V

Skills Development in Atlantic Canada

The emergence of an economy that is increasingly based on knowledge has resulted in significant structural changes within labour markets. In Atlantic Canada, major differences have been observed in employment growth according to economic sectors, forms of employment (i.e., groups of workers), and economic regions. Employment in the dynamic services sector, for example, and particularly corporate services, has grown considerably in the last decade (see box 2). While the growth of full-time employment rate in Atlantic Canada has shown more modest increases (0.4 percent from 1990 to 1999), part-time employment and self-employment have increased. Also, knowledge-related economic activities are unevenly distributed across the region, which is indicated by the differences in subregional growth.

In this chapter, we will take a closer look at the changing nature of employment and its effects on qualifications/skills. We will see, among other things, how the skills structure has evolved in the last decade (by focusing on skills development in two emerging sectors in Atlantic Canada) and what role education and training play in the context of the new economy.

The Skills Structure in Atlantic Canada

To better understand the changes occurring in labour market requirements and what skills are in demand in the region, a skills typology will be drawn based on the various occupations found in the present labour pool. Originally developed by Wolff, Baumol et al.,[70] this approach was recently applied in Canada by Lavoie and Roy in order to determine if labour markets effectively promote a highly skilled workforce and to what extent they foster the knowledge and skills in demand in today's economy.[71]

70. E. Wolff, W. J. Baumol et al., "Sources of Postwar Growth of Information Activity in the United States," *The Information Economy: The Implications of Unbalanced Growth,* ed. Lars Osberg, Edward N. Wolff, and William J. Baumol (Montreal: Institute for Research on Public Policy, 1989).

71. Lavoie and Roy, *Employment in the Knowledge-Based Economy*.

Box 2

Structural Changes in Canada's Labour Markets

Jobs in Decline		Jobs in Demand
Primary and manufacturing activities, partly because the share of these sectors in overall production is decreasing but also because they have experienced a rapid growth in productivity.	ACTIVITY	In general, the service industries are experiencing strong growth, particularly health-care, corporate, and tourism-related services (i.e., lodging, food, and leisure).
Full-time employment in Atlantic Canada has stumbled throughout the 1990s. With a modest growth rate of 0.4 percent from 1990 to 1999, full-time employment in the region increased at a slower pace than the national average, which was 0.9 percent in the same period.	FORM OF EMPLOY-MENT	Self-employment and part-time employment, two forms of employ-ment that are much more widespread and undergoing rapid growth in the service sector. In the 1990s, for example, 38 percent of the new jobs created in Atlantic Canada were in the category of self-employment.
Industries which use mainly traditional technologies. For example, employ-ment in the medium-knowledge-intensive industries dropped by 5.6 percent from 1991 to 1996.	KNOW-LEDGE CONCEN-TRATION	Employment in the high-knowledge-intensive industries. From 1991 to 1996, employment in these industries increased by almost 16 percent in the Atlantic region.

Sources: Statistics Canada, *Labour Force Survey*; 1991 and 1996 census data; compiled by the authors.

Like Lavoie and Roy, we divided the labour force into six major occupational categories, namely, knowledge, management, data processing, service delivery, goods manufacturing, and data services. The knowledge category is made up of occupations which primarily generate new knowledge. Among these workers are scientists, computer analysts/programmers, and artists that innovate, create, and develop new ideas. By contrast, the data-processing occupations are described as "users" of this new knowledge and include those that exploit and handle information. As noted by Lavoie and Roy, such a distinction is essential if we are to understand how the various "pools" of knowledge are linked to the knowledge economy and the labour market evolution.

The management category encompasses all occupations that use both the creative and the practical aspects of knowledge (e.g., its application), since workers in administrative positions must simultaneously produce new information (e.g., administrative decisions) and implement and exploit this new information. As for the goods-

manufacturing category, it includes all occupations that entail some processing of materials or physical objects, whereas the service-delivery category, as its name implies, consists primarily of providing personal services. Finally, the data-services category comprises workers who divide their work equally between data processing and service delivery.

To better understand the nature of the changes occurring in the knowledge and management occupations, these two categories were broken down into subcategories. The knowledge occupations as a whole were thus subdivided into science and engineering, computer technology, and social and human sciences. As for management occupations, they were subdivided into science and technology, public administration, financial services (including insurance and real estate), retail sales (including food and lodging), and a category for other areas. The occupational breakdown of the labour market in Atlantic Canada is outlined in table 12.

