of the most clearly foreseen opportunities in those sectors in Alberta lie outside health. It is reasonable to expect that vigorous general growth in these fields will lead to some "spillover" into development of new health industry ventures. Certainly, far-sighted observers see the power of linking platforms to yield major innovations. Consequently, policy favourable to growth in IT and biotechnology in general may be an appropriate objective

⁶ See the example described in C.H. Langford, J.R. Wood, and T. Ross, "The Origin and Structure of the Calgary Wireless Cluster" in D.A. Wolfe, ed. "Clusters Old and New" McGill-Queens Press, Montreal and Kingston, 2003. Chap. 6.

⁷ The paragraphs in italics are quotations from interviewees.

for those interested in growing Alberta health industries. Our interviews indicate that BioAlberta is the strongest Alberta association in support of the industry. It has proved an effective proponent and done a great deal to raise the profile of the industry. It is active in representation to government, organization of knowledge transfer and mentoring, and leveraging the group purchasing power. It is an Alberta organization because of the provincial jurisdiction but it has regional and national linkage.

BioAlberta. I think they're important, I think they're key, especially for smaller companies...

One well informed commentator suggested that some of the health industries are not yet mature enough to fully benefit from associations. His test was that associations could be recognized as effective when firms value them enough to contribute significantly to their financial support. Another put it this way:

BioAlberta is a good network organization, but you have to have something to network into, and for bio/pharma in Alberta there's not [too] much to network into.

Two important linkages in the networks need to be strengthened. The industries' linkages to universities remain less than optimal (see below). The critical linkages to the regional health authorities are seen as very weak by the interviewees.

4. The role of research institutions

The universities and research in hospitals have played an important role in the emergence of the young firms we interviewed. This is not a unique Alberta phenomenon. Analysis of both spin-off and licensing of IP from universities shows that the biomedical field leads worldwide⁸. These two paths of commercialization of university research are not nearly as common in any other sector of industry. The key factors are the critical role of IP protection in the long development cycles of drugs and other health care products in the regulatory framework and the relative youth of the world science base in biotechnology and advanced molecular biology. The link of product innovation to basic research conducted in the public sector is stronger. Contrast, for example, IT where hardware innovation is critically linked to manufacturing process innovation that is outside the scope of most public sector research. However, there are indications that

⁸ See footnote 4 above.

some respondents in the medical sector are also finding this to be an issue. One interviewee working in the bio-pharma field reported that:

...I made a conscious decision to leave the university to do the pharmaceutical research, but also to do the science that I'd been trained to do. It sounds funny, but I felt that at the university I wasn't able to do what I wanted to do, in terms of the research dollars I would need to get the research done. I thought I would be more successful doing the research on my own and trying to fund it myself.

Nearly 72% of the firms interviewed reported influences of the universities (and affiliated hospitals). Spin-off of firms based on ideas generated in university research was significant, both by formal pathways involving the institutions and by informal pathways where entrepreneurial activity occurs by entrepreneurs leaving the research institution to pursue the industrial opportunity. The difficulties in developing a company through the university were mentioned by several interviewees, as illustrated by the following:

A lot of universities think that they've hit the motherload with these companies and they cripple them, so that they can't develop. Because no investor is going to come in and put money into a company if a university maintains that it has at least 50% of the IP, it's already hard enough for them to get their money back...

The interviews give case study evidence for the conclusion reached statistically that university IP transfer and spin-off exceeds that through tech transfer organizations, and that is counted officially⁹. However, the relations between universities and firms is much more complex than simple transfer of IP from university research. Other important relationships that lead to knowledge flow include teaching roles for firm staff, access by firms to research infrastructure, establishment of collaborative research projects with university laboratories, assistance with problem solving, identifying product opportunities from problems encountered in teaching hospitals, access to clinical trial expertise, and business process advice.

It is important to note that firm relations with universities are not limited to links to Alberta universities. The basic biomedical sciences are

⁹ C. H. Langford, J. Hall, P. Josty, S. Hall, A. Jacobson, "Outcomes of University Research in Canada: Innovation Policy and Indicators of Triple Helix Relationships," *Research Policy*, 35(10), 1586, (2006).

global and Alberta firms benefit from linkages to many universities outside Alberta. A fairly typical response about collaborations was:

that's going to be an interesting project because it ties in with the University of Alberta, McMaster University, UBC, we have a research component with a... company from the States...and also with the University of Toronto.

