PROSPECTS FOR GROWING KNOWLEDGE-BASED INDUSTRIAL CLUSTERS IN ATLANTIC CANADA

FINAL REPORT
PART 1 - Concepts, Analysis and Recommendations

PROSPECTS FOR GROWING KNOWLEDGE-BASED INDUSTRIAL CLUSTERS IN ATLANTIC CANADA

Part 1:
Concepts, Analysis and Recommendations

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EXECUTIVE SUMMARY

This study reviews the prospects for knowledge-based industrial cluster development in six industrial domains in Atlantic Canada. This six industrial domains are:

- Information Highway;
- Geomatics;
- Aquaculture;
- Ocean Technology in Newfoundland;
- Medical Devices/Services in Nova Scotia; and
- Food Processing in New Brunswick/Prince Edward Island.

The first three were analyzed from a pan-Atlantic perspective, while the last three were studied from a sub-regional perspective. The profiles of these six clusters can be found in the Part 2 Report, along with cluster specific analysis. Collectively, they capture the characteristics of clusters at different stages of development as well as from different geographical perspectives within the Atlantic region. This permits an analysis of cross-cluster issues and related general policy directions.

The Knowledge-based Industrial Clustering Phenomenon

Knowledge-based industrial clusters are regional or urban concentrations of firms supported by a technical and socio-economic infrastructure made up of universities/colleges, financing/business institutions, advanced communications/transportation systems and so on.

The key characteristics of knowledge-based industrial clustering, based on the analysis of a large number of cases, are:

- strong formal and informal linkages among firms and the supporting technological and business infrastructure in a region or locality stimulate the innovation process and the growth of the cluster;

- geographic proximity of firms, educational and research institutions, financial and other business institutions enhances the effectiveness of the innovation process;

- the larger the cluster (e.g. large number of firms and workers) the higher the level of self-sufficiency; i.e. less need to get key functions (e.g. supplies, financing) supplied from outside; that is there is less “leakage” outside the cluster.

The six clusters were analyzed from this perspective of the dynamics of industrial clustering.

Industrial Clustering in Atlantic Canada

It was found that the economic potential of the six clusters was well recognized and the fundamentals for growth were in place (i.e. there is a well developed technical and physical infrastructure, champions are in place and major market opportunities exist). However, they do face important development challenges at the present time. The main issues to be addressed are:

- weak management within firms (e.g. lack of sound business practices; lack of international marketing skills);
- weak linkages among firms in the clusters;
- weak linkages between R&D institutions and industry;
- difficulty in accessing financing due to immature business practices; and
- a lack of skilled people, especially IT personnel.

Moreover, the limited size of the regional economy and its population and the remoteness of major markets are other important factors that add to the difficulties of cluster development.

Industrial clustering is a local phenomenon. The geographic proximity of the players is key to cluster development. Therefore it is not surprising to find that the principal level of communication, decision-making and affinity regarding cluster development in Atlantic Canada falls mainly within provincial jurisdictions. The local level should be the primary focus for considerations regarding cluster development at this time, given their small size. As the clusters grow they will inevitably spread to other parts of the region. They could then be considered on a region-wide basis.

A Strategy to Stimulate Industrial Clustering

A four point strategy is proposed to address the current situation. The main recommendation of the study, which is the first element of the strategy is that:

- **all levels of government should stimulate the development of linkages among the key players in individual clusters. This means that their programs and activities should be aimed at the formation of alliances among firms and between firms and technical and business support institutions.**

In this context major projects provide focal points to bring firms and other organizations together. Identifying such major projects should be a priority. Examples of such projects are given in Exhibit ES-1.

Exhibit ES-1: Potential Projects

Cluster	Projects
Information Highway	• Vista phones • extension of TARA project • smart venture capital capability
Geomatics	• Placentia Bay Traffic management • Port of Halifax Traffic management
Aquaculture	• joint marketing • aquaculture link to bio-medicine • export of "growing systems" and brood stock • cost containment research
Oceans Technology (NFLD)	• oil and gas technology • environmental technology • seabed mining/exploration
Medical Devices and Services (N.S.)	• outsourcing solutions for hospitals • new health care management technologies
Food Processing (NB/PEI)	• marketing of vegetables • export of "wildbush" blackberries and other fruits • support of export clubs • increased efficiency of pesticides and machinery • increased use of computers • internship program • packaged meals

The three other elements of the strategy are:

- **upgrading management skills**; by
  - training entrepreneurs, managers and staff of existing firms;
  - attracting seasoned managers and mentors to be retained by existing firms; and by
  - providing management services on a contractual basis.

- **bridging the skilled people gap**; by
  - identifying the human resource needs of each sector in order to put in motion those education and training programs needed;
  - recruiting specialists from the ex-Soviet Union (as firms in other parts of Canada are doing);
  - contracting-out work around the world;
  - attracting Atlantic Canadians working elsewhere; and through
  - strategic alliances between firms.

- **attracting external investment**; by
  - working closely with Foreign Affairs and International Trade Canada and the new Investment Partnerships Canada agency to develop appropriate approaches and activities.

Such a strategy has to be sustained over the longer term because experience around the world shows that it takes several decades to grow successful clusters. There is no quick fix.

1.0
INTRODUCTION

With the shift to the "new economy", sub-national regions around the world are setting in place the infrastructure and public policy tools required to support technology-intensive industrial development. This phenomenon is knownas knowledge-based industrial clustering. It has become one of the key tenets of industrial development and growth strategies in Europe, Asia and the United States. The purpose of this study is to examine the prospects that trial cluster theory holds for growing knowledge-based firms in Atlantic Canada, by examining six case studies.

Six industrial clusters, representing key technological areas at different stages of economic development, were selected for the study. Three were to be studied from a pan-Atlantic perspective while the other three were to be studied from a sub-regional perspective. They are:

a) *Pan-Atlantic Clusters*
Information Highway
Geomatics
Aquaculture

b) *Sub-Regional Clusters*
Ocean Technology in Newfoundland
Medical Devices and Services in Nova Scotia
Food Processing New Brunswick and Prince Edward Island

In considering the selection of these cases it is important to note that this list was not intended to be comprehensive. There are other competitive, capable industrial clusters in the region. The six selected clusters, collectively, capture the characteristics of clusters at different stages of development as well as from different geographical perspectives within the Atlantic region. This permits an analysis of cross-cluster issues and general policy directions, and will enable the development of an assessment of the prospects for growing knowledge-based industrial clusters from an Atlantic perspective.

The methodology used to analyze these clusters is described in Section 2.2. The resultant profiles of the clusters can be found in Part 2 of this report. The approach taken was one that led to an understanding of the structure of each cluster, illustrated by selected firms and organizations, and of the dynamics of each cluster through a series of interviews with relevant players. Some 50 interviews were undertaken across Atlantic Canada to gain an appreciation of the dynamics of the six clusters. The intent was to obtain an understanding of the workings of each cluster, not to prepare an exhaustive profile of the firms and other organizations in each cluster. The purpose was also to extract general lessons and propose generic policy recommendations.

The following sections of this report discuss the major issues identified and propose a strategy that addresses these issues and that aims at building stronger industrial clusters in Atlantic Canada.

2.0
WHAT IS INDUSTRIAL CLUSTERING?

2.1 THE CONCEPT

Knowledge-based industrial clusters are regional or urban concentrations of firms including manufacturers, suppliers and service providers, in one or more industrial sectors. These firms are supported by an infrastructure made up of universities and colleges, research institutes, financing institutions, incubators, business services and advanced communications/transportation systems.

With the shift to the "new economy", sub-national regions and municipalities around the world are setting in place the infrastructure and mechanisms needed to support technology-intensive industrial development. This phenomenon is known as knowledge-based industrial clustering. Through the work that Nordicity Group Ltd. has undertaken related to this phenomenon we have estimated that there are about 200 or so sub-national regions and municipalities active in developing strategies to attract knowledge/technology-based investment. Examples include the well known Silicon Valley, California, Austin Texas, and Boston's Route 128 in the USA; the regions of Rhône-Alpes, France, Baden-Wurttemberg, Germany, Lombardy, Italy and Catalonia, Spain, in Europe; as well as the 26 clusters set up under Japan's Technolopolis Law of 1983. There is now a sufficient body of knowledge regarding the dynamics of knowledge-based industrial clusters to be able to draw conclusions related to the characteristics of success.

The idea of industrial clustering has a long history and is well anchored in the study of economic geography. Benefits can accrue to an area from the activities of firms in that area. These benefits typically arise from the fact that a firm cannot capture all the economic benefits from its innovation process (i.e. bringing its products to market). There are spillovers out from the firm that can benefit the community at large if there are suitable structures and receptors in place to take advantage of them. For example, people with expertise leave firms to work for other firms or to set up their own firms. Capturing these spillovers leads to the establishment of new capabilities and more growth in the community.

With globalization and the shift to a knowledge-based world economy, time-to-market and just-in-time delivery become more critical. This encourages the clustering of capabilities in regional/local centres to support the innovation process and thus to minimize the "leakage" of external benefits outside the community. Firms are attracted to communities that can provide the key functions needed to bring their products or services to market rapidly.

While a region/locality can have more than one cluster in place, the analysis of clusters is usually undertaken from a technological domain perspective. This is the approach taken in this study. Very few regions/localities around the world have industrial clusters having more than 100,000 people working in industry. After some 50 years of development, Silicon Valley, California is such a cluster in the information technology and related microelectronics area, with about 250,000 people in more than 3,600 firms. At that level the cluster is usually self-sufficient or complete, in

that it has in place all the essential technical, business financial, legal, etc. capabilities needed to sustain industrial activity in the cluster. The more firms and the more people working in industry in the cluster, the more it tends to be self-sufficient, i.e. fewer outside resources are needed. The growth of clusters follows the general principles of local level economic development. As noted by Jane Jacobs; "Economic life develops by grace of innovating: it expands by grace of import replacing. These two master economic processes are closely related both being functions of city economies."[1]

In summary then, the key characteristics of industrial clustering are:

- strong formal and informal linkages among firms and the supporting technological and business infrastructure in a region or locality stimulate the innovation process and the growth of the cluster;
- geographic proximity of firms, educational and research institutions, financial and other business institutions enhances the effectiveness of the innovation process;
- the larger the cluster (e.g. large number of firms and workers) the higher the level of self-sufficiency; i.e. less need to get key functions (e.g. supplies, financing) supplied from outside; that is there is less "leakage" outside the cluster.

Through the various clustering projects that Nordicity Group Ltd. has undertaken[2], we have identified eight ingredients for success. They are:

1. the recognition of the potential of knowledge-based industries by regional/local leaders;
2. the identification and support of regional strengths and assets;
3. the catalytic influence of local champions;
4. the need to have an entrepreneurial drive and sound business practices;
5. the availability of various sources of investment capital;
6. the cohesion provided by both informal and formal information networks;
7. the need for educational and research institutions; and most importantly,
8. the need to have "staying power" over the long term.

Underlying these elements is, of course, the need for sustained economy activity.

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1 Jacobs J.; Cities and the Wealth of Nations; Vintage Books 1985, p39

2 See for example (a) Nordicity Group Ltd.; Regional/Local Industrial Clustering: Theory and Lessons from Abroad prepared for National Research Council; February 27th, 1996 (b) Roger Voyer and Jeffrey Roy; "European High-Technology Clusters" in Evolutionary Economics and the New International Political Economy (ed. J. de la Mothe, G. Paquet) Pinter 1996

These indicators provide collectively a generic benchmarking framework that was used to evaluate the level of development of the industrial clusters in Atlantic Canada.

2.2 THE METHODOLOGY

The methodology for the study, which flows from the above concept, is described below.

The approach is to map the industrial clusters by reference to existing markets and applications, alongside potential new market opportunities, all in relation to a structural hierarchical or tiered model of industrial and infrastructure capabilities in a given technological domain.

First, the framework starts with existing markets. These turn out to be demand industries both in the region and outside.

Second, the framework poses specific potential for new opportunities beyond the existing markets. These new opportunities represent technology and market areas that relate to both the existing markets and to the region's supply base.