However, before analyzing the data collected, a few words of explanation are in order. First, it is important to remember that individuals working in the management category are primarily responsible for managerial functions, that is, planning, organizing and coordinating, and operational control.[72] For example, retail sales managers are listed in the management-occupational category, while retailers and sales clerks are placed in the data-processing category. Second, unlike the industrial classification outlined in chapter 4, this occupational-based classification allows us to include the knowledge occupations found in the public sector (it will be recalled that the classification of industries according to their knowledge concentration, as developed previously, was limited to private sector industries). Finally, like Lavoie and Roy, we used the national occupational classification (NOC) instead of the standard occupational classification (SOC). Not only is the NOC slightly more detailed than the SOC, but it also has the advantage of enabling us to identify various skill levels for each occupation, something that we will discuss later.[73]

72. As defined by Statistics Canada. Also, supervisory work is not considered as a managerial function.

73. For more information on the classification of occupations, see appendix B.

Table 12

Employment Breakdown in Canada and Atlantic Canada by Occupational Category, 1996

	Proportion of Jobs (%)	
	Canada	Atlantic Canada
All occupations	**100.0**	**100.0**
1. Knowledge	**8.3**	**6.2**
1.1 Science (pure and applied) and engineering	2.3	2.0
1.2 Computer analysis and programming	1.2	0.6
1.3 Social and human sciences	4.8	3.6
2. Management	**9.4**	**8.4**
2.1 Science and technology	1.3	1.2
2.2 Public administration[a]	1.1	1.2
2.3 Financial services, insurance, and real estate	1.4	1.0
2.4 Retail sales, food, and lodging	3.1	3.2
2.5 Other areas	2.5	1.8
3. Data processing	**35.4**	**33.4**
4. Service delivery	**13.4**	**15.8**
5. Goods manufacturing	**27.3**	**28.8**
6. Data services	**6.3**	**7.5**

Examples of occupations according to their occupational classification:

1. Medical practitioners, agrologists, biologists, engineers (science and engineering); analysts and programmers (computer technology); lawyers, consultants, auditors/accountants, artists (social and human sciences)
2. Health-care managers, engineering services managers (science and technology); senior officials, school directors and other school administrators (public services); financial managers, bank managers (financial and other services); retail sales managers (retail sales and others); other managers
3. Sales clerks, cashiers, secretaries, accounting clerks, engineering and drafting technologists and technicians
4. Waiters, security guards, caretakers and other cleaning personnel, cooks, hairdressers, police officers
5. Mechanics, fish-processing plant workers, farm and other labourers, carpenters, truck drivers
6. Nurses, social workers, human resource consultants

Source: Statistics Canada, 1996 census; compiled by the authors.

Note: See appendix C for a more comprehensive table and data on each of the Atlantic provinces.

[a] Other areas than science and technology.

As indicated by table 12, knowledge jobs occupy a rather modest place in the economy of the Atlantic provinces. In 1996 they accounted for only 6.2 percent of the region's total employment compared with 8.3 percent of the nation's. Over half of these jobs (58 percent) came from the social and human sciences category (lawyers, consultants, etc.), while 32 percent were linked to the pure and applied sciences (physicists, engineers, agrologists, biochemists, etc.) and 10 percent to computer analysis and programming.

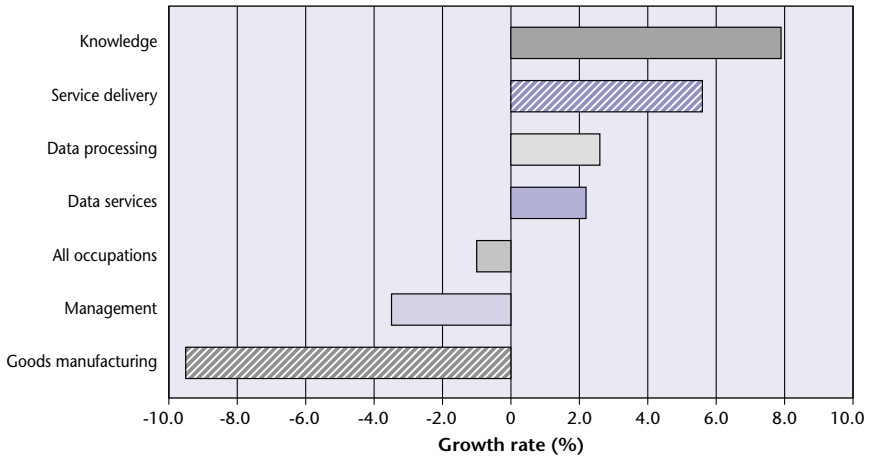
The other five major occupational categories make up most of the jobs in Atlantic Canada. The data-processing category (secretaries, sales clerks, teachers, cashiers, etc.) alone represents one-third of total employment. Because of the relative importance of the natural-resources-processing industries (fisheries, forestry, etc.) within the Atlantic provinces' economy, the goods-manufacturing category comprises close to 29 percent of workers. As for the service delivery category, it accounts for 16 percent of the workforce, while close to one job in ten falls into the management category.

Since only 6.2 percent of occupations are part of the knowledge category, we must ask ourselves if the Atlantic region has really embraced the knowledge economy. If one follows the evolution of occupations over time, it soon becomes clear that labour market dynamics are inevitably evolving towards knowledge-related jobs (see figure 17). For example, while total employment decreased by 1.0 percent from 1991 to 1996, knowledge occupations rose by 7.9 percent in the region owing to the creation of more than four thousand new jobs. This is the largest increase in all occupational categories. By contrast, occupations in the goods-manufacturing sector dropped by 9.5 percent, for an overall loss of about twenty-eight thousand jobs.