However, reported links are more frequently with Alberta institutions. In contrast to the remarks about associations, proximity to our mature research institutions seems to be a recognized benefit. A good deal of policy attention has been given to promotion of spin-off and IP licensing. Yet, the firms do not presently rank university research as a strong influence on their ongoing innovative activity, the driver of growth from small to large firms. More programs going well beyond IP transfer within the research institutions to improve contacts between research scientists and relevant firms will be beneficial. One model exists in the eHealth Industry Project (see below).

Where scientific and technical talent is a strength of Alberta, a common concern in the Alberta health industries community is the shortage of experienced managerial talent.

A fairly typical response was::

As the company matured though, we found that more and more of the activities were outsourced: our manufacturing is currently done in the US and Europe, our clinical research organizations are in the US and Europe, our biostatistician is in the US, our medical director is actually US based. You don't find those types of people in the province.

There is no substitute for the emergence of a generation of “graduates” from successful firms. The research institutions, in their educational role, have begun to address the problem through the development of the biotechnology oriented MBA and/or the Master of Biomedical technology (MBT). As well, the University of Calgary is piloting a program at the Ph.D. level that is focusing on entrepreneurial scientists with practical experience in mission directed research. The programs will include an innovative mix of academic and industry participation through:

- Industry focused course in business and project management, organizational structures, financial, management, PI, and team

building together with project specific courses in science and technology,

- Evaluation of projects for both academic appropriateness and commercial potential,
- Direct industry involvement in mentoring,
- Industry internships.

The pilot project will be launched in September of 2007.

5. The role of infrastructure organizations

Two key infrastructure organizations have not been mentioned. These are NRC's Industrial Research Assistance Program (IRAP) and the Alberta Heritage Foundation for Medical Research (AHFMR). Interviewees mentioned both frequently.

More than one third of the firms we consulted reported financial support to their technology from IRAP. But, IRAP engagement is not limited to grants. IRAP operates with industrial technology advisors who are mature experts in specific domains. The advisors seek out young and smaller firms and provide a wide range of consultation and mentorship over the full spectrum of concerns from finance to management to markets to technology. As is the case in other industries¹⁰, IRAP is the most highly rated government assistance program.

AHFMR has had a technology commercialization program since 1985 that has supported 280 people and projects with a total of \$28 million. A revised program was announced in June, the ForeFront program. In addition to assisting innovators with advice, mentorship, and pre-commercialization funding, the ForeFront program will provide career development internship for recent graduates wishing to pursue real world, practical, paid training within Alberta's biotechnology industry. Four new initiatives: Executive-in-Residence award, Senior Recruitment Health Industry Award, Industrial Researcher Award, and the Masters in Biomedical Technology/MBA Studentship awards will reinforce AHFMR's commitment to supporting people who are translating knowledge into products that lead to improved health.

The university technology transfer agencies, UTI (Calgary) and TecEdmonton have both been engaged with the Alberta health industries

¹⁰ See footnote 6 above for an example.

as would be expected from the international prominence of biomedical IP in licensing and spin-off from universities. Several interviewees have found them helpful, but the opinion was not unanimous. They have been viewed as a bureaucratic impediment by some. It is important for the growth of health industries that transfer agencies see their role as facilitating industrial development ahead of earning money for the universities.

I think UTI serves a very useful function, I think that the problems that we ran into with UTI come from the fact that they wear three different hats. One is that they're there to serve the researcher, two they're there...as an arm's length company for the university, so they have to serve the university. And three, they have to serve themselves. And those are 3 conflicting issues, which is not always to the benefit of the researcher,...

A few interviewees expressed concerns that the health industries have not yet attracted adequate attention of the professional services community. The comments touched on both IP law and industry-specific accounting expertise.