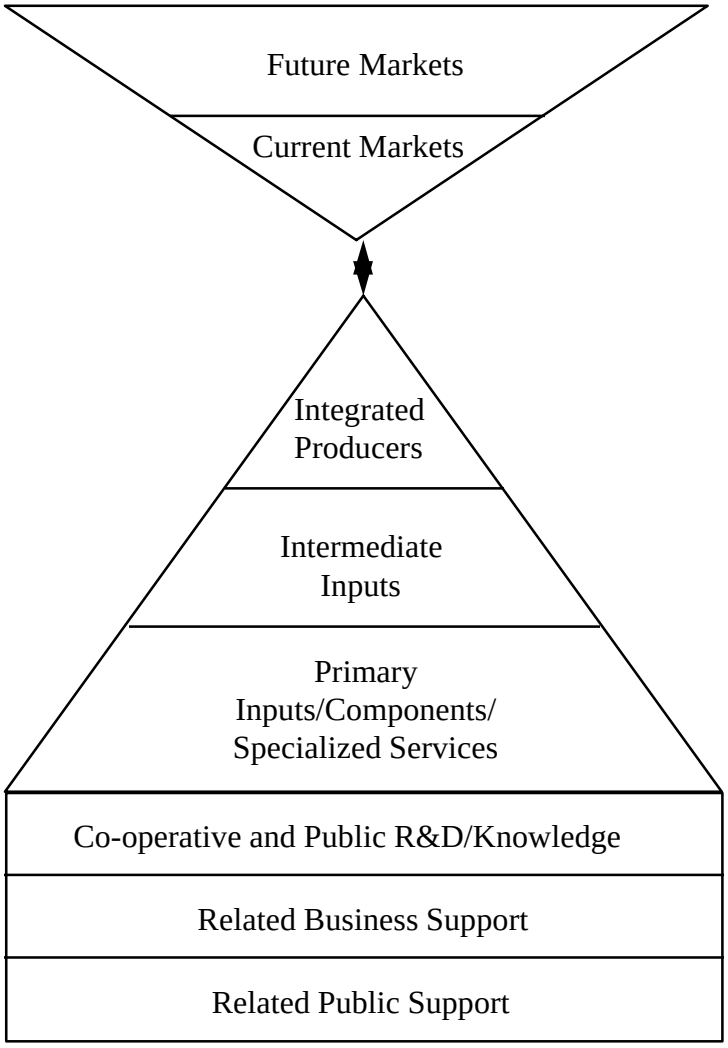
Third, the framework sets out the infrastructure supply base to the cluster. At the top tier or layer level of the framework are specific private-sector (i.e. wealth-generating) firms that provide both products and services for the domestic and export markets in end-user form, or as close to end-user form as the cluster can provide. They are backed by specialized organizations, in both the public and private sectors, that provide primary and intermediate goods and services to the top tier level. These specialized organizations may well be larger than any in the top tier and may serve much more than just the upper level tier; however, within the context of the cluster they are providing support to the market-oriented firms in the cluster.

Fourth, backing these multiple layers are support levels. The upper support tier provides publicly-available or co-operatively-developed knowledge through R&D. These are predominantly public institutions, but also includes industry associations and consortia. Finally, there are two tiers of related business support and related public support that do not serve the cluster exclusively but are nevertheless relevant.

This approach, which is shown conceptually in Exhibit 2-1, was used to present the six industrial cluster frameworks.

Based on this framework, the dynamics of each cluster was described, based largely on an interview process, and issues related to cluster development were identified.

Exhibit 2-1
Conceptual Framework for Cluster Analysis



3.0
ATLANTIC CANADA IN CONTEXT

3.1 ECONOMIC PATTERNS

Atlantic Canada has a population of some 2.5 million, which represents 8.5% of Canada's population (down from 9.2% in 1982) and about 6% of the Canadian economy.

Current economic patterns are captured in the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis presented in Exhibit 3-1. SWOT analyses are subjective. There may therefore be differences of opinion regarding some of the observations. However, collectively these observations do provide a framework for cluster analysis.

Exhibit 3-1
Strengths, Weaknesses, Opportunities and Threats in the Atlantic Economy

STRENGTHS	OPPORTUNITIES
• Strategic location • Good ports • Strong urban knowledge base • Highly developed centres of natural and applied science • Nationally recognized universities • Growing strength in tradable services • Good communication links • Strong culture and linguistic assets • Good quality of life • Relatively clean environment • Growing regional cooperation among governments	• Transportation centre • Marine industries • Aquaculture • Opportunities for value-added activity • Move to a knowledge-based economy • University-business spin-off • Information industries • Service exports • Adventure tourism • Cultural industries • Home-based and micro business • Increased efficiency of business based on increased competition within the region
WEAKNESSES	**THREATS**
• Resource dependence • Dependence on government • Underdeveloped private sector • Poor access to investment capital • Low level of linkages/weak clusters • Lack of entrepreneurs or aversion to risk • High taxation • Low levels of technology transfer • Road and rail infrastructure • Low levels of productivity • Minimal private sector R&D • Low human capital relative to other regions	• Growth in global competition • Declining federal transfers • Declining role of government • Environmental constraints • Resource supply • Competing transportation networks • Marginalized human resources

Source: DRI Canada; Atlantic Canada; Facing the Challenge of Change (Executive Summary); Prepared for ACOA, Sept. 1994

Globalization of the world economy is forcing major adjustments to national, regional and local economies. Atlantic Canada is faced with a major challenge is to become more responsive and integrated into the global economy. As the SWOT analysis indicates the region has significant strengths in its infrastructure but has major weaknesses related to its business orientation. A much more dynamic business/industry sector will be needed if the region is to seize emerging opportunities, especially those related to the "new economy".

Similar conclusions come out of a recent industrial clustering study of Western Canada;[3]

> "To-date, there is limited evidence that Western Canada is adopting the new business climate strategies. Its industries are fragmented and firms compete fiercely to take their share of a market that many perceive to be shrinking without thinking about collaborative actions that could increase the overall size of the accessible market to the benefit of all. Generally, firms have the attitude that the government should be the source of most strategic regional economic development actions. Furthermore, their demands are generally static requests for lower business costs such as taxes or even R&D expenses. Finally, the general approach across the region is an unfocused process of job creation, R&D spending and business attraction."

A recent study for ACOA has highlighted how Atlantic Canada overall is vulnerable to "leakage" in its manufacturing sector. Supplies from outside the region are needed as capital goods and equipment inputs. Such supplies are especially needed the more technologically-intensive the class of products (see Exhibit 3-2). This situation leads to the weak linkages in the clusters as discussed in Section 4.1.4.

Exhibit 3-2
Imported Inputs (1989) to Atlantic Canada s Manufacturing Industries

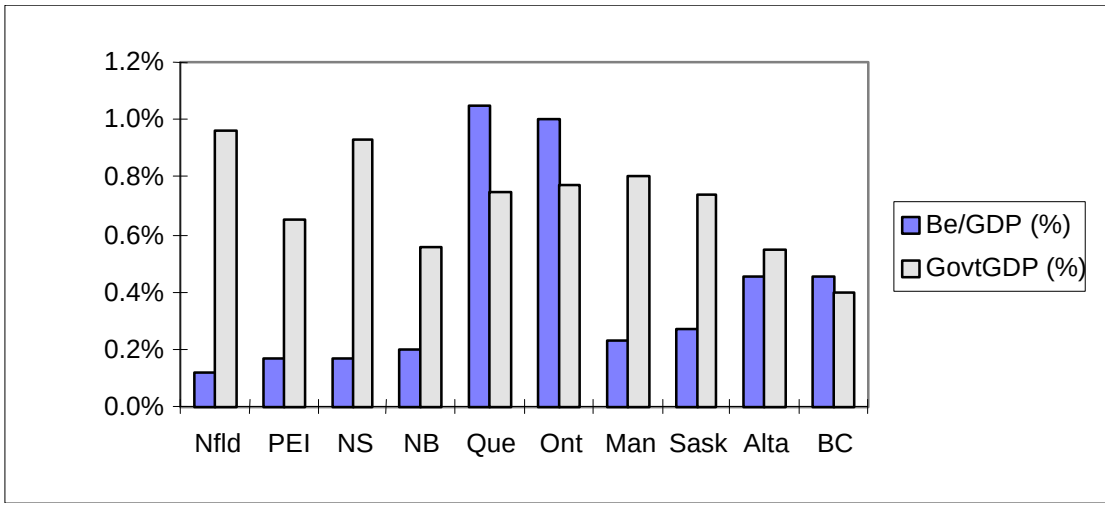
Input	Purchases by Atlantic Canada Manufacturers ($ million 1989)	by % Supplied	
		Atlantic Canada	Imported
Chemicals, chemical products	183.9	16.7	82.3
Primary metal products	126.0	13.5	86.5
Electrical and communications	44.9	11.6	88.4
Machinery and equipment	44.1	6.1	93.9
Metal fabricated products	22.6	21.9	78.1

Source: DRI Canada; Atlantic Canada; Facing the Challenge of Change; Prepared for ACOA, Sept., 1994

[3] KPMG, DRI/McGraw-Hill, IMPAX; Building Technology Bridges: Cluster-based Economic Development for Western Canada: Vol. 1 Summary Report, p.13

R&D expenditures by business enterprises (Be) are a traditional indicator of the dynamism of industrial innovation. As can be seen in Exhibit 3-3, the R&D expenditures by business enterprises as a percent of provincial GDP is lowest in Atlantic Canada. On the other hand, public sector expenditures on R&D are roughly comparable with those in other regions of Canada. The low level of private sector R&D in Atlantic Canada is well recognized as weakness in the region which also has an underdeveloped private sector (see Exhibit 3-1).

Exhibit 3-3
R&D Expenditures (1992)



Source: Statistics Canada

3.2 SIX CLUSTERS WITH POSSIBLE POTENTIAL

While the regional economy as a whole needs to renew itself in the face of globalization, the focus of this study is on six industrial clusters that are at the leading-edge of the new knowledge-based economy and that can provide leadership in transforming the economic structure of the Atlantic region. As can be appreciated from Exhibit 3-4, these are relatively small clusters at the moment. Together, they represent only about 10% of the regional economy. Two of the clusters, Information Highway and Food Processing, are dominated by a few large firms.

Exhibit 3-4
Size of Clusters

CLUSTER	VALUE OF OUTPUT ($ MILLIONS)	INDUSTRY EMPLOYMENT
Regional Clusters		
Information Highway	2,000[2]	20,000[2]
Geomatics	35-70[2]	750[1]
Aquaculture	200[2]	approx. 1,000[1]
Sub-Regional Clusters		
Ocean Technology	100[2]	1,000(+)[1]
Medical Devices/Services	NA	"a few hundred people"[1]
Food Processing	1,800[2]	10,000[1]

1 DRI Canada: Atlantic Canada; Facing the Challenge of Change; Prepared for ACOA, September 1994
2 Nordicity estimate.

4.0
FINDINGS

4.1 CROSS-CLUSTER ISSUES

4.1.1 Limited Size of the Regional Economy and of the Population

Atlantic Canada is relatively small. It had a population of 2.5 million in 1995 (8.5% of the Canadian population) and its economy represented about 6% of the Canadian economy.

Population has been growing at about half the national average over the last 20 years. While urban centres are capturing the largest share of this growth, over 50% of the population in the region continues to live in rural communities.

An important factor in cluster development is to have a concentration of population and economic activity in a given geographic area so that the "spill-over" effects of the economic activity (e.g. technology transfer) can be captured locally. There is even a rule of thumb developed through experience suggesting that it takes a population of about 500,000 people in a locality to be able to develop a complete cluster.[4] Otherwise, the threshold level of firms needed to develop and retain key support elements in the area will not be reached resulting in leakage from the area. This does not mean that clusters cannot be grown, but aspiring to establish a complete cluster would be difficult. However, new information technologies can extend the reach of an area with a limited population base.

No sub-region in Atlantic Canada approaches the 500,000 population level. Halifax is the census metropolitan area with the largest population (i.e. 343,000 in 1995). This would imply that information technologies would have to be marshaled to play a more important role in building clusters than they would have to be in more populated jurisdictions.

Other localities with limited population are attempting to develop clusters. Two examples, Montpellier, France and Lübeck, Germany are described in Exhibit 4-1. These two small municipalities saw knowledge-based industries as an opportunity to diversify their local economies away from traditional economic activities. The approach is to build up a critical mass of capabilities locally before moving further afield to seek new markets and to link up to other clusters.