By breaking down the knowledge and management categories (as in table 12), trends that reflect the scope of occupations can be identified. For example, we have already seen that the social and human sciences are the most important group of occupations related to knowledge in the region. And except for computer analysts and programmers, this is the group that has enjoyed the strongest employment growth between 1991 and 1996. This phenomenon is not unique to the Atlantic region. In a recent speech, Pierre Lacroix, president of the Université de Montréal, described it as follows: "There is, in certain environments, a much too limited concept of the knowledge economy, which suggests that the only labour requirements for this new economy are in science and engineering, and particularly

Figure 17

Employment Growth in Atlantic Canada by Occupational Category, 1991–96



Source: Statistics Canada, 1991 and 1996 census data; compiled by the authors.

in areas such as computer technology and biotechnologies. Nobody denies that scientific sectors play a key role in the knowledge economy. But this role is far from being exclusive."[74]

To illustrate his point, Mr. Lacroix referred to UBI Soft, a high-tech firm that was established in Montreal in 1997 and which designs video games. Among its 400 employees, 45 have an administrative profile, 150 a creative profile (e.g., game designers, scriptwriters, etc.), and 105 a technical profile (e.g., computer experts); 100 are game testers with a diversified knowledge background. Although a little over 25 percent of these employees are computer experts in charge of the production and technical aspects of product development, the real strength of the firm lies in the development and creation of new products. In other words, UBI Soft's success in the electronic game market depends on the work of the 150 employees with a creative profile. And these employees have qualifications in a wide range of disciplines such as philosophy, history, design, literature, etc. In the final analysis, they are the reason for the firm's creativity and success.

74. Robert Lacroix, "Économie du savoir et formation universitaire," speaking notes for a conference given at the convention of the Association des économistes québécois (Montreal, 19 May 2000), 7–8.

Even though the management category decreased by 3.5 percent from 1991 to 1996, the science and technology management subcategory was just behind the knowledge category with a growth rate of 6.8 percent. In particular, the number of managers in the engineering, health-care, and telecommunications fields increased significantly, adding to the already perceptible vitality of the knowledge economy in the Atlantic provinces — to the point that the labour market is feeling some pressure, especially regarding occupations in science and technology management. In the marketing of new biopharmaceutical products, for example, a lack of skilled workers could impede the sustained development of this emerging industry, which shows encouraging signs of contributing to the Atlantic region's economy. The same is true for a few other emerging industries where the availability of an educated and competent labour force is a major issue. This will be examined more closely in the following section, which deals specifically with two emerging sectors.

Skill Requirements in Two Emerging Industries in Atlantic Canada

The knowledge economy includes a surprising variety of industries, most of which require a highly skilled workforce. It is beyond the scope of this study to estimate the specific requirements of each one of these sectors; however, in order to get a clearer sense of this skills-related problem, we will take a brief look at two case studies pertaining to rapidly growing industries in Atlantic Canada that require increasingly skilled workers: the offshore oil and gas industry and industrial biotechnology.

The Offshore Oil and Gas Industry: Overview and Issues

The birth of the oil and gas industry in Atlantic Canada dates back to the 1960s and 1970s, when several large oil companies launched exploration projects in search of new oil deposits off the coasts of Newfoundland and Nova Scotia. But it was not until the 1990s that the industry really began to flourish in the region.

After several years of exploratory work, the Cohasset-Panuke deposit, some 250 kilometres southeast of Halifax, produced the region's first barrels of sweet light-crude oil in 1992 (this deposit continued producing until December 1999, when its resources were depleted). This was the first offshore project in Canada. The following year in Newfoundland, after a rather slow start, the first concrete

pillars were poured for the Hibernia fixed platform. The construction of this megaproject, valued at more than $5.8 billion, lasted several years. At its peak, about five thousand people worked on the huge 600,000-tonne structure. The Hibernia platform began operating in November 1997. Today, it produces close to 140,000 barrels of oil a day, which are loaded onto shuttle tankers for shipping to various markets (most of Hibernia's production is exported to the United States).

Other projects followed. The discovery of substantial reserves of natural gas near Sable Island marked the beginning of the development of a new energy source in the region. In 1998, a business consortium began building the infrastructure required to tap into these natural gas reserves, which were estimated at close to 3.5 trillion cubic feet. Over $2.3 billion was invested in production (e.g., the offshore platform), processing (in Goldboro, NS), and fractioning (in Point Tupper, NS) units during phase 1 of the project. In addition, a 1,050-kilometre pipeline is being planned, at a cost of $1.7 billion (of which more than half will be used to build the distribution system in the Maritime provinces), for the transportation of natural gas to the New England states and Quebec.