6. Advantages and Limitations of the Alberta Environment

The “Alberta advantage” embedded in government policy is based on a low tax business friendly government that does not engage itself with the affairs of firms. This advantage is expressed by most of the interviewees in terms of the favourable cost structure for business in Alberta. However, the relative advantage of low taxes may not be very powerful. Many respondents indicated that they were here for personal reasons, more than for any particular benefit from the Alberta economic or policy environment:

The advantages basically are that [we] live here, many of our employees are people who had their university training at the U of Alberta in Edmonton. It's been more, partly of loyalty, that we want to keep companies in Alberta, and partly it is the most convenient at the present time...Alberta has some tax advantages from the point of view of personal taxes and the corporate taxes are low. Alberta has some disadvantages in that there not money, good venture capital as there should be, and there is not a lot of tax breaks for people who put

money into venture capital, as there should be. So I mean there is no financial advantages, really big financial advantages, for trying to start a company in Alberta, or keep it here.

The comprehensive Bank of Boston study of factors influencing location decisions of more than a thousand MIT graduates who had started firms¹¹ finds quality of life, access to skilled professionals, and proximity to markets as most important while taxes are least important among eight factors. The interviewees rated the “entrepreneurial spirit” of Albertans as a positive of the Alberta location (especially in Calgary).

I guess a general statement about having an office in Calgary is that there's an entrepreneurial spirit in Calgary which you just cannot beat. It's been fairly easy in the early days to raise money and run with an idea here, where I just don't think you could have done that in a lot of other centers.

On the other hand, an almost equal number of interviewees ranked Alberta policies and programs as an inhibitor to growth of the industry. This is also related to tax policy – not all within the provincial jurisdiction. Alberta was seen to compare unfavourably to other provinces, notably BC and Quebec with respect to tax assistance to young firms. Development of an Alberta capital pool was demanded. Also, the accounting treatment of stock options was seen as a major barrier to recruitment of creative people. Firms with limited cash often cannot pay competitive salaries, but growth promise makes stock options the attractive alternative. A common phrase was: “*not a level playing field*”. The underlying thought was: “*in comparison to the oil and gas industry*”. One respondent was very passionate on the issue, and said that if he could have one wish granted it would be to:

Make stock options affordable for small companies again. Since they changed the rules on granting stock options, it costs us several dollars for every option we issue. Whereas before we could issue options at no cost to us...And that meant that they were enormously attractive for us, because we don't have the best salaries by any means. We have a tremendous talent pool here. People work weekends, evenings, they have a real giant-killing attitude of let's take on the world with this thing. And they work really hard. We

¹¹ Bank of Boston, “MIT: The impact of innovation”, 1997, Bank of Boston Economics Group, Boston, MA.

can't, because of our growth and such, we still don't pay at the top end of the pay scale, we have to compete with the oil industry. But one thing we can do is we can give people stock options, and stock options are worth a fortune in a company like this when the value has [risen] up tremendously. And yet with the rule changes that came in about a year, a year and a half ago, we can barely afford to give stock options.

Finance is always a matter of concern to young firms, especially when clinical trials and other regulatory hurdles make for long periods before revenue can finance further development. Local sources of capital were considered scarce by many but not all interviewees. Some complain of the oil and gas orientation of Alberta money. There was a common perception that outside money was critical. An interesting point is that relatively little concern was expressed about the funding of development of the first commercial prototype and small production run. The focus was on later stage financing. The roles of IRAP and the AHFMR commercialization programs offer part of the explanation.

A very important and unique feature of the Alberta scene is the presence of very large integrated health service delivery regions. The Capital and Calgary regions are capable of playing a major innovative role in shaping the future of service delivery and are already innovating¹². They have large-scale needs and require a certain critical mass from a supplier whether it is in terms of the number of units in an order or the scope of related products that must be acquired together to achieve operational efficiency. Thus, procurement strategy cannot usually be friendly to local firms on the way up. For these firms, the inability to satisfy needs of major customers lies in limits on both scale and scope. However, the health regions could be of great help to innovators in providing:

- access to technical and system expertise,
- connections to a larger research community,
- problem solving,
- improving in house R&D,
- focusing understanding of health care markets,
- information about the cutting edge.

All of these have been demonstrated at the pilot project level. This is well illustrated by the Capital Health Office of Health Innovation that has a mandate to undertake:

¹² See footnote 1 above.

- Response to requests from physicians and other health care professionals to simplify and manage the process of the introduction and use of new, innovative technologies.
- Respond to a recommendation from the Capital Health Supply Chain Study that indicated that our suppliers were interested in gaining access to Capital Health's internal resources for the purpose of product development and evaluation.
- Provision of a single point of entry for businesses, inventors and researchers for the evaluation of innovative ideas.¹³

An illustration of how organized interaction with firms can work is found in the eHealth industry project organized by the telehealth group at the University of Calgary, Faculty of Medicine.