[4] Anderson G.G.: Industry Clustering for Economic Advantage: SRI International, May 1994

Exhibit 4-1
The Montpellier and Lübeck Clusters

Montpellier, France	Montpellier, a historic sun-belt city with a population of about 220,000 developed and implemented a strategy to diversify out of tourism through the support of high-technology industries beginning in the early 1980s. The architect of the strategy was the deputy mayor of Montpellier, George Frêche. The Montpellier strategy is based on the development of four "technopoles". • *Pôle antenne*: to support the development of telecommunications and broadcasting. As a first step, M. Frêche decided to provide the city with an optical fiber cable network as the infrastructure to support the development of advanced video communications. This activity is supported by the Grammont Centre International d'Images, which has complete facilities for performing arts, television and film production, and the Gutenberg Médiatheque, which has audio-visual viewing and teaching facilities. • *Pôle informatique*: to support the development of software, artificial intelligence and electronics. The centerpiece of this activity is the IBM plant established in 1965, which manufacturers IBM's supercomputers, and its network of supplier. This activity is supported by the University Computer Center and the national Center for Supercomputing (CNUSC), the second most important in France. There is also a high-tech park (Parc du Millénaire), which has some 150 firms, most of them SMEs. • *Pôle euromédicine*: to support the development of biotechnology and pharmaceutical firms. The activity is built around the university's medical faculty, the oldest in Europe (1289), and its hospital complex, the third largest in France. This "pole" also has its own science park, which has about 100 firms, mostly SMEs. Related research institutes such as those of CNRS and INSERM have some 2,000 researchers. • *Pôle Agropolis*: to support the development of agribusiness. The related teaching/research complex has 20 institutes and 2,000 researchers. This "pole" also has its own science park, which currently has some 20 firms.
Lübeck, Germany	Lübeck is a city near the Baltic Sea with a population of about 210,000. With the closing of its major employer in the early 1980s, the shipyards, local business leaders began to explore other options for industrial development through the chamber of commerce. Because the municipality had a medical faculty with some researchers interested in the application of laser technology to medicine, it was decided that this technological focus should be made a priority. A medical laser research center was established. An incubator – the Technizentum (TZL) – was set in place in 1986. The TZL can take equity positions in the start-ups in the incubator, and at present there are some 40 technology-intensive SMEs in the TZL. In all, there are now over 100 technology and 400 software firms in the immediate region, many of which are related to medical lasers. Many of these firms have links with firms in Scandinavia. Given Lübeck's geographic location a particular affinity to Scandinavia has developed. This example illustrates how an opportunity emerged from a very difficult situation. The transition to knowledge-based firms was due to the tenacity of the local business leadership.

Source: Roger Voyer and Jeffrey Roy (ref 1)

4.1.2 Geography - Far From Markets

The remoteness of Atlantic Canada from major Canadian markets creates a disadvantage in two ways. Firstly, the local/regional market is relatively limited and does not provide as stable a base for pursuing markets outside of the region as in other parts of the country. In central Canada, for example, firms have access to a large "home" market close at hand which provides a strong base for export. Whether they operate in the Canadian or foreign markets, firms in knowledge-based sectors tend to want to be close to, or have ready access to, their most demanding customers to be better able to respond to changing requirements. Increasingly firms set up product development and marketing units close to their major customers. New East of St. John's, for example, has set up marketing functions close to major markets to offset the firm's distance to these markets. Other corporate functions (e.g. R&D) remain in St. John's.

Secondly, transportation costs of getting some products (e.g. food stuffs) to distant markets can be onerous.

However, other remote areas have set in place knowledge-based/high-technology development strategies that overcome the remoteness barrier. Take Scotland for example. Over four decades it developed a very strong electronics sector which supplies over one-third of European market and 10% of the world market for PCs. It is also a major centre for silicon chip manufacture. This was brought about by a sustained targeted foreign inward investment strategy that offered significant capital subsidies and low taxation rates. This strategy attracted many multinational firms wanting a foothold in the European Union. The strategy, however, mainly generated low value-added manufacturing and assembly plants with little coupling to Scotland's strong academic R&D base. Few spill-overs leading to new firm formation flow from assembly operations. Scotland is therefore a truncated cluster, since it lacks higher level design and systems integration functions. Jobs were created but the brain drain situation was not solved.

Strategies can be set in place (by both firms and governments) to offset distance to markets. However, from a cluster development perspective, the strategies should focus on the development of capabilities in all elements of the innovation process to avoid the problems of truncation.

4.1.3 Management Weakness as a Key Issue

The clusters studied have technical strength and appear to be product driven. There appears to be an implied need for an increased international marketing focus and improved access to financing. This is particularly important in the face of globalization of markets with the dismantling of trade barriers.

Generally, the clusters showed an underlying weakness in management (not atypical of SMEs). In particular, management expertise related to financing and international marketing is not widely present in the clusters. This is amplified by the problem of retaining in the region the skilled people needed for success.

Management issues relate to the business context in which firms are operating. They include:

- limited exposure to international market situations where related skills could be developed;
- limited experience in managing larger firms since the bulk of firms are SMEs;
- limited scope of experience in that firms often have truncated operations so that full spectrum of management functions from design to production and marketing are not present.

Specifically, the issues related to management for each of the clusters were:

CLUSTER	ISSUES
Information Highway	Marketing: market research, distribution, international marketing, skills to penetrate markets Finance: skills to access funds
Geomatics	Marketing: specifically international marketing Finance
Aquaculture	Marketing: commercialization Finance: commercialization
NF Ocean Technology	Marketing: marketing intelligence, international marketing skills
NS Medical Devices	Finance: private investment
NB/PEI Food Processing	Marketing

Source: Interviews

The study has identified requirements for management skills such as:

1. business planning managers familiar with science and technology who can prepare realistic financial and marketing plans;

2. science and technology managers who know how to successfully approach financiers for access to available funds; and

3. managers who are capable of international marketing (including international market research and intelligence gathering, international marketing strategy and international distribution and sales).

The November 1996 Atlantic Technology Forum reinforced the need for management skills in Atlantic Canada S&T firms.[5] Leadership in strategic and operational management was identified as a regional weakness in S&T firms. Training for this leadership role was seen to be lacking - particularly as it related to strategic leadership management.

With experienced management and related skills, several of the other issues facing the clusters could be positively impacted. For instance, mature management in marketing would recognize the need to and benefit in establishing linkages within clusters. They would endeavour to build and facilitate the establishment of linkages for the eventual success of their firm(s). This, in turn, would lead to strengthened clusters and more dynamic growth.

4.1.4 Weak Linkages in Industry

This remains a major impediment to growth of all the clusters. The problem manifests itself in both the vertical and horizontal axes of the cluster structures, i.e. in the flow of increased value-added upwards through the supply chain to the target markets, and in problems of missing "critical mass" and/or adequate diversification at any layer within the clusters.

Weak linkages hinder the supply capabilities of the clusters. These weak linkages take several forms, such as:

- lack of an integrating, end-user product supplier: the Atlantic Canada clusters frequently lack a cluster "focal point" to tackle the market. This arises either because there is no such identifiable most-value-added supplier (the cluster is, in effect, missing its top supply layer), which is the case in Oceans Technology and Geomatics clusters, or there is such a supplier but it does not act in an integrating way, capitalizing on the cluster's value-added chain, which is the case to a considerable extent in the Medical Devices and Services cluster - the hospitals provide a full range of services but do not integrate locally to get the inputs. Even the IH cluster lacks this focus to a certain degree. Without such integration in the supply chain, the cluster's units have difficulty to be mutually supporting. On the other hand, there are end product suppliers which are large and vertically integrated in the Food Processing cluster. However, the lack of interaction with other elements in the cluster stunts cluster development;

- low value-added: a complete supply chain running from raw materials through to end-user products would involve several definable technological transformations (meaning several different layers in the clusters) but all too often the Atlantic Canada clusters do not show this. There is only one or two supply layers with a supporting services layer. This suggests that the clusters' value-added is not as great as it could be. Where there are relationships they tend to be traditional. As one executive in the aquaculture industry stated; "we rely on our traditional

[5] Proceedings of the Atlantic Technology Forum; November 25-27, 1996

contacts in low end processing". The weak vertical linkages mean that complete customer-supplier relationships up and down the cluster structure are not built up. Hence, the high imports of technologically-intensive supplies to the region as shown in Exhibit 3-2;

- lack of diversification: weak horizontal linkages sometimes mean that even when a strong, vertically linked, supply chain does exist it cannot grow faster because the supply base cannot readily expand, i.e. the cluster does not grow "sideways". Examples are the Food Processing, Aquaculture and IH clusters. The former lacks diversity in both resources and machinery inputs and the others lacks strong local alliances to provide higher-value-added services through complementarity; and

- over-specialization: paradoxically, the weak vertical and horizontal linkages sometimes cause too much diversification, in the sense that, at any layer in the cluster, small firms are forced to concentrate on very selective "niche" products. This allows them a certain competitive differentiation, but it also means reduced competition and growth opportunities. This is a problem with the Oceans Technology and Geomatics clusters. As noted by a company executive in an interview:

"The lack of cooperation among companies is rooted in the competitive environment. We have a small market and a lot of people competing for a piece of it. They should focus energies on combining their efforts to go after international markets".

Not only are the industry linkages weak but there is suspicion that goes against establishing such linkages. As observed by a Vice President of a firm interviewed; "a cluster and its linkages can cause problems such as idea "rip-offs" and the "copycat" syndrome". A strategy to create linkages and collaboration and thus overcome resistance to clustering is presented in Section 5.0.

Weak or missing industry linkages are also apparent in other clusters across Canada. For example, take Canada's telecommunications industry which is very much a sector of technological strength. Exhibit 4-2 provides a summary of cluster structure in this sector in seven metropolitan areas.[6] Extensive industry linkages are found in Ottawa, Toronto, Montreal and Calgary, which exhibit total systems development capabilities. Weaker linkages are found in Vancouver, Canada's Technology Triangle (CTT) in Southern Ontario and Edmonton where the telecommunications industry is not as fully developed. However, they still participate in the development of Canada's telecommunications industry. The following observations are significant:

Exhibit 4-2

[6] This summary is extracted from a Nordicity Group Ltd. study undertaken for Foreign Affairs and International Trade Canada in 1995. The study used the same methodology as the one utilized in the present study (see Section 2.2).

Comparison of Seven Canadian Telecommunications Clusters

CLUSTER	MAIN CHARACTERISTICS	STRUCTURE
1. Metro Ottawa	• 1 million population • 32,000 persons employed in cluster (1994); 37,000 in 1996 • 700 firms	• Total systems development capability in telecommunications up to world-class central office (C0) switches • New technology for global markets derived from $600 million+ in R&D, including Canada's largest private-sector R&D lab
2. Toronto Census Metropolitan Area	• 4.5 million population • 50,000 persons employed in electronics sector • 1,000+ firms	• Manufacturing of total systems in telecommunications and computer networks • Total systems development capability in computer networks • Largest IBM software lab outside U.S. • Large multi-media and entertainment development capability
3. Greater Montreal Region	• 3.5 million population • 14,000 persons employed in telecommunications, plus 4,000 more in related electronics (1995) • 575+ R&D-intensive firms	• Systems development capability in telecommunications, with special reference to fibre-optic transmission, and photonic systems • Canada's only commercial semi-conductor fabrication facility (component-level manufacturing)
4. Calgary	• 1 million population • 26,700 persons employed in telecommunications and high technology • 200+ firms in telecommunications	• Systems development capability in telecommunications, with special reference to R/F wireless (cellular) systems and business multi-media systems • More than 400 R/F engineers in R&D and support - among the largest collections of skilled wireless personnel in the world
5. Great Vancouver Regional District	• 1.8 million population • 10,000 persons employed (approx.) in electrical and electronics manufacturing including telecom.	• Development capability in small and medium systems • Specialized sub-systems such as wireless and satellite ground stations
6. Edmonton	• 1 million population • Several thousand persons employed in high technology	• Micro-electronics R&D • Laser and photonic R&D • Diverse industrial base
7. Canada's Technology Triangle (Kitchener, Waterloo, Cambridge, Guelph)	• 500,000 population • 14,000 persons employed in high technology • 350+ high tech firms	• Diverse manufacturing industry • Network development capability at local or region level • Sub-system telecom development capability

Source: Nordicity Group Ltd.; based on a study prepared for Foreign Affairs and International Trade Canada (1995)

- size alone does not guarantee extensive linkages (e.g. Vancouver, Edmonton), although the smallest, the CTT, has the weakest linkages;

- being situated in Canada's industrial heartland also does not guarantee extensive linkages (e.g. CTT); and

- major investments can drive growth, linkages and technological sophistication (e.g. Nortel's presence and investment in Ottawa, Montreal, Toronto and Calgary).