Meanwhile, a second offshore oil project began to take shape in Newfoundland. The development of the Terra Nova deposit, with recoverable reserves estimated at 470 million barrels (Hibernia's estimate was 750 million barrels), was approved in 1998: $4.5 billion will be invested in the project. Barring delays, the Terra Nova floating production system should begin operating towards the end of 2001.

Undoubtedly, the Nova Scotian Plateau and the Jeanne-d'Arc Basin in the Grand Banks region (off the Nova Scotia and Newfoundland coasts respectively) have some of the highest oil and gas potential in the country. In the 1999–2000 fiscal year, there were seventeen geophysical survey programs and eight exploratory drilling campaigns under way in the area. That same year, Husky Oil announced the selection of a production platform for the development of the White Rose deposit (estimated at 250 million barrels of recoverable oil), with the beginning of operations planned for 2004. Delineation wells have also been drilled in the Hebron field, located near the Hibernia and Terra Nova deposits. In Nova Scotia, deep exploratory work is being carried out under the old Cohasset-Panuke deposits, and the drilling of three other production wells in Sable Island is planned for the future.

All this oil and gas activity has had a significant impact on job creation in Atlantic Canada. To examine the employment opportunities generated by the development of energy reserves, the Canadian Association of Petroleum Producers (CAPP) commissioned a study in 1999 on the industry's human resource requirements.[75]

Based on a simulated approach, this study estimated the human resources needed for exploration and production activities in the offshore regions of Nova Scotia and Newfoundland from 2000 to 2010.[76] Projections were based on three activity scenarios. Each scenario (or case) was drafted according to assumptions about the number of projects anticipated during this period.

Considering what recently happened with the White Rose and Hebron deposits, it is clear that the medium-activity scenario is the most likely one for now and through to the end of the next decade. According to this scenario, it was estimated that 1,880 jobs would be directly linked to the offshore oil and gas sector in the Atlantic region in 2000 (see the breakdown of these jobs by province and by component in table 13). This figure should increase by almost 45 percent in the next four years, reaching 2,723 in 2004. Afterwards, the employment level is expected to stabilize at around 2,850 jobs until 2010.

Apart from its employment projections, this study also gives some idea of the skills requirements since close to fifty types of occupations were surveyed under the NOC. A brief look at the data shows that the offshore oil industry rests on highly skilled workers. For the year 2000, for example, over 61 percent of the workers in this sector had a university degree or a college or technical diploma.

In this sector, international competition for technical workers and highly skilled specialists is strong. In the Atlantic provinces, about 15 percent of all workers in the oil and gas sector have an advanced university education in a specialized field, namely, geological engineers, geophysicists, petroleum engineers, and corrosion engineers. Recruiting these highly skilled workers is a constant challenge, especially since there is no local training in these specialized fields.

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75. Canadian Association of Petroleum Producers (CAPP), *Estimation of Direct Human Resource Requirements, Offshore Exploration and Production, Newfoundland and Nova Scotia, 2000–2010* (Halifax: CAPP, 1999).

76. The jobs associated with the construction of the projects were not considered, nor were the indirect jobs created by the development of the deposits (e.g., procurement services, etc.).

Table 13

Human Resource Requirements in the Offshore Oil and Gas Industry in Atlantic Canada (Exploration and Production Activities), by Component, 2000

	Number of People		
	Newfound-land	Nova Scotia	Atlantic Region
Mobile platform	160	160	320
Elevating platform	—	154	154
Supply vessel	22	26	48
Exploration management	40	26	66
Offshore facilities	—	44	44
Hibernia (platform)	382	—	382
Mobile drilling platform	160	—	160
Operations management	137	88	225
Deepwater PSUV[a]	100	100	200
Gas-processing plant	—	35	35
Shuttle tanker	40	40	80
Helipad	14	14	28
Others	46	92	138
Total	**1,101**	**779**	**1,880**

Source: Canadian Association of Petroleum Producers (CAPP), *Estimation of Direct Human Resource Requirements, Offshore Exploration and Production, Newfoundland and Nova Scotia, 2000–2010* (Halifax: CAPP, 1999).

[a] PSUV = production, storage, and unloading vessel.

However, except for these positions (which represent only a handfull of the overall workforce), there is no lack of workers within this regional industry, since the training infrastructure seems to be adequate to meet the human resource needs. Anyway, that is the conclusion reached in an analysis conducted by the Newfoundland government, in conjunction with the CAPP and the petroleum industry, to examine the existing and future capabilities of the local labour supply.[77]

Customized training programs are being offered by several educational institutions in the region to meet the needs of exploration and production platforms for human resources and support services. For

77. Petroleum Industry Human Resources Committee, *Analysis of Gaps and Issues Related to Labour Supply and Demand in Offshore Exploration and Production in Newfoundland* (St. John's: Newfoundland Ocean Industries Association, 2001).

example, the College of the North Atlantic, in St. John's, offers three-year programs in instrumentation techniques and petroleum engineering. Also, in 1999 close to $800,000 was invested in ultramodern equipment at the Memorial University Marine Institute to train workers for various contingencies at sea. To meet the needs of highly skilled jobs, Memorial University also announced in September 2000 that it would implement a new five-year initiative, the Oil and Gas Development Partnership, to establish closer research and training links with the industry. Other initiatives include the creation of graduate degree programs in petroleum and gas engineering, deposit engineering, and other oil and gas sector-related areas.