Unfortunately, the regions cannot justify investment of large resources in these activities. It is logical to suggest that resources should be provided to efforts of this kind from outside the health service delivery envelope by ministries responsible for economic development and innovation.

7. The local and the global

The Alberta research institutions are strong yet contribute only a very small fraction of the world life and biomedical sciences research. To put the situation in perspective, the Saskatoon Canola biotechnology cluster makes a good case that has been carefully analyzed. In the 1995-98 period, Saskatchewan accounted for 29.5% of the global research effort on Canola. Yet Phillips¹⁴ shows that the majority of the basic science used by the cluster comes from outside. The key to Saskatoon's success is not that it does all the research or maintains a monopoly on the "know-why" (scientific publication) or "know what" (patent) knowledge that can be written down and transmitted across the globe, rather it turns on the "know-how" and know-who" knowledge that is hard to write down and remains tacit. As Phillips puts it: "... generation and transmission of non-codified knowledge in the region is the key factor holding things together.

¹³ OHI website:

<http://www.capitalhealth.ca/InnovationandResearch/OfficeofHealthInnovation/default.htm>. Accessed 12 12 2006.

¹⁴ P.W.B. Phillips, "Regional Innovation Systems as R&D Entrepreneurs: The Case of the Saskatoon Biotechnology Cluster" in J. Christensen, J. Holbrook, and J. Chua, eds. "Innovation and Entrepreneurship in Western Canada", University of Calgary Press, Calgary, 2002.

People develop skills and working relationship that, together, convert bits of information in operable knowledge”.

There are occasional calls to try to exercise a monopoly on “our” research knowledge. This fails to recognize how so much of what can be accomplished here depends on the global knowledge system. One leading Alberta research executive points to the value of our ability to combine that which we “proudly find elsewhere” with our knowledge plus skills to create successful value adding initiatives.

Understanding the scope of the Alberta health industries makes clear that we find places in the global innovation system where Alberta brings together resources of both codified and tacit knowledge to build a successful niche. The dependence of the Alberta firms on the global system came out clearly in the interviews in terms of the dependence of innovation in Alberta on knowledge from partner firms, customers, suppliers, competitors and university research from outside Alberta. As one interviewee put it: “we are not Boston or California”. The strategy is to find niches that integrate into the global system and building a local system that is good at circulating the tacit components of “know-how” and know-who”.

More than once in our interviews we encountered a firm delivering equipment and/or services to patients and, thus, operating close to the consumer (patient) end of the value chain, who recognized the opportunity to use the expertise acquired to move their business to a broader base extending to a higher level of value added. As an example, the skills developed in providing equipment to the disabled can be extended to involvement in construction of housing for the disabled. This specific example scenario is, of course, an addition to the more obvious case of moving from being a supplier to being a manufacturer. It is raised to point out the wide range of possibilities.

Businesses with such opportunities commonly work in close relationships with the health system. There is an opportunity for the system to use procurement to help grow local businesses into suppliers to a wider client base beyond the region. The role of the health authorities will be central to promotion of this growth path. Frustration with the procurement practices of the regions was widespread in our interviews. We commented on a few moves to ameliorate this problem above.

8. Radical innovation

The development of secure regional advantage depends on innovations that put barriers in the road of imitators. This depends in most

cases on combination of features to achieve more than a single step advance, a radical innovation. Two cases serve to illustrate that the Alberta system does contribute. One of these is primarily IT based and the other is in instruments.

Chenomx. One expected area for radical biomedical innovation is development of “personalized medicine” that responds to individual differences in metabolism. Moving toward the goal depends on developing new chemical analysis that can cope with the very complex mixtures of small molecules in the living cell. One of the most powerful tools to obtain information is the “NMR” technique, but unraveling the data is a huge challenge. Chenomx of Edmonton has introduced a sophisticated software platform for generating, classifying, and interpreting metabolic information from biological fluids using NMR. The result aids correlation of metabolic responses to pathology, toxicity, drug reactions, and genetics. Chenomx can be an influential player in emergence of personalized medicine through the new discipline of “metabolomics”. Chenomx’s work is linked to both the University of Alberta and the University of Calgary.