Even in a very dynamic sector such as telecommunications there are major differences in the level of development of participating clusters across the country. So it should not be surprising that the structures of Atlantic Canada's relatively small clusters are not that well developed at the present time.

4.1.5 Weak Links Between R&D Institutions and Industry

Atlantic Canada has a relatively strong publicly-funded R&D infrastructure as exemplified by the level of public expenditures on R&D (see Exhibit 3-3). However, a recent study concluded that "publicly-funded research is largely disconnected from the needs of the community."[7] The need to improve linkages between the research community and the private sector was recognized at the Atlantic Technology Forum. The situation is possibly best captured by the following statement made in the Proceedings of the Atlantic Technology Forum;

"The jury is still out as to whether the university should outreach to the business community or the business community take the responsibility to approach the university."

While the "buck is being passed" others are acting. Many publicly-funded research organizations in Canada (e.g. University of Calgary, University of Guelph) and elsewhere (e.g. MIT, Oak Ridge National Laboratory) have set in place technology commercialization mechanisms. Such models bridge the academic and business cultures.

For example, GUARD (Guelph University Alumni Research and Development) is the first for-profit, publicly-traded company in Canada devoted to exploiting university inventions and technologies. The corporation provides evaluation, financing and management expertise to commercialize an invention/technology. The company recently issued an initial public offering which brought its total capitalization to $7.8 million. GUARD is currently involved with start-ups in a number of areas including veterinary vaccines, molecular modeling technology and gamma ray backscatter technology. Initially nurtured by the university's research office, GUARD is now re-located in the affiliated Research Park Centre.

[7] SECOR; A Science, Technology and Innovation Framework for Atlantic Canada; Prepared for ACOA October 1995

The federal government is attempting to establish closer links between universities and industry through its Technology Partnerships Program (TPP) which aims at developing technology from universities to industry on a shared cost basis. The TPP funds R&D activities that are aimed at demonstrating to companies that an idea is technically and economically feasible. Both the university researcher and the industrial partner must be actively involved in the project. This program goes some way to bridge the academic and business culture.

As Denzil Doyle mentioned in his discussion paper for the Atlantic Technology Forum, the key ingredients needed for technology commercialization are:

a) scientists and technology transfer officers who can visualize the products, services and processes they can create;
b) investors (either the owners of the existing companies or outside investors) who are capable of making early-stage, high-risk investments;
c) entrepreneurs who can attract the necessary resources and launch and manage the new enterprises; and
d) an infrastructure that can supply the supporting services.[8]

Bringing these players together is the challenge facing Atlantic Canada. Some mechanisms have been set in place in Atlantic Canada such as Memorial University's Seabright Corporation and NUTech. As well, there are technology commercialization offices within universities. The effectiveness of such mechanisms should be gauged on their ability to create new firms and transfer technology to existing firms. The offices that have been most successful have placed far greater emphasis on collaboration with firms than on "technology-push" activities.[5] "Technology-pull" from industry is needed.

A counter perspective is that leading edge firms do not need to interact with university researchers because these researchers are not at the leading edge. To quote a senior executive interviewed:

> "Our company is leading in its field, but no professors are spending time with us to understand what we are doing. Therefore, there is no need to do cooperative R&D and the students who will graduate in future will not have the specific skills that we need. Professors need to spend time with leading edge companies to enhance the education that they are providing to their future graduates".

[8] Doyle D; Linking Research Capacity to Commercialization Capacity; Prepared for the Atlantic Technology Forum, November 25 to 27, 1996

4.1.6 Financing Issues

Firms with a successful track record usually do not have difficulty financing their activities using traditional instruments such as bank loans and issuing equity. Such is not the case for emerging firms. With less grant/loan money available from government in the future, venture capital can help fill the void.

There is a consensus that there is no shortage of venture capital.[9] ACOA has contributed $10 million to this $30 million venture capital pool through the establishment of ACF Equity Atlantic. However, as shown in Exhibit 4-3, Atlantic Canada companies are not accessing much of this funding. The reasons for this include:

- the reluctance of the entrepreneur to give up equity to obtain funding;
- the lack of experience of the entrepreneur in dealing with venture capitalists (e.g. the lack of understanding of the need for a credible business plan as the basis for negotiations);
- the lack of role models and success stories; and
- the lack of mentors.

Exhibit 4-3
Venture Capital Pattern in Atlantic Canada

Venture Capital	Q2 96	Q1 96	Q4 95	Q3 95	Q2 95	Q1 95
Total new venture capital investment in Canada ($ millions)	177.1	128.1	200.8	110.4	90.4	73.9
$ millions invested in Atlantic Canada	0.5	0.8	0	3.6	2	0
# of companies	1	1	0	2	1	0
% of total $ invested	0.3%	1.0%	0.0%	3.0%	2.2%	0.0%

Source: Anaka M., Financing Issues for High Tech Companies in Atlantic Canada: Prepared for the Atlantic Technology Forum, November 25-27, 1996

While these characteristics related to entrepreneurship can be found across Canada they seem to be more accentuated in Atlantic Canada because of a risk-averse and equalitarian culture[10] and a history of dependence on government financial support (e.g. grants). Moreover, there is a relatively smaller private sector than in other parts of Canada to provide lessons. As well, Atlantic Canada has had a declining proportion of business formations, from 7.4% in 1975 to 5.8% in 1991. However, there are some spectacular entrepreneurial success stories, such as New East and Guigné International of St. John's, which provide models as to what can be done.

[9] Proceedings of the Atlantic Technology Forum; November 25-27, 1996.

[10] Anaka M.; Financing Issues for High Tech Companies in Atlantic Canada: Prepared for the Atlantic Technology Forum, November 25-27, 1996.

To overcome barriers related to financing will require awareness raising and business training programs for entrepreneurs so that improved management skills can be developed.

From the investor's perspective, the investment has to have a substantial financial return. However, in a Canadian fiscal environment where the tax treatment for dividends is more favourable than that for capital gains (the favored venue of venture capitalists), there can be resistance to invest in new ventures if returns from less risky investments in mature firms (i.e. providing dividends), are more attractive. If government priority is to stimulate the formation of new firms to create jobs, then the tax treatment of capital gains needs to be reviewed.

There is also the appeal of Central Canada for Atlantic Canada investors. There are more opportunities and a perception of more stability in the business environment. And investors from outside the region resist entering Atlantic Canada because there is a perception of more and better opportunities elsewhere.

4.1.7 High Demand for Information Technology Personnel

The availability of appropriately skilled workers is critical to the growth and sustainability of technology clusters. Continuing access to trained employees at various levels of management is necessary to support increased output and diversity of products/services needed to ensure the viability of the cluster.

The growth of information technology related, "knowledge based", industries is well documented, as is the increasing demand for IT professionals and IT trained workers. Les Hulett, President of NewfoundKnowledge prepared a discussion paper on human resource issues as one of the five "theme" papers for the Atlantic Technology Forum held in November 1996. In that paper he summarizes the situation as follows:

> The knowledge-based sector in Atlantic Canada, in pace with the rest of North America, is experiencing rapid growth. This growth is placing severe strain on the supply of skilled human resources needed to sustain industry's demands, and ultimately could limit development in the sector. The most severe problems are associated with the supply of new, skilled workers entering the work-force, the need for knowledgeable managers, and the out-migration of skilled workers from Atlantic Canada.[11]

Mr. Hulett estimates that "it is not unreasonable to predict that there could be as many as 2,000 to 2, 500 jobs vacant in the knowledge-based sector in Atlantic Canada by the end of the decade."

[11] Hulett L.: The Human Resource Crisis: Discussion Paper prepared for the Atlantic Technology Forum, November 25-27, 1996.

The technology clusters most reliant on information technology, geomatics and the information highway, are most affected by the shortage of IT professionals. This was confirmed through interviews with firms in these industries. One geomatics firm interviewed was able to explain the problem from their company's perspective as follows;

> "Geomatics firms as a specialized stream of IT draw upon the same workforce pool as mainstream IT firms. Although specialized training in geomatics is available through a few Atlantic institutions, graduates of these programs are often lured west and south by larger firms offering higher salaries. Similarly, the opportunities for advancement and diverse experience is more readily available in larger companies outside of the Atlantic region."

4.1.8 Information Technology is Needed in All Clusters

The problem of demand for skilled IT workers is not limited to IT dependent industries. As information technology becomes increasingly important to all organizations regardless of size or the nature of the business, the need for IT skilled workers at various levels of expertise grows. Business increasingly relies on IT to support business imperatives including: administrative functions; access to new sources of information (related to markets, current research, other companies in the same industry) as well as information needed for more effective day to day operations (weather reports, commodity prices, industry news); controlling telecommunications costs by allowing the use of less expensive electronic mail and document transmission/reception. Examples of the use of IT by firms interviewed in this study can be found in Exhibit 4-4.

Exhibit 4-4
Examples of the Use of IT in Sectors Studied

Aquaculture	• planned automation of the plant and use of a computer to monitor the facility while away from the site • recent hook-up to the Internet for information transfer and marketing
Food Processing	• reliant on IT because of EDI. Extensive use of e-mail, hand held sales recorders, electronically controlled baking. Launching a "paperless flow" project within and between offices in 1997.
Geomatics	• looking for ever faster means of transferring data
Medical Devices and Services	• tracking medical data • exchange of research and design information with other companies • international linkages; need more involvement in teleconferencing
Oceans Technology	• opportunities identification

Source: Interviews

Les Hulett summarizes the human resource challenge as follows:

- to produce entry level workers that have the requisite skill sets to meet the challenges of knowledge-based industry;
- to produce sufficient numbers of managers that have the skills and experience to manage growth in the knowledge-based sector;
- to find incentives that would attract managers and skilled workers to the region; and
- to develop the appropriate mechanisms to retain those workers who are contributing to the sector in Atlantic Canada.

Atlantic Canada has strength in the amount, quality and accessibility of training through universities and community colleges needed to meet these challenges. (The number of students in post secondary institutions in the Halifax metropolitan region alone exceeds 26,000.) The issue becomes one of refocusing to address today's issues.

In the *Summary and Next Steps* of the Technology Forum the human resources discussion resulted in the following recommendation:

> "Human resource development opportunities would be enhanced by more specific and clearer identification of the requirements of industry, more effective communication of those requirements to the educational institutes and timely responsiveness by the educational institutes. The problem can be distilled into identification and communication. Furthermore, not only do basic technological needs of industry have to be met, graduates must be equipped with better and more appropriate business skills."

4.1.9 Jurisdictional Influences

The information highway, geomatics and aquaculture were analyzed from a regional perspective although in reality they function more as provincial clusters. Although there is interaction between firms/organizations in different provinces, the significant linkages appear to be within the boundaries of each province. Geographical proximity and common operating environment facilitate linkages being established at the local or provincial level. This was confirmed by our interviews. As a result, it is difficult to draw conclusions about cluster dynamics that are equally applicable across the region.

The information highway cluster exhibits very pronounced differences between provinces. Using four of the eight criteria for successful clustering and comparing these elements in each province illustrates this point.
Recognition of potential.

New Brunswick is marketing the province as the IT centre of Canada for specific niche markets (i.e. call centres).

Nova Scotia is planning to initiate a major IH project with MT&T known as the Integrated Wide Area Network.

Prince Edward Island has also been targeting call centres. Recently a $32 million investment was announced to "connect" and support the government and business communities via PEI Broadcast Communications Network.

Newfoundland has set in place an IT strategy driven by Operation On-Line.

Regional Strengths

New Brunswick has two very aggressive, home grown, competing infrastructure providers (Fundy and NBTel) which results in a more responsive customer service environment. In addition, the NB government has gained the reputation of being "business friendly" by responding quickly and favorably to requests made by business. NB has also had success with using their bilingualism as a lever with national firms.

Nova Scotia is the traditional base for the Atlantic region offices of major national or international equipment and services firms. Nova Scotia also has more IH firms and more diverse university and R&D support.

Champions

Frank McKenna of New Brunswick is unquestionably the IT Champion in the region. However, his interests are in his own province which are often in competition with the other Atlantic provinces.