Although the training infrastructure meets current requirements for human resources, giving new graduates and young employees the necessary experience remains a major challenge for the local workforce. Professional experience in the oil and gas industry is a highly valued asset, especially on offshore exploration and production platforms. In many cases, it is a prerequisite in the offshore industry. For instance, the position of instrumentation technician on production platforms requires technical and practical knowledge that can only be acquired on the job: "These people are expected to maintain the operation of the platform under all conditions. Downtime and production losses are very expensive, so technicians are expected to have a high level of relevant workplace experience to complement their training.... Usually, at least ten years of experience is required for a position such as an instrument technician on a production platform."[78]

To enable new graduates or novice employees to acquire relevant experience, the industry continues to establish links with educational institutions. For example, the opening of a geoscience professional training centre in Calgary will allow new graduates to put their knowledge into practice and increase their chances of finding work with oil companies. For local employees seeking added experience and training, distance education is an increasingly popular tool.

There are also cooperative work-study programs at the master's level in public administration and engineering schools. According to the various senior managers that we interviewed, these programs are extremely popular and enable many students to get a job as soon as they graduate.

78. Davis and Hulett, *Knowledge-Based Skills Gaps in the Natural Resources Sector in Atlantic Canada*.

With respect to recruitment, it is hard to attract skilled and experienced workers to Atlantic Canada. The petroleum industry in the North Sea and the Gulf of Mexico is very active and already absorbs a large number of skilled workers. For Canadians employed by large multinational companies (Husky Oil, Chevron, and Mobil, all partners in the region's offshore projects), it is often more profitable to work abroad and benefit from isolated-post allowances. Many Newfoundlanders and Nova Scotians, for example, gained their experience this way, having worked abroad on exploration projects from the 1960s to the 1980s. Lifestyle and quality of life are other factors that play an important role in recruiting. Offered the same salary, many employees of large oil companies in Canada prefer to work in Calgary rather than St. John's in order to enjoy the amenities of a bigger city. Even for expatriates (i.e., workers with roots in the Atlantic region), such considerations override the desire to return home.[79]

Other long-term challenges are also appearing on the horizon. *Multi-skilling*, that is, the acquisition of a wide range of abilities, is a growing trend in the offshore oil industry, because employers are increasingly on the lookout for workers with varied skills that are easily transferable from one field to another. Workers are thus encouraged to become more versatile in order to increase their chances of being hired.

Similarly, due to the development and integration of new technological applications, the industry's employees must continually upgrade their technical knowledge. The need for training courses and skills improvement is a key element in creating a highly qualified workforce. As the frontiers of exploration keep being extended in the search for new oil and gas deposits, ultramodern drilling platforms are appearing in the region. An example of this is the implementation of horizontal drilling methods and deepwater exploration techniques using submersibles. Employees must be trained in the operation of such machines.

Another disquieting factor is the aging of the labour force in the oil and gas sector, something that is occurring in many other industries.[80] In a recent article, it was reported that between 60 and 70 percent of the geologists in western Canada were between forty-five and

79. Petroleum Industry Human Resources Committee, *Analysis of Gaps and Issues*, 14.

80. "Future Issues for the Oil and Gas Industry," remarks by CAPP's public affairs vice president, David MacInnis, at the Annual Oil and Gas Conference in Houston, TX (8 September 2000).

fifty-five years old.[81] Considering this demographic reality, shortages should be expected in certain occupations in the next ten to fifteen years.

Finally, the need to diversify the labour force is another concern of the industry. For example, women are greatly under-represented, a problem that is largely due to working conditions characterized by isolation and work periods of three-week shifts.

Biotechnology and the Skills Challenge

As with the offshore oil and gas industry, the industrial biotechnology sector is developing at a fast pace in the Atlantic provinces. At present, it is estimated that about eighty businesses in the region are directly related to industrial biotechnology (see table 14). Of these, about 26 percent are active in industrial and urban processing, 21 percent in agricultural, aquaculture, and horticultural activities, 17 percent in biopharmaceuticals, and so on. As this is still a nascent industry, it is not surprising that the great majority of these businesses are small and that their sales figures remain relatively low. Close to 65 percent of the biotechnology firms in the region have reported sales figures under $5 million. According to a recent Statistics Canada study, total revenues from biotechnology in Atlantic Canada exceeded $86 million in 1999, which is a spectacular increase of almost 300 percent relative to the previous year's figures.[82] Furthermore, it is estimated that from now until 2002, revenues in this sector should increase by another 70 percent to nearly $150 million. R & D expenditures, a key element for success in the biotechnology sector, also rose in the last few years, and it is expected that private investments in R & D in Atlantic Canada will double between 1999 and 2002, reaching the $12 million mark.