IDC. The Calgary-based Imaging Dynamics Company (IDC) is emerging as a worldwide leading provider of high performance digital x-ray technology. It is capturing a global market share with systems that provide the sharpest images available, while requiring a low patient dose. The system captures the image with a very high resolution CCD (charge coupled device) linked to elegant image processing software, combining to produce a new way to obtain superior x-ray images cost effectively. Like many radical innovations, the idea came from outside the industry. The initiator was a geophysicist interested in artificial intelligence working in the oil patch whose wife was a veterinarian. Among IDC’s many awards is the Manning Innovation Award to CTO Robin Winsor in 2005. In the Deloitte Touche 2005 “Fast 50” list of Canadian growth companies, IDC stands 10th with five-year growth of 2,173%.

9. Disruptive innovation: A path to sustainability?

9.1. Introduction

A key issue for the future growth of health industries in Alberta is the prospect for major innovations that displace existing activity and set growth off in new directions. The leading commentator on these phenomena is Clayton Christensen of the Harvard Business School. The important observation in his work is that such innovations initially fail to satisfy the needs of large-scale leading customers, but grow in niche

markets until they acquire all the characteristics required by these leading markets. Since good management is based on careful attention to the needs of customers, current leaders tend to be the last to realize the potential of the disruptive innovation. This is a situation that can be exploited by a region not dependent upon current market leaders, an emergent player.

We do have major customers in Alberta – one of advantages of Alberta lies in the very large scale of health systems that regionalization has created. However, they clearly play the classic role of the customers of current leading firms. The problems and opportunities they create were discussed in section 5.

Christensen and his colleagues have published an article with the striking title; *Will disruptive innovations cure health care?*¹⁵ They have assessed the prospects for disruptive innovation in health care and propose a path driven by the problems of cost of the health care system, a path to sustainability. The key concept is promotion of innovations that move down the ladder of elaborate specialized training in the delivery of service. That which required the specialist may become deliverable by the primary provider. A Nurse Practitioner or a Pharmacist may deliver that which is now delivered by an MD. Finally, the user may self-deliver without a health professional involved in each instance. Primary examples cited by Christensen et al are a low cost x-ray machine that could easily be used by primary providers (that is having difficulty finding a manufacturer because of lack of interest from current x-ray firms) and pregnancy testing that has evolved from a procedure requiring animal tests to one using lab instruments, and finally to an over-the-counter kit in the drugstore.

The underlying assumption of the analysis is that capacity to deal with complex diagnosis and treatment is evolving faster than a rise in the level of care that patients need and can use. Figure 9.1 shows how this assumption leads to the continuing opportunity for care to migrate down the ladders of professional specialization.

9.2. *Disruptive health innovation in Alberta*

Three recent innovations in health care that have been developed in Alberta and exploited by Alberta companies follow Christensen and illustrate empowerment of the patient in ways that reduce the load on health care professionals. These are the stories of SagaTech Electronics (Calgary), The Litebook Company (Medicine Hat), and CV Technologies (Edmonton).

¹⁵ Christensen, C. M. Bohmer, R. and Kenagy, J. *Harvard Business Review*, 2002, Sept.-Oct. p. 102-110.

SagaTech Electronics specializes in sleep disorders, especially the constriction of breathing known as sleep apnea. It manufactures a diagnostic device known as the Remmers Sleep Recorder named for John Remmers, a professor in the Faculty of Medicine at the University of Calgary. The device is a disruptive innovation with respect to a device known as polysomnograph that is employed in a hospital procedure known as polysomnographic analysis (PSA). PSA requires overnight hospitalization of the patient and services of a respiratory technician. In Canada, this leads to diagnosis waiting times of 1.4 to 3 years. The Remmers machine can be used at home and does not require a technician. Costs are \$1,000 to \$2,000 in a sleep lab compared to as low as \$150 at home. The device can also be used for diagnosis of some other sleep disorders.