Information Nets

Nova Scotia has more industry associations (such as NovaKnowledge and SIANS, as well as active chapters of national associations) than the other three provinces. In addition, these organizations tend to have been established earlier than similar organizations in the other provinces and as a result have larger memberships and more experience in bringing together firms with common interests.

These differences can be attributed to several factors: political jurisdictions and provincial identities; service territories of key infrastructure providers (most notably the cable and telephone companies), and; a tendency by firms to focus on easily accessible local markets. The effect is that although the four provinces that make up the Atlantic region have much in common, each is distinct.

Political jurisdictions impact business registration, taxation levels, support available from provincial and to a lesser extent federal agencies, provincial government procurement practices that can help firms grow, and the territory that firms view as their local markets.

While licensed service territories relate only to the information highway cluster, similar service boundaries are evident in aquaculture as a result of licensing requirements.

Industry associations with few exceptions (i.e. Champlain, the Atlantic Agri-Products Competitiveness Council) are also provincially focused. Practical reasons such as proximity for organizing and attending association functions, common business interests and business environment are the primary reasons for associations limiting geographical interest. In addition, many associations are partially funded by government agencies under federal/provincial sub-agreements administered by each province.

In all clusters, the easiest (and least expensive) markets to serve are local. As a result firms tend to think of their local markets in terms of provincial boundaries.

Finally, provincial patriotism (for lack of a better term) is perhaps more of a factor in Atlantic Canada than in Central Canada. Firms within each province will try to support other firms within the province first, within the region second, and elsewhere third. The telephone companies are one, but certainly not the only, excellent example of this attitude. The health of the telcos is reliant on the growth of firms within their service territories and they attempt to source locally/provincially whenever possible. The end result of these factors is that although there are common characteristics of each cluster on a regional basis, in reality there are also significant differences among provincial clusters.

As well, the concept of clusters often cuts across the responsibilities of various government agencies creating further fragmentation. Aquaculture illustrates this point. While aquaculture is viewed as a development opportunity by both the Federal Department of Fisheries and Oceans and the Provincial Departments of Fisheries, there are issues of jurisdiction. DFO regulates ‘everything that is in the water’ while provincial agencies regulate what happens once it is landed. So, DFO has no say over the processing of fin-fish or shellfish whether they be wild or grown via aquaculture. And if grown via aquaculture, DFO has no say over the licensing of aquaculture facilities. Across provinces, different regulations affect aquaculture licensing and processing. These varied regulatory and jurisdictional issues make it difficult to form pan-Atlantic cluster synergy in the aquaculture cluster.
The fact that the key linkages for cluster development appear to fall, in large part, within existing provincial jurisdictions should not be surprising. Cluster development is very much a

local phenomenon where proximity among key players is important. So, while a pan-Atlantic approach to economic development can provide economies of scale in certain areas, such as public sector procurement, such an approach is not appropriate for encouraging cluster development because the locus of activity is at the local level.

However, as the clusters grow they will spread to other areas in the region, which could eventually entail the development of an Atlantic Canada perspective.

4.1.10 Short vs. Long-Term: The Need for Staying Power

It can take a long time to build a successful knowledge-based industrial cluster. The origins of Silicon Valley, California, can be traced back to the late 1930s, and those of the Ottawa cluster to the late 1940s. This means that support activities have to have a long term perspective. They have to transcend the usual 4 to 5 year political time-frame.

In Ottawa, for example, the two principal drivers of the development of the cluster were Bell-Northern-Research (now Nortel Technologies) and federal government laboratories. Having both private sector and public sector elements diversified funding sources and budgetary cycles. Moreover, until recently, the funding for federal government laboratories was relatively stable.

In Atlantic Canada much of industrial development take place within the context of federal-provincial agreements that usually have a 4 to 5 year time-frame. In many instances, agreements terminate just when they are becoming effective. It must be remembered, that it can take a new firm more than 5 years to become viable, even longer if it has to face a regulatory process (e.g. bio-technology products). Related publicly-funded support structures have to take into account of industrial product development and return on investment cycles.

An example of this “time period” problem was raised during an interview with the Manager of the Hidden Valley Char Farm in PEI. It was suggested by the Manager there is a need for a project to be carried out jointly by the Gene Probe Lab at Dalhousie, the Vet College and the growers to cultivate an improved brood stock to sustain the char aquaculturists. He added that such a stock could become a valuable export product. However, such a project would require eight to ten years and this time frame does not fit present funding programs.

A stable government program environment is needed so that clusters can be built over time. This means understanding that cluster development takes a long time and needs long term commitment. Also, a diversity of approaches to support both public and private mechanisms with longer time-frames and various budgetary cycles should to be set in place to create stability and offset any discontinuities in industrial development support activities.

4.2 CLUSTER SPECIFIC ISSUES

4.2.1 Atlantic Canada Information Highway Cluster

The Information Highway cluster appears to be the one that is closest to "take-off". It is a cluster that is renewing itself. It has a larger regional market base than other clusters, such as geomatics for example. The cluster renewal if being driven by deregulation of the telecommunications industry and by new opportunities presented by new technologies (e.g. multimedia, digital communications). It is a cluster that provides enabling capabilities for other clusters.

The cluster has a high profile and has been the focus of government attention across the region. Premier McKenna particularly has been a strong advocate of Information Highway development in NB. Linkages are developing within specializations at the sub-cluster level.

Two major factors could limit the development and growth of this cluster; they are the bottleneck in getting skilled people and problems in accessing venture capital due to the immature business discipline entrepreneurs.

4.2.2 Atlantic Canada Geomatics Cluster

The Geomatics cluster has developed historically to serve primarily local markets. The cluster has only limited marketing experience and outreach beyond the region. There is a good diversity of products and services, but they are not integrated into larger packages.

Future growth would be more promising if there could be a higher level of integration within the cluster, that could support stronger international marketing efforts and also spur more in-depth product line development.

The cluster has a champion in the Champlain Institute.

4.2.3 Atlantic Canada Aquaculture Cluster

The Aquaculture cluster is small but has excellent growth potential. It is not yet well recognized outside its immediate region. It has a diverse product range, but is primarily concentrated on Atlantic Salmon.

Constraining factors on the cluster are its small size and lack of explicit links to regional value-added food processors. The small size is creating problems of marketing development and management skill levels, and especially financing support for small firms.

4.2.4 Newfoundland Oceans Technology Cluster

The Oceans Technology cluster in Newfoundland has been in place for more than 20 years and is developing slowly. Distance of markets is a specific issue along with weak management skills and limited financing for small firms. The slow pace of development of the local market (i.e. the oil industry and the downsized fishery) has slowed the expansion of the cluster. Moreover, while there was a champion in the 1970s, Angus Bruneau, then of Memorial University, there is no clear champion today.

The cluster is technologically sophisticated, but lacks an overall systems integrator to provide larger packages for export markets. The firms have remained relatively small and typically have faced problems of continuity of market opportunities. They lack strong external marketing capabilities.

4.2.5 Nova Scotia Medical Devices/Service Cluster

The Nova Scotia Medical Devices and Services cluster is a collection of advanced service providers and specialized medical devices suppliers. Although the cluster has leading-edge capabilities from a scientific and technological viewpoint, there are major weaknesses in the linkages between elements of the cluster.

Most of the supplier firms are small, facing constraints in marketing efforts and management experience, and also facing constraints in available financing options.

Procurement by public-sector agencies has been important to the development of clusters. In the Nova Scotia nascent medical devices/services cluster "smart" procurement by the hospitals could go a long way in helping to build the cluster. Hospitals buy on a least cost and value for money basis. This will continue, driven by budgetary constraints. However, in some areas where they have expertise, hospitals could show leadership in new product development and make money in the process. The case of Sunnybrook Hospital in Toronto as described in Exhibit 4-5 illustrates what can be done.

Nova Scotia has a strong R&D base in its universities and hospitals that can be used to build a strong medical device/service cluster. The case of Minnesota, a region which like Nova Scotia is not close to major markets, is described in Exhibit 4-6 to illustrate what can be done.

This cluster is currently evolving towards a "bio-industries" cluster which cuts across several sectors (e.g. medical, environment, agriculture, forestry).

Exhibit 4-5
Sunnybrook Hospital Procurement Strategy

Sunnybrook's holding company, Sunnybrook Health Services Ltd., established the Centre for Studies in Aging Inc. (CSAI), as a non-profit organization, to hold the technology developed by the researchers at its Centre for Studies in Aging (CSA) and the associated group at the University of Toronto. In turn, CSAI has established a Lifestyle Innovations Inc., a for-profit subsidiary to exploit its technology. Royalties flow back to CSA to support is reach program and to the investors of assistive products. Some examples of the many products developed are:

- Access Bathtub: a uniquely designed bathtub that provides easier accessibility and safety for everyone, while maintaining its appeal to people who have no apparent disabilities.

- Skywalker: the first in a new generation of four-wheeled walking aids, featuring a grip-free braking system.

- Sturdy Life™: the first battery powered portable overhead lift in the world; a revolutionary caregiving tool used to lift individuals during transfer tasks.

Most of these products are manufactured in the Toronto area.

Exhibit 4-6
The Minnesota Medical Device Cluster

The medical device industry grew around Medtronic Inc. and the University of Minnesota's surgery research program. Medtronic was formed as a partnership in April, 1949, by Earl Bakken and Palmer Hermundslie. The two men thought of the idea while talking about Bakken's part-time work at Northwestern Hospital in Minneapolis.

Mr. Bakken had become familiar with the staff at Northwestern while waiting after work for his wife, a medical technologies. The staff soon learned that Bakken was a graduate student in electrical engineering at the University of Minnesota, and began asking him to repair electronic hospital equipment. Hospital engineers could service heavy machinery, but were not trained to repair more delicate laboratory equipment.

Bakken and Hermundslie recognized their opportunity. Bakken left his graduate studies, Hermundslie quit his job with a local lumber firm, and together they formed a medical equipment repair company. The original site of the firm was a garage in Minneapolis.

Over time, Medtronic started building custom devices for medical research laboratories in Minneapolis and the Mid-West. A break came in the mid 1950s when Medtronic cooperated with Dr. Walton Lillehei, a pioneer in open hear surgery at the University of Minnesota Medial School to develop the first cardiac pacemaker. Medtronic has grown to become a company with over $2 billion (US) in sales in 1996. It is estimated that at least 24 companies have spun-off Medtronic. These spin-offs were nurtured by venture capitalists, beginning in the 1970s, who became knowledgeable in medical devices. The growth of the medical devices firms in turn led to the growth of more venture capital in the region. Minnesota now ranks tenth in the USA in terms of venture capital money per capita.

Key lessons from Minnesota experience are:

- entrepreneurs (Bakken and Hermundslie) drove the development;
- a champion (Lillehei) catalyzed the growth of the cluster;
- there was a close on-going relationship between Medtronic engineers and the University of Minnesota Medical School;
- it took over 40 years to grow the cluster to what it is today; and
- the cluster developed by "growing" its own firms.

4.2.6 New Brunswick/Prince Edward Island Food Processing Cluster

The Food Processing cluster in PEI/NB is a mature cluster with a few large firms and many smaller firms. The larger firms are vertically integrated and do not link closely with other players in the cluster. The main issue is whether the cluster can renew itself by seizing on new product and processing opportunities that provide new linkages among the players.

Large firms can be seen as a measure of success but they can also cause structural problems that can adversely affect cluster development as observed by Bo Carlsson in his study of industrial clustering in Sweden, a country which has more firms on the list of Fortune 500 companies in relation to its GDP than any other country. These firms are characterized by the following:

- they have strong market positions;
- their growth has taken place abroad;
- they have relatively slow technical change and slow market growth; and
- they have been able to generate successful innovations in existing product areas but not in new areas.

The dominance of these large firms also contributed to stifling the formation of new firms, hence dampening entrepreneurship.[12] There is a lesson here for the PEI/NB Food Processing cluster (i.e. can the cluster renew itself given the presence of a few large and dominating firms?).

4.2.7 Summing Up

The key characteristics of the six clusters are show in Exhibit 4-7. They are presented against the eight criteria for success described in Section 2.0. The implication of these characteristics are presented in the following section.