The reason for the impressive increase in revenues and R & D expenditures is the growing demand for biotechnology products on world markets. In the Atlantic region, exports of these products are expected to rise from $2 million in 1999 to over $22 million in 2002. Whether they are new products derived from enzymes and aimed at increasing the efficiency of industrial products, new diagnostic tools, or health-enhancing foods, it is clear that the region's biotechnology industry has great economic potential.

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81. From the *Daily Oil Bulletin* (4 April 2001).

82. Chuck McNiven, *Biotechnology Use and Development, 1999*, study prepared for the Science, Innovation and Electronic Information Division, Statistics Canada, Ottawa, 2001.

Table 14

A Look at Biotechnology in Atlantic Canada

In 1999 in Atlantic Canada, there were about 19 biotechnology firms (forming the nucleus of the biotechnology sector) and about 60 businesses related to industrial biotechnology. In total, these firms included a little over 5 percent of the Canadian workforce engaged in this sector.

	1999	2002 (projections)
Total revenues ($ million)[a]	86	146
Total R & D expenditures ($ million)[a]	6	12
Total exports ($ million)[a]	2	22
Fields of activity of biotechnology firms		**(%)**
Industrial and urban processing		26
Agricultural, aquaculture, and horticultural biotechn.		21
Pharmaceutical and biomedical		17
Instrumentation		10
Agri-food biotechnology		8
Others		18
Number of employees		990
Average (national) salary for 2000–01		**($)**
Senior manager		133,000
Business development manager		111,500
Regulatory affairs manager		101,300
Senior scientific researcher		78,900
Associate (clinical) scientific researcher		70,500
Biological computing engineer		65,900

Sources: Statistics Canada, Science, Innovation and Electronic Information Division (2001); Biotechnology Human Resource Council (2000); Fabrice Rigaux, *Industrial Biotechnology in the Atlantic Provinces: From Emergence to Development?* (Moncton: Canadian Institute for Research on Regional Development, 1997).

[a] Nucleus of biotechnology firms.

Nevertheless, its future depends to a large degree on the human resources factor, that is, the regional capacity to attract, train, and retain workers with the skills that are essential and specific to biotechnology. As will be seen later, the skills requirements of the biotechnology industry revolve around two main issues: the industry must have access to a pool of highly skilled scientific and technical personnel, and there must be experienced management personnel available to facilitate the marketing of its new discoveries.

Although figures vary somewhat from one study to another (there are a number of definitions and data bases that are used to evaluate the industry's structure), it is estimated that 990 people worked in the industrial biotechnology sector in Atlantic Canada in 1995.[83] Of these, about 690 were involved in biotechnology activities per se, including 440 working directly in R & D.

Geographically, Nova Scotia had the largest concentration of activities related to biotechnology, with close to 44 percent of its total employment centred in the Halifax-Dartmouth area. Next came New Brunswick, with 31 percent of its jobs divided mostly between Fredericton and Saint John. Last were Newfoundland and Prince Edward Island, with 15 and 10 percent respectively in the St. John's and Charlottetown areas. Between 1992 and 1995, total employment in the biotechnology sector rose on average by 3.5 percent annually in the Atlantic region. This is quite impressive as employment for the regional economy as a whole grew by only 0.7 percent during this period. Provincially, the highest average annual growth rates were in New Brunswick and Nova Scotia, followed by Newfoundland and Prince Edward Island.

Since the biotechnology industry is based on science and technology, it is not surprising that its labour force is highly skilled and educated. For example, it is estimated that no less than 65 percent of the jobs created in this sector in Canada in 2000–01 required a university education; over 25 percent required a postgraduate degree (see figure 18).[84] Among the disciplines which most often lead to careers in biotechnology, are biology, microbiology, biophysics, biochemistry, genetics, chemical engineering, and computer technology. As a rule, the region's supply of scientific and technical personnel has been satisfactory (particularly at the undergraduate and master's levels) thanks to its solid university infrastructure, which is capable of training enough people to sustain basic and applied research activities.