Beyond the reduction of load on the health system, is the impact on the disease. Sleep apnea is thought to be one of the most under-diagnosed conditions recognized in medicine with as many as 95% of those affected going undetected. In addition to health risks, there is a major social consequence. It has been demonstrated that sleep apnea significantly increases the risk of motor vehicle collisions. Reliable authorities estimate the 15% to 20% of collisions may involve sleep apnea as a factor. It is especially important to improve diagnostic activity among professional drivers, five percent of whom are suspected to suffer from an undiagnosed sleep disorder

The Litebook Company manufactures a light emitting diode (LED) array on a small book sized platform called a Litebook. The Litebook is the world's first hand-held light-therapy device. It can produce an ultra-bright white light without emitting ultraviolet radiation and produces very low heat. The 15 cm-by-12.5 cm Litebook weighs 225 grams where a white fluorescent-tube bright light in the same price range weighs 13 times as much, is 30 times bigger and uses 13 times more power. The Litebook offers portable treatment for seasonal affective disorder (SAD) and mitigates the effects of jet lag. Beyond these, areas of application include shift workers' adaptation, fatigue, and low mood. A joint venture points toward therapy for acne.

The Litebook offers an elegant example of support by the innovation system. The Medicine Hat Economic Development Officer arranged first meetings with engineers at the Defense Research Establishment for entrepreneur and SAD sufferer, Larry Pederson. Pederson was able to engage two engineering graduate students from the University of Calgary (one with experience from Prof. Irving-Halliday's LED based "light up the

world” project) as designers. NRC-IRAP advisers assisted. Initial financing came from a Medicine Hat angel network.

One of the first physicians to become involved was Dr. Raymond Lam who had a light therapy clinic for mood disorders at UBC. With his six-month waiting list, the attraction of the Litebook for him was immediate. Therapy could move from the clinic to the patient’s home. There is a striking parallel to Dr. Remmer’s move of diagnosis to the home with the sleep recorder.

CV Technologies innovated differently to make care more directly accessible to the patient. There is a long tradition worldwide of herbal medicines. Indeed some pharmaceutical companies have looked to traditional knowledge to suggest leads toward new drugs. The limitations of traditional medications have been two fold. First it is difficult to determine if dosage is consistent from one preparation to the next. Second, solid evidence from well-constructed clinical trials is lacking. With the introduction of ColdFX, CV technologies addressed both of these weaknesses. ColdFX is a specific extract from North American ginseng that is obtained by a proprietary technology and dose is standardized by specific chemical analyses. It is claimed to have reinforcing effects on the immune system and clinical trials have shown it to reduce the incidence and severity of upper respiratory viral infections, colds and flu. ColdFX is claimed to have benefits comparable to other anti-viral medications including Tamiflu, Relenza, Amantidine and Rimantadine, but is available without a prescription.

ColdFX is not a pharmaceutical that emerged out of work in a research institution along the commonly expected path. Nevertheless, it was out of research at the University of Alberta that recognition of a path and a business model to overcome limitations on the status of a traditional medicine arose.

10. In conclusion - A look to the future

A few interesting views toward the next five years emerged in the interviews. One starts from the observation that Canada is only behind the United States in number of biotech companies with the UK close behind Canada. This suggests some consolidation is to be expected.

It’s an industry where either you make it or you don’t, because burn rates are often so high. The other trend I think we will see, is... some efficiencies, just looking at new testing methods that might be virtually based...a visual genomics lab

in a CAVE environment... an opportunity to examine molecules and proteins on a different level that we've never thought of before, so that we don't have to spend as much time in the lab, but we can work [from] computer simulations. Can we actually test a drug virtually?

The impact of an aging population is clear.

...people are getting older! ...Our line of equipment... caters to the elderly, and that is a growth industry, so in the next few years, well, a year ago I wasn't really looking for a salesman, and now I am .

The globalization of business is evident.

The single challenge facing the firm and any firm like us is the really the consolidation of the industry. Its becoming a commoditized industry and very much a global industry, for example... trials [are run] in North America, and Latin America, have an office in Buenos Aires..., One of the trials we are... just about to start, will be running in 5 countries; Canada, US, Mexico, Argentina and Australia. We can't possibly run [Australia] from here, so we have found a partner, we have a partnership arrangement with a company in Australia.