[12] Bo Carlsson: Innovation and Success in Sweden: Technological Systems in Evolutionary Economics and the New International Political Economy (ed. J. de la Mothe and G. Paquet), Pinter 1996

Exhibit 4-7: Summary of Key Characteristics of the Structure and Dynamics of the Six Clusters

Cluster / Criteria for Success	Information Highway	Geomatics	Aquaculture	Ocean Tech. Nfld	Medical N.S.	Food Processing PEI/NB
Recognition of potential by regional leaders	• Yes; especially in NB	• Yes, but erratic	• Yes • support uneven	• Yes; long standing	• Yes; (e.g. InnovaCorp)	• Yes; McCain, Cavendish
Identification & support of regional strengths	• opportunity driven • bilingual work force in N.B. • good potential as pilot market	• broad skill base • specialized development (e.g. oceans)	• builds on traditional skills in processing and markets • public R&D & testing	• anchored in local environment	• publicly funded R&D base • health services and education	• raw materials available locally • large existing investments • strong R&D base
The catalytic influence of regional champions	• e.g. Premier McKenna (Nova Knowledge)	• Champlain Institute	• Grand Isle and other processors	• Angus Bruneau in the 1970s • no one today	• govt.	• none identified
The need for entrepreneurial drive	• high in software/content	• medium	• medium/high	• medium	• low in hospitals • high in suppliers	• variable (low to high)
The availability of investment capital	• access to VC a problem for emerging firms	• self financing • project specific	• problem for SME farmers	• access to VC a problem for SMEs	• govt. incentives available	• good for established firms • problem for SMEs
Informal and formal information networks	• Ind. Assoc. and orgs • good informal contacts (e.g. Nova Knowledge)	• Ind. Assoc in each prov. (+Nat) • Champlain Institute • good informal contacts	• Ind. Assoc (Prov & Nat) • Cooperatives • good informal contacts	• Ind. Assoc. and orgs (C-CORE) • limited informal contacts	• limited contacts overall due to diversity and international orientation of firms	• limited contacts overall • good contacts in R&D
Educational and research institutions	• demand exceeds supply of skilled people	• demand exceeds supply of skilled people	• excellent publicly funded R&D support base	• Memorial a good source of skilled people	• excellent research capabilities and personnel	• specialized training being developed • emerging R&D base
Staying power over the longer term	• cluster is renewing itself • diverse and rooted in region	• slowly emerging cluster • strong niche market potential	• steadily emerging cluster	• long standing but slow development	• nascent cluster	• mature cluster

Note: The characteristics presented here in summary form emerged from the development of the profiles of each cluster (see Part 2 report). The profiles were developed through a review of the literature and an interview process with key players in each cluster.

4.3 CLUSTERS IN PERSPECTIVE

As indicated in Section 2.0, we have found through previous cluster studies that there are eight key ingredients of success in cluster development. In Exhibit 4-8, which provides a template to illustrate the importance of these ingredients collectively for each cluster, each ingredient of success is given a value, on a scale of 0 to 10. The ideal situation would be a "10". If a cluster is well developed, the resultant shape of the figure would resemble an octagon which would be relatively close to the outer perimeter of the diagram. A departure from the ideal octagon shape indicates areas of weakness.

A value is given for each of the eight parameters reflecting the study findings for each cluster and a consensus among the Project Team members. The results of this analysis for the six clusters is shown in Exhibit 4-8 (A full page illustration for each cluster can be found in the Part 2 report).

A first observation, as illustrated in Exhibit 4-9, is that, overall, all clusters are faced with major challenges at the present time. While the potential appears to be well recognized, there are problems that have to be overcome related to most other characteristics of success for each cluster.

A second general observation is that all clusters have problems related to entrepreneurship, financing and the establishment of meaningful informal and formal information networks and other linkages. The lack of champions is also noteworthy in most sectors.

On the other hand, it appears that the technical infrastructure (i.e. education and R&D institutions) is well developed in most clusters. However, as indicated in Section 4.1.5 there are only weak links between most R&D institutions and firms in the clusters.

Weak industrial linkages (see Section 4.1.4) means that there is a substantial level of leakage outside the cluster (i.e. key supplies and services come from elsewhere as indicated in Exhibit 3-2). A similar situation exists in other knowledge-base industrial clusters around the world (e.g. Baltimore, U.S.; Taedok, South Korea; Tsukuba, Japan). Most clusters have some degree of leakage. However, as they grow, the key elements needed to ensure success migrate to the clusters. For example, in the Ottawa telecommunications/information technology cluster which is growing rapidly and now has more than 700 firms and 36,000 people in the industry, new international marketing and legal services as well as new product packaging capabilities have been set in place.

As stated in Section 2.0, geographic proximity enhances the effectiveness of industrial clustering. So it is not surprising to find that cluster development in Atlantic Canada is very much a local, provincial, or at best, a sub-regional phenomenon. The key linkages are largely within provincial jurisdictions as indicated in Section 4.1.9. This reality should guide the development of policies and programs for cluster development. As clusters grow they will extend their linkages further afield across the Atlantic region. Cluster development, unlike other areas where there can be

economies of scale through aggregation at the Atlantic Canada level, is very much a local phenomenon.

The cluster study of Western Canada also came to the same conclusion;

> "Most of the important linkages are found within provinces, or even with single metropolitan areas....[13]

The challenge for the sub-regions of Atlantic Canada is to begin to set in place the programs and activities that strengthen linkages within the clusters and address the issues identified above in order to grow the clusters. It has to be understood that building successful clusters is a long term effort. A strategy aimed at building successful clusters in Atlantic Canada is presented in Section 5.0.

[13] Reference 3, p.62.

Exhibit 4-8: Template for Illustrating the Status of Cluster Development

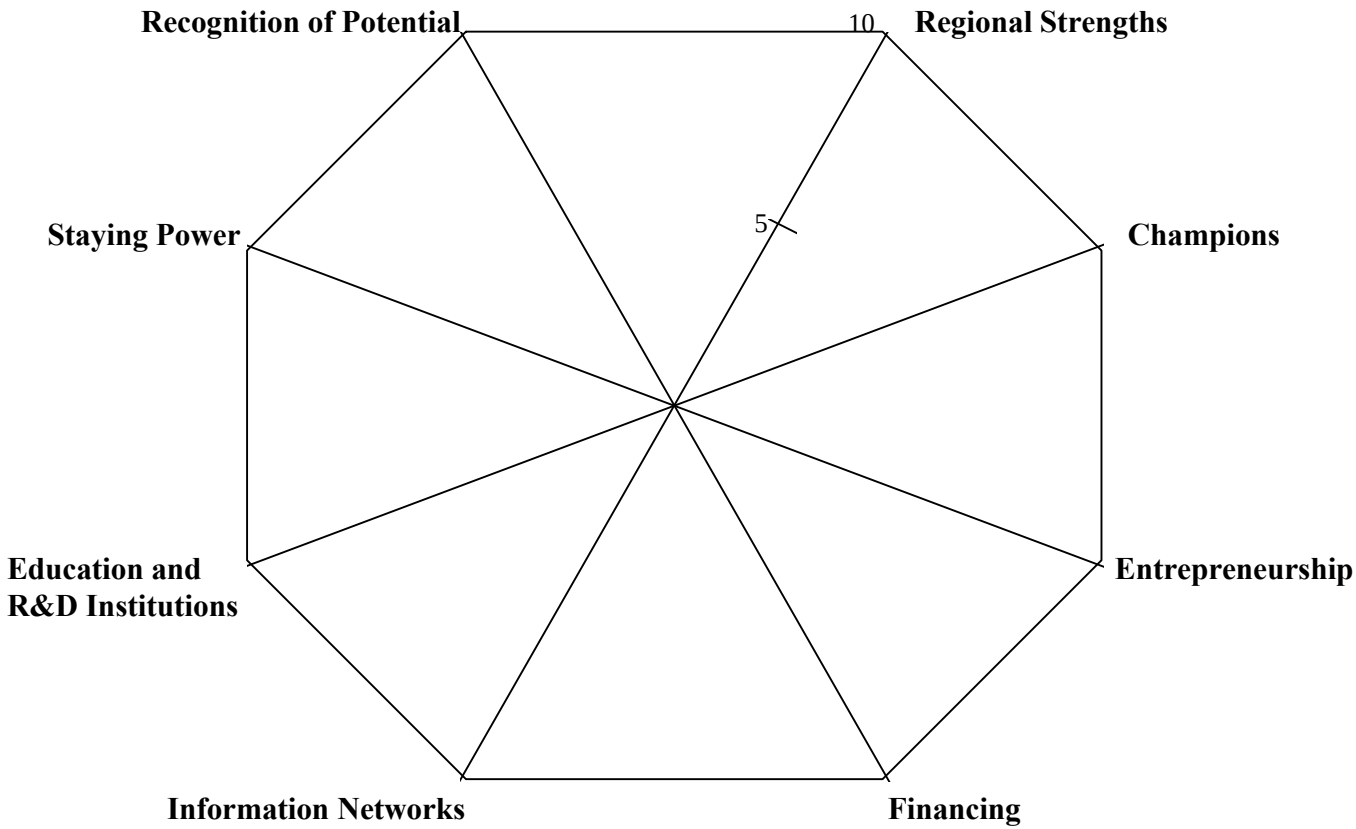
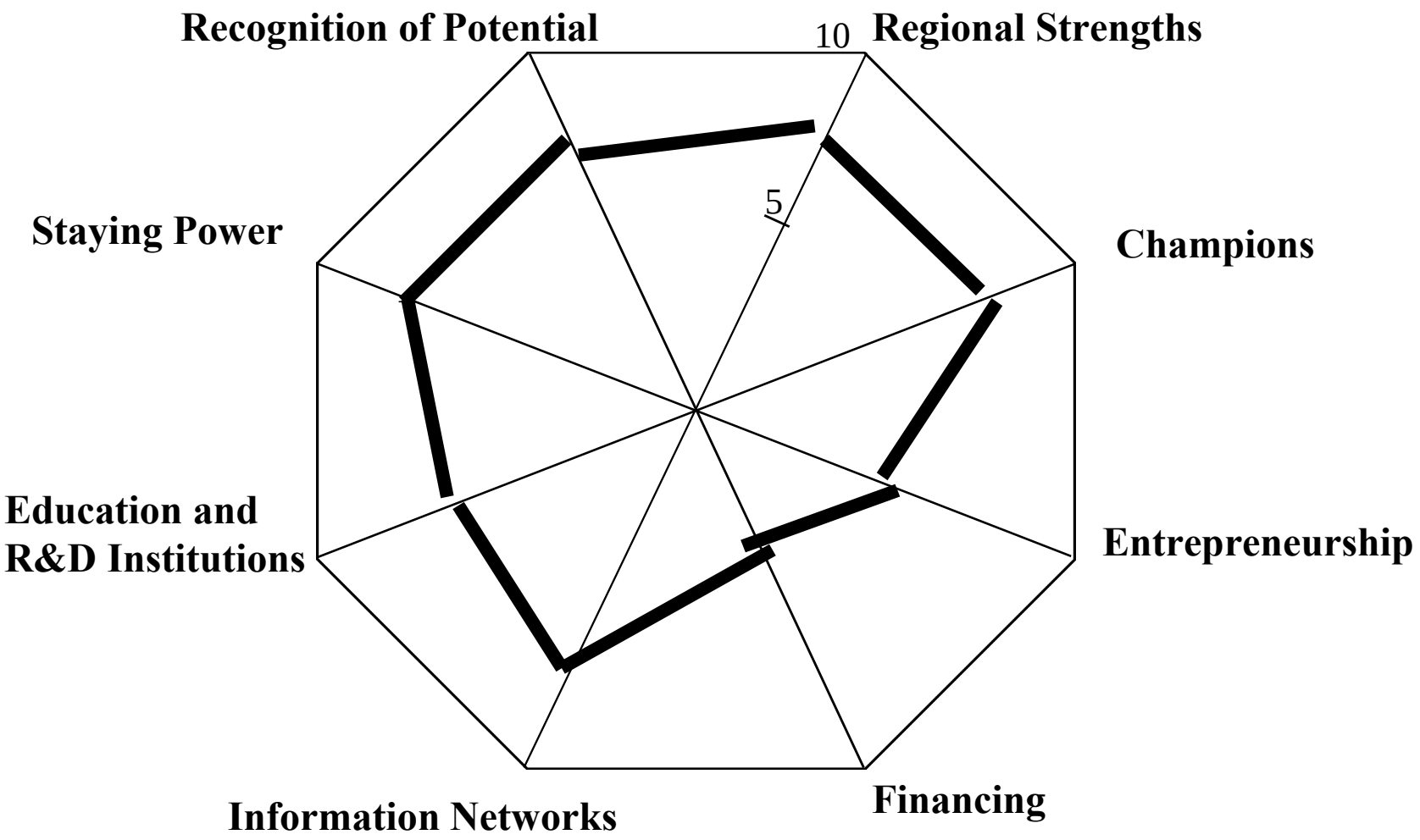