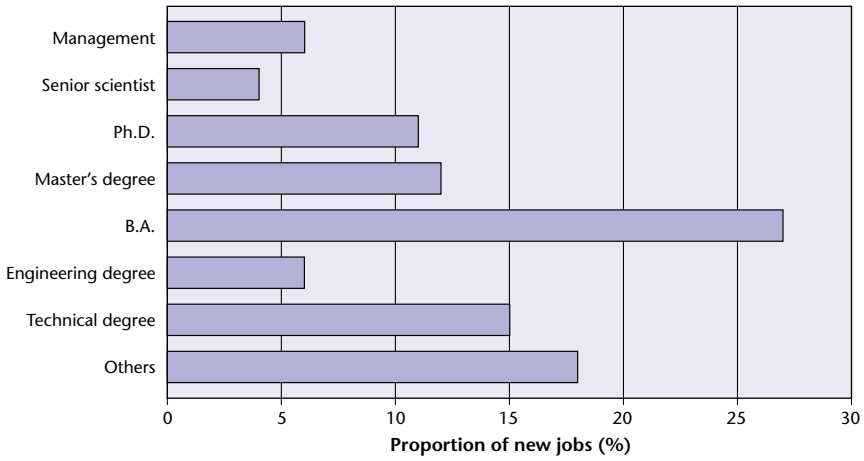
However, personnel requirements are changing rapidly as the industry expands, and competition is already increasing in the labour market for these kinds of workers. For example, the shortage of experienced researchers (with both a postdoctorate diploma and industrial experience) is one of the major challenges facing biotechnology's future development in Atlantic Canada. As the majority of biotechnology

83. Fabrice Rigaux, *Industrial Biotechnology in the Atlantic Provinces: From Emergence to Development?* (Moncton: Canadian Institute for Research on Regional Development, 1997) 94–95.

84. Biotechnology Human Resources Council (BHRC), *Biotechnology Industry Intelligence Briefing: Human Resources Trends and Projections* (BHRC, 2000).

Figure 18

Breakdown of New Jobs in the Biotechnology Industry in Canada, by Education/Expertise Level, 2000–01



Source: Biotechnology Human Resources Council (BHRC), *Biotechnology Industry Intelligence Briefing: Human Resources Trends and Projections* (BHRC, 2000).

firms are still nascent, R & D programs aimed at new products are the cornerstone of any commercial initiative. And innovative, international-calibre research work of this kind is done by those with doctorate and postdoctorate diplomas, people who form the nucleus around which biotechnology firms are built. But since specialization is a requirement in the industry, these exceptionally skilled workers are highly coveted, both nationally and internationally.[85]

Several obstacles to the recruiting and hiring of experienced researchers in the region have been reported by the industry's stakeholders in Atlantic Canada. For example, remunerating scientists seems to be a problem. Although wages in the industry are high nationally (see table 12), they are, on average, from 15 to 20 percent lower in Atlantic Canada. Also, as the region is somewhat outside the biotechnology mainstream, the task is even more difficult. Business managers report that the prospect of better working conditions and more attractive training and career opportunities offered by the leading industrial biotechnology clusters makes it hard for the Atlantic provinces to compete. Out-migration of workers is another serious problem for the region. Although it is still difficult to track the move-

85. For example, the CEO of BioMed Management, a Halifax company that supports nascent businesses in the biopharmaceutical field, reports that it takes an average of at least nine months to recruit researchers at the postdoctoral level.

ment of scientists, it is estimated that close to one-third of those leaving the region are experienced researchers. Many are young scientists (tomorrow's entrepreneurs) who are leaving for a more promising future elsewhere in the country, particularly Quebec, Ontario, and British Columbia, while others are the region's graduates, beckoned by opportunities with the huge American biotechnology firms.

As for the evolution of scientific personnel training, the biotechnology industry has a growing interest in graduates at the leading edge of emerging fields, graduates who already have some experience working on multidisciplinary research teams. It is also becoming increasingly desirable that their training include expertise in computer technology and the more traditional sciences. Indeed, the importance of computer skills keeps growing, particularly in biological computing or molecular modelling. As well, other disciplines, such as genetics and gene therapy, are fast becoming the way of the future in biotechnology.[86]

In addition to its needs for scientific personnel, the biotechnology industry in Atlantic Canada is constantly looking for people with the necessary skills and experience to manage and develop bioenterprises, a task that is proving to be especially complex in the biotechnology sector. A study was recently published by the Biotechnology Human Resources Council on the trends and needs of the biotechnology industry with regard to skills (see table 15).[87] It clearly shows that among the most sought-after skills are those related to business management and development. Biotechnology firms need administrative personnel capable of dealing with regulatory matters, intellectual property protection (patents), relations with investors (risk capital, etc.), strategic alliance development, marketing, and all other activities related to the marketing of new products. From this standpoint, multiskilling is a valuable asset, particularly as it is scarce among employees. Unfortunately, according to many industrial leaders, the lack of management skills has been an impediment to the development of biotechnology in the region. As the industry keeps growing in the coming years, the shortage of highly skilled managers is expected to become more acute, exacerbating the problem even more.

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86. For more on this subject, see the following studies: Paget Consulting Group, *Building Long-Term Capability Now: Canadian Human Resources Study in Biotechnology* (Ottawa: Human Resources Development Canada, 1996); G. Fletcher and B. Pereboom, *Profile of the Biotechnology Sector* (Ottawa: Expert Panel on Skills, Advisory Council on Science and Technology, 1999).