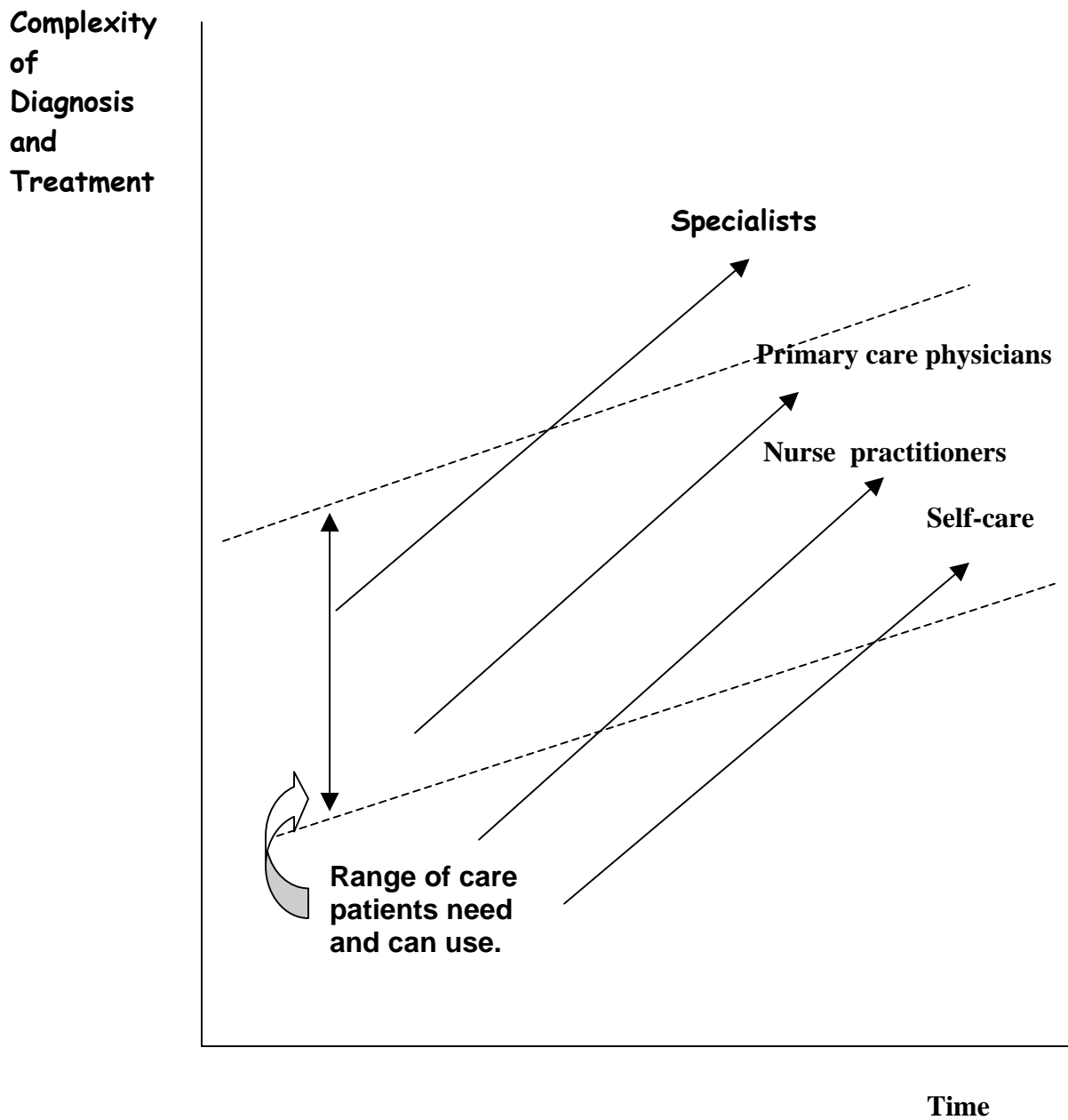


FIGURE 9.1 INNOVATIVE TREND OF SERVICES AVAILABLE FROM PROVIDERS (→) RELATED TO TREND OF SERVICES PATIENTS NEED AND CAN USE (----) AS COMPLEXITY OF DIAGNOSIS AND TREATMENT RISES OVER TIME.

People.

The ability to attract good people here is I think at the centre...[of attracting people is] importantly, the right environment, the right attitude. I think where we underemphasize the advantage of Alberta is that it is fundamentally just a good place to live.

The Patients

[The system] has to become more patient centric and when we do that, patients can monitor their health. See a history of pertinent information and make decisions. The system is not broken but it needs to be more patient-centric.

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