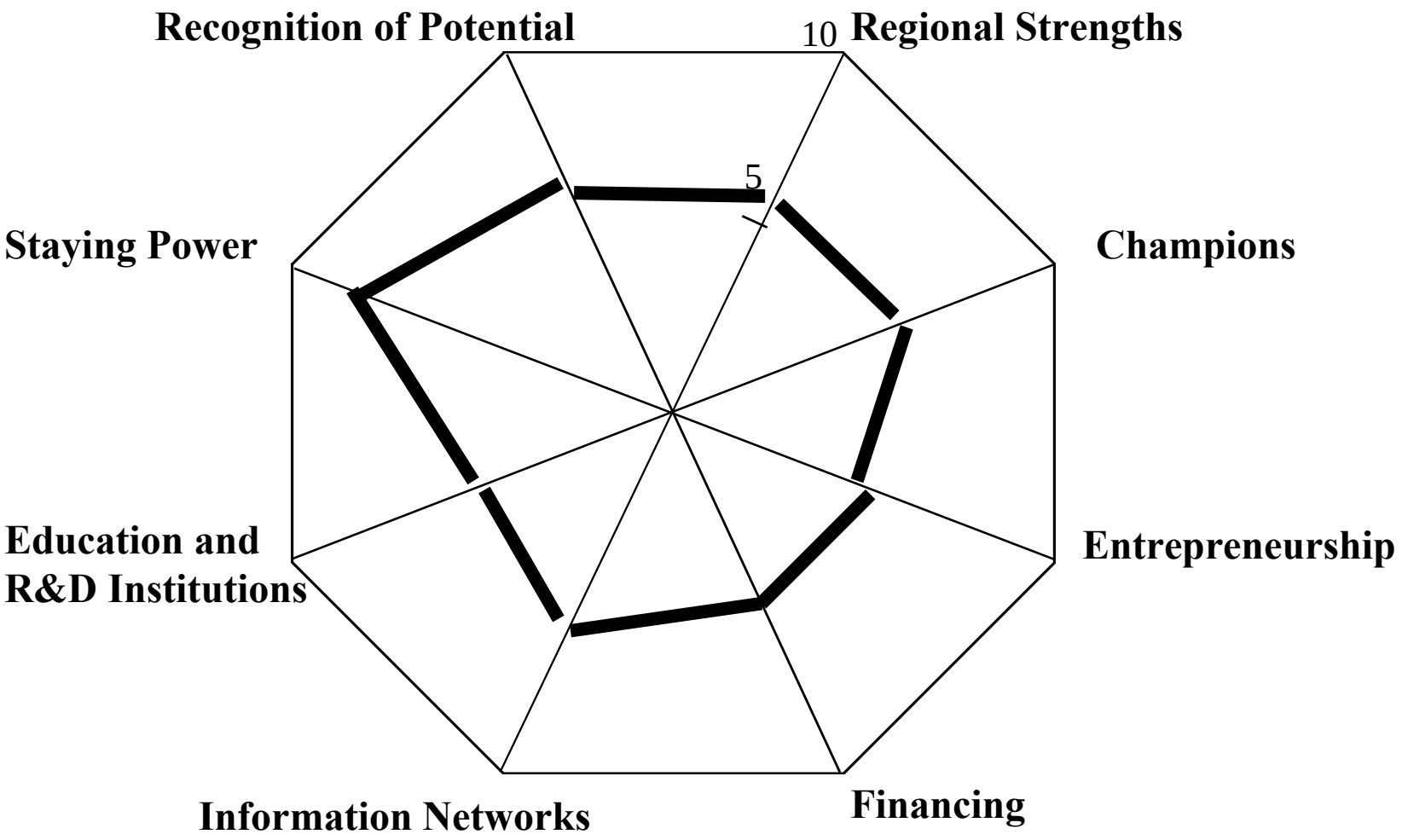
Exhibit 4-9
Development Status of Six Clusters

Note: Each of the eight characteristics for each cluster is given a value between 0 and 10, based on the findings of the study. The ideal situation is a value of 10.

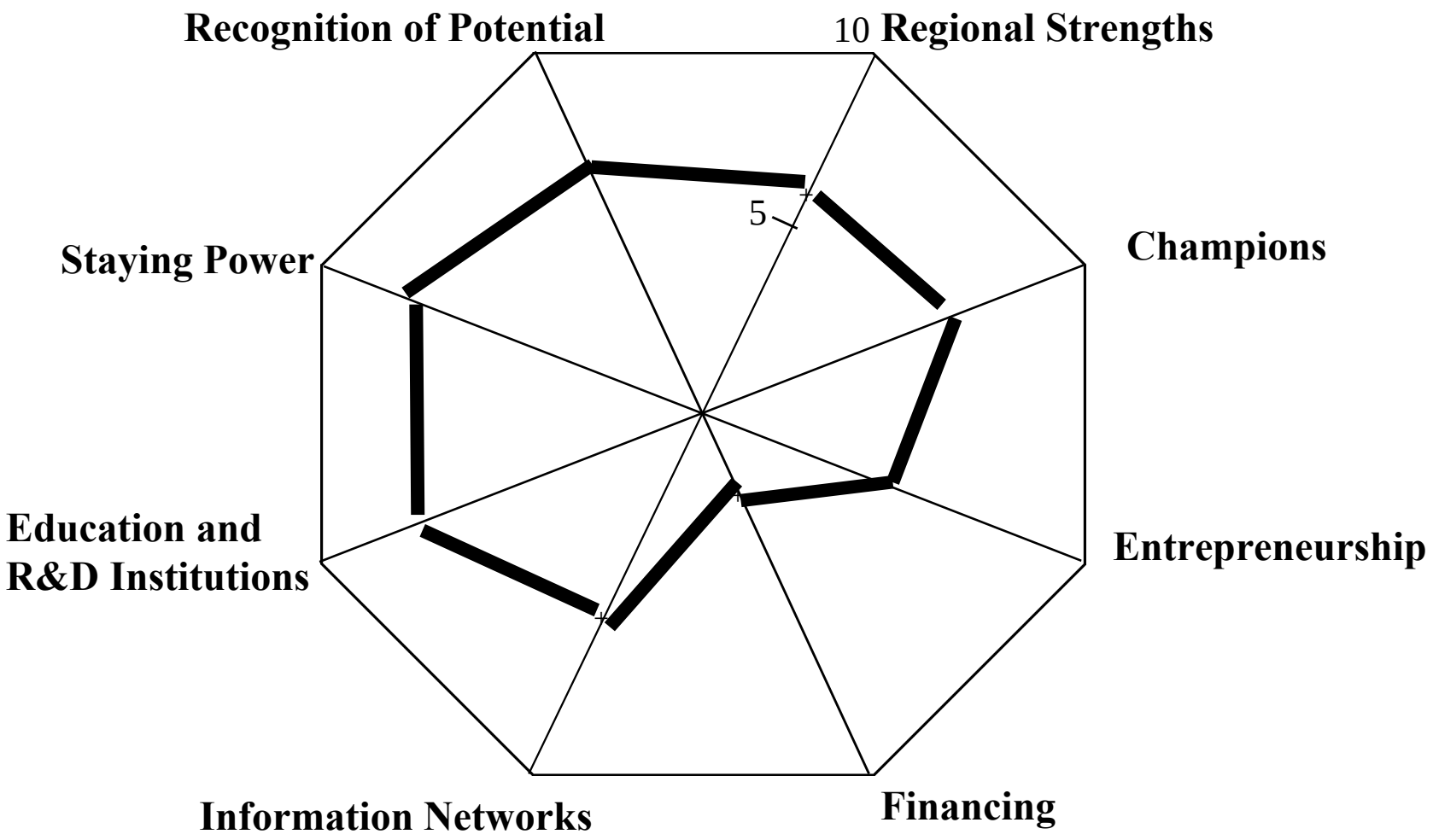
DEVELOPMENT STATUS OF THE ATLANTIC CANADA INFORMATION HIGHWAY CLUSTER



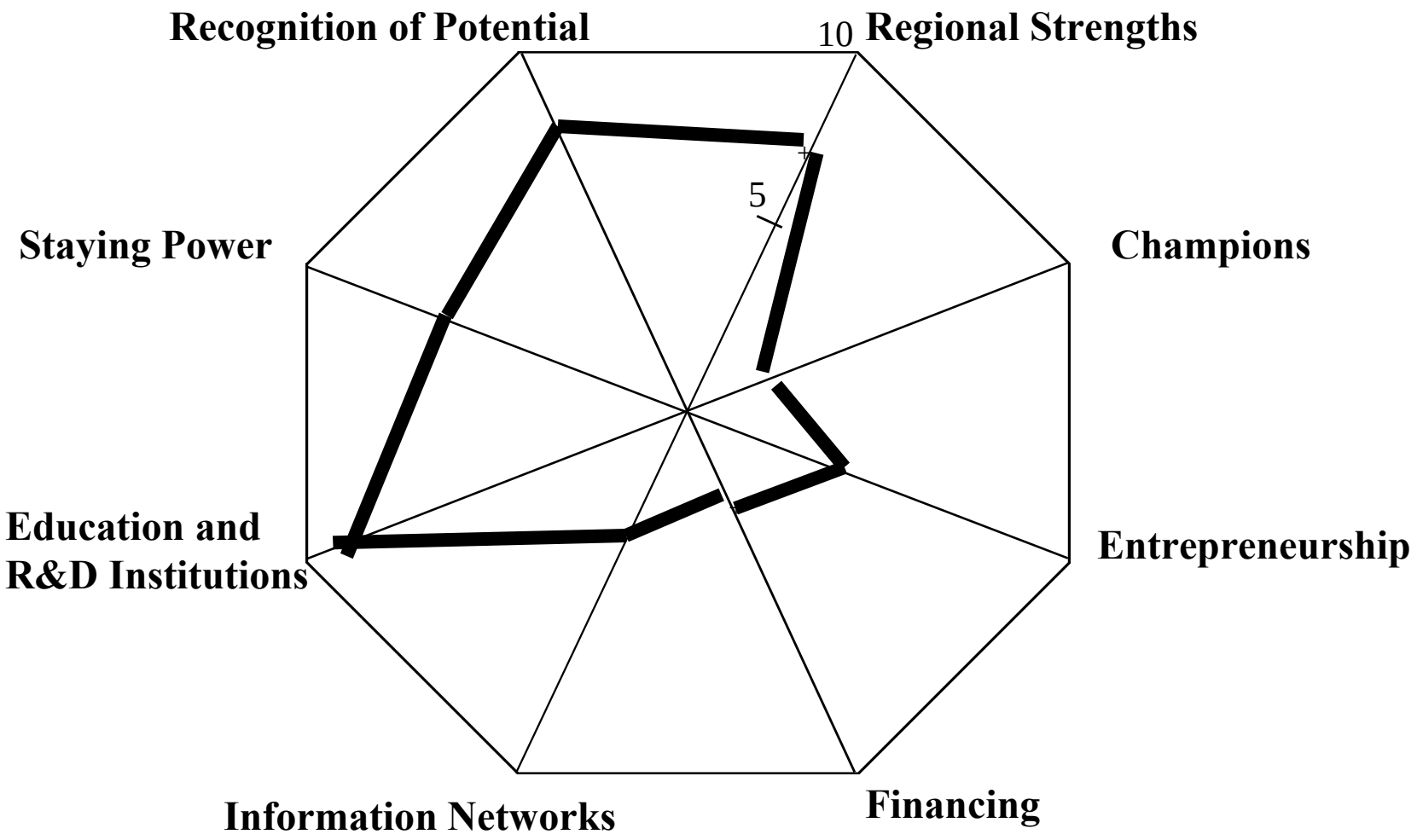
ATLANTIC GEOMATICS CLUSTER



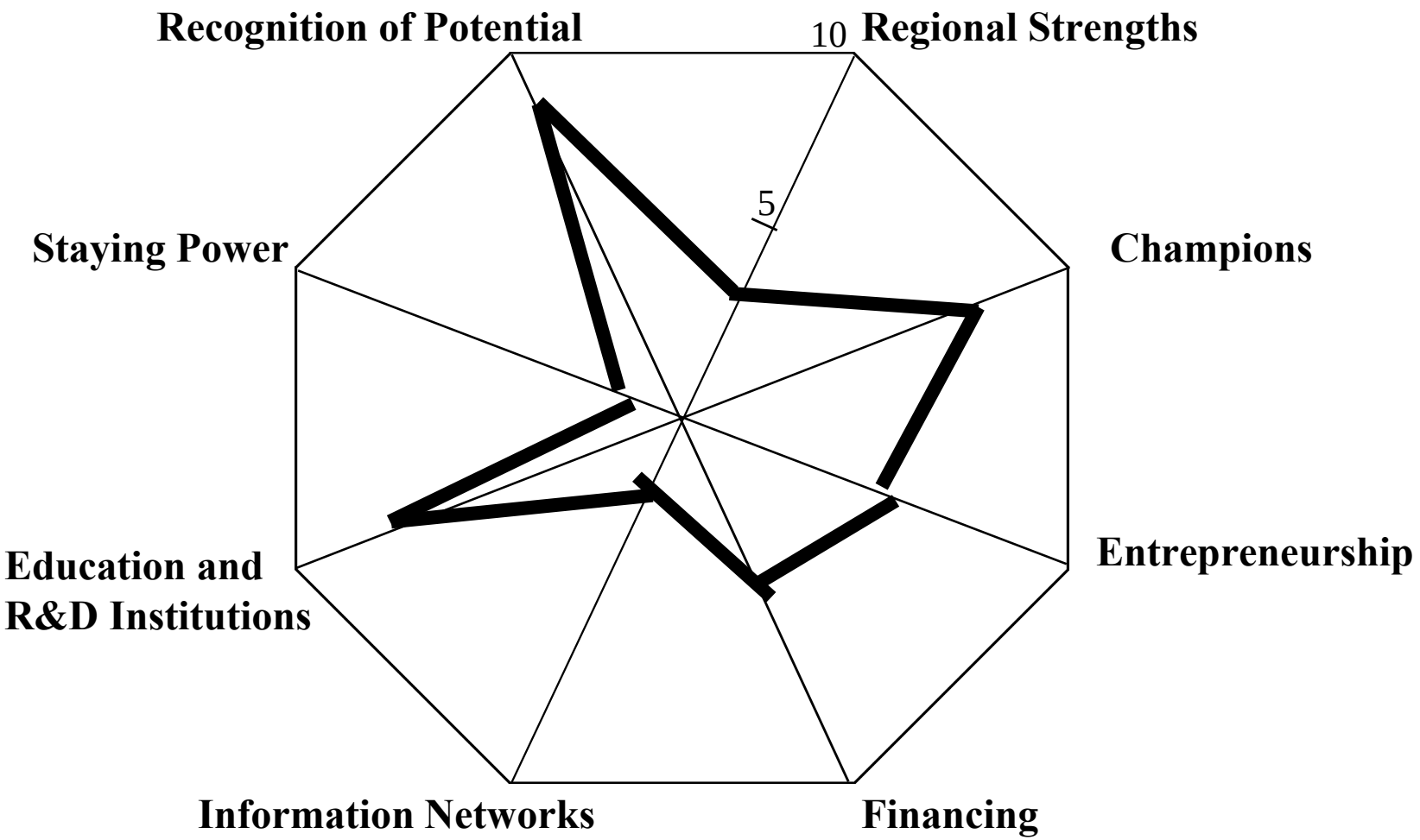
ATLANTIC AQUACULTURE CLUSTER



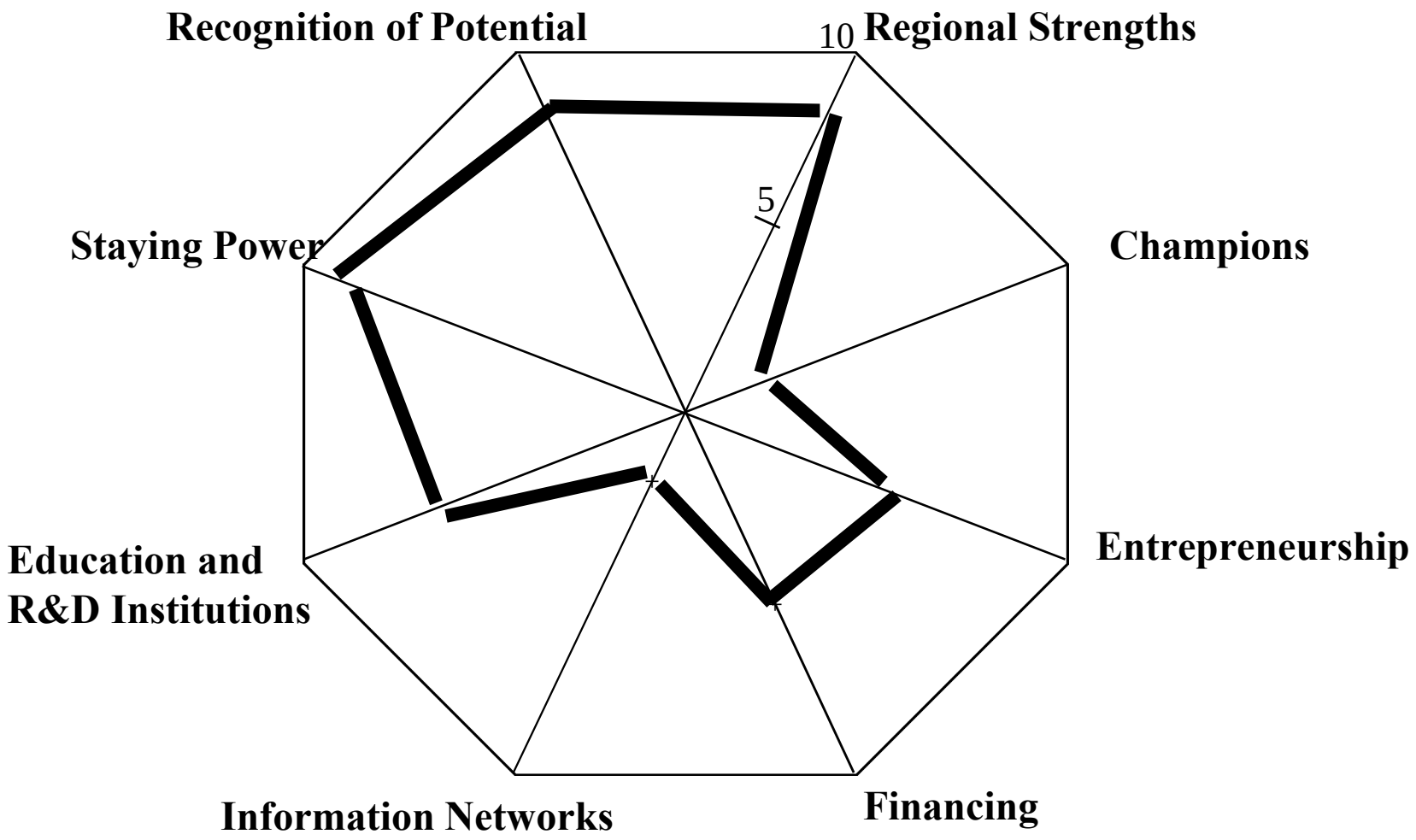
NEWFOUNDLAND OCEAN TECHNOLOGY CLUSTER



N.S. MEDICAL DEVICES/SERVICES CLUSTER



N.B.-P.E.I. FOOD PROCESSING CLUSTER



5.0
BUILDING CLUSTERS: A STRATEGY

5.1 GOVERNMENT HAS A ROLE

While entrepreneurial activity is central to cluster development, governments have also historically played a role in the development of clusters in their jurisdictions. They have offered subsidies and tax concessions, as in Scotland for example. Defence procurement played a role in the development of the Los Angeles, Silicon Valley and the Boston clusters. Procurement and the presence of government laboratories played a key role in the early development of the Ottawa area cluster. In Atlantic Canada, procurement such as that in New Brunswick in the information technology sector, has also been used but it has not been focussed on cluster development.

Individual government agencies and staff have also played a role in stimulating specific industrial development initiatives that have supported cluster development in Atlantic Canada.

Government has had and continues to play a role in supporting cluster development. The four point strategy presented here focusses on the supporting and enabling role that government can play. This strategy can be applied to all six clusters in varying degrees and possibly to others in the future.

5.2 CREATING LINKAGES

A cluster is the mutually-supporting presence of related firms and industries within a given area - in this study, Atlantic Canada or a sub-set thereof. A strategy for government to grow the six clusters analyzed in this study has first, to address the gaps and problems identified and second, to build on the dynamics of the clusters to speed up the growth process.

Ideally the cluster works by providing two separate flow streams (based on the concept illustrated in Exhibit 2-1):

- the first is a flow of products that go through a series of technologically based transformations within the cluster's layers that make them of higher-value to consumers and are then sold to external markets;

- the second is a flow of information from the market back through the layers of the cluster to guide how the various technologically-based transformations need to be improved through new or better research, investments, organization, up-skilling and so on.

Accordingly, the units within each cluster are linked through these two flows.

Two questions come out of this ideal picture for any cluster. First, are the two flows operating throughout the cluster? Second, are all the units in the cluster linked to the existing flows? If the answer to either or both questions is "no", then some sort of action is required to facilitate the flows. The act of establishing these two-way flows throughout a cluster will encourage the cluster will grow. Consider the pyramidal model that this study has used to analyze each cluster. This pyramid captures what value-added product stream is flowing "up" through the cluster and it also suggests what market information can be implicitly presumed to be flowing back "down" through the cluster.

The problem is that both flows can be interrupted for a variety of reasons and this is what is happening in the Atlantic Canada clusters (e.g. key supplier linkages coming from outside the cluster).

However, this analysis does provide an action agenda: what are the mechanisms needed to establish continuous two-way flows?

There is not any one "model" that ensures such flows up and down the pyramid. Rather, there are a number of practical *criteria* that provide performance benchmarks for judging if any proposed new structure for facilitating linkages - such as consortia, joint marketing efforts, outright acquisition, trade associations, co-operative research, information links, or whatever - will in fact contribute to reaching the real goal. These criteria can be listed as follows. All of them are important.

Organizations that are in place in Atlantic Canada and that could serve as "models" on how to structure activities related to individual clusters are presented below. While these organizations' mandates generally meet more than one of the criteria described in the following sections, they are slotted against the one criterion which appears to meet a major part of the mandate.

5.2.1 Identification of External Target Markets

No matter how far removed from an identified target market any structure may be, there has to be an external market targetted as part of the terms of reference of the unit. This market must be external to the region so as to provide objective proof of competitiveness. The market must be targetted in terms of sales volume, geographic location, or specific consumers (individuals, other companies, or some other institution such as external governments), or (better) a combination of these. The external target market must be specified. The external market provides new opportunities for firms in Atlantic Canada (i.e. it makes the "pie" bigger).

International marketing consortia should be formed to aggressively pursue targetted markets.

Some examples of target markets that could be exploited by individual Atlantic Canada clusters are described below.

Information Highway - Transportation

The Port of Halifax is likely to see a major expansion and renewal, based on its prime location on North America - Europe shipping lanes, great circle routes and also on new, enhanced Canadian rail links right into the mid-west U.S. that feature expanded physical facilities (tunnels, bridges), to accommodate double-stacked containers on railroad flatcars. Total throughput could treble over the next ten years. There will be immense opportunities for systems and software to support this flow, including manifests, trans-shipments, customers clearance, etc. For example, state-of-the-art traffic management systems capable of accommodating ship, rail, air, and inter-modal freight traffic in/out/stored/handled at the Port would have substantial export potential. Relative to the costs of expanding the Port's physical facilities, the development investment costs would be low.

Information Highway - Telco-in-a-box

NBTel is already developing "turn-key" telco-in-a-box approaches to supplying complete telco capability to developing regions and other overseas markets. The approach involves "build, operate, transfer" concepts to areas that potentially can accept NBTel's level of services and organization. Modern concepts of telecommunication de-regulation means competing telco systems are being set up in smaller jurisdictions. Atlantic