87. BHRC, *Biotechnology Industry Intelligence Briefing*. Although this is a nation-wide study and statistics could not be obtained for the Atlantic provinces owing to issues of confidentiality (given the more restricted business sample), we asked regional bioindustry representatives to interpret these results based on a regional perspective.

Table 15

The Top Five Most-Wanted Skills in Biotechnology, by Field of Activity

Skills Sought	Priority Rating	Field of Activity
Laboratory and instrumentation techniques	1	Research
Intellectual property management and protection	1	Intellectual property
Business development, strategic alliances, and investments	1	Business management
Quality control (regulatory matters and validation)	2	Quality control
Marketing development	3	Business management
Financial management	4	Business management
Laboratory best practices	5	Research

Source: BHRC, *Biotechnology Industry Intelligence Briefing: Human Resources Trends and Projections* (Ottawa: BHRC, 2000).

There is also a lack of management training programs for bio-industries. This concern was raised at the federal level when the National Biotechnology Advisory Committee reported, "Canada has a serious lack of programs to nurture the management skills, such as product development, strategic alliance management, international regulation and technology transfer."[88] As a long-term solution, it was recommended that industry and government work in cooperation with universities and schools of commerce to develop programs that will enable industry managers to improve these skills.

This gap is now being filled through the establishment of specialized programs. In British Columbia, for example, the British Columbia Institute of Technology, together with the University of British Columbia, has created a bachelor's program in applied biotechnology that leads to advanced studies in business management (M.B.A.), law, or science. Similar programs also exist in Saskatchewan (University of Saskatchewan), Ontario (University of Waterloo and Carleton University), and Quebec (Université de Montréal, McGill University, and Université Laval). In Atlantic Canada, there are still no undergraduate training programs in applied biotechnology,

88. National Biotechnology Advisory Committee, *Leading into the Next Millennium* (Ottawa: Industry Canada, 1998), 23.

although technical diplomas in biotechnology are being offered by the College of the North Atlantic (Newfoundland) and the New Brunswick Community Colleges.

Other solutions have also been proposed to remedy the lack of management skills. Cooperative work-study programs at the M.B.A. level are increasingly aimed at understanding the specific challenges of the knowledge industries, such as bioindustries, and encourage students to do their practical training with these businesses. Conversely, undergraduate and graduate science programs now provide students with the option of taking courses in business administration. At Dalhousie University, for instance, students can now get a bachelor's degree that combines a major in biochemistry and molecular biology and a minor in administration. Mentoring programs are also being offered to new entrepreneurs in the various marketing phases of new products. In St. John's, the Memorial University Genesis Centre matches entrepreneurs with mentors experienced in knowledge-based industries, thereby facilitating the acquisition of proven skills in the business world.

Some Common Features of Both Case Studies

It is generally agreed that there is no widespread shortage in the supply of labour to the region's offshore oil and gas industry and to industrial biotechnology. Up till now, the Atlantic provinces' education and training infrastructure seems to have been adequate in meeting its human resource requirements, particularly with respect to the more common technical skills.

And yet employers are having difficulty filling key positions that require a combination of expertise and special skills. For example, one of the challenges that were most often mentioned during our interviews with managers in the biotechnology sector but which apply to many other emerging sectors of the new economy is the difficulty finding people with skills in new-product managing and marketing. There has been a persistent shortage of qualified personnel capable of raising capital (risk and other), preparing business plans, developing strategic alliances and partnerships, and undertaking regulatory and technology transfer activities. To remedy this situation, which to a certain extent may slow down the progress of some innovative industries, the Expert Panel on Skills recommended that "ministers responsible for post-secondary education encourage colleges and universities to establish advisory committees of representatives from industry and

other appropriate stakeholders, for programs in science and technology, business and administration, and all other program areas that could benefit from closer links with the world of work."[89]

While the focus must clearly be on the improvement of management skills, the acquisition of work experience is another important factor. It is often hard to integrate young graduates directly into the various work environments not only because employers demand advanced technical skills but also because they consider practical experience very important. As a remedy, cooperative work-study programs have been established to allow future graduates to train with businesses and acquire useful experience.

Nonetheless, among all the observations made in our two case studies, the most significant one undoubtedly concerns the fact that education and training are considered as critically important by employers in the knowledge economy. They are constantly looking for *knowledge generators*, that is, people on the lookout for innovative research work, new products, etc. For example, competition to recruit skilled technicians and highly qualified specialists, both in the offshore oil and gas industry and the biotechnology industry, is very strong internationally. That makes it difficult to attract people with this kind of human capital to the Atlantic region and then convince them to stay. Whether looking for geological engineers or postdoctoral researchers in genetics, the recruitment of candidates for highly qualified positions is a constant challenge for the region. But it is not only in high-technology sectors that education and training of human resources play a crucial role in the knowledge economy. As will be seen in the next chapter, today's economy demands broadly based skills.

89. Expert panel on Skills, *Stepping Up*, 72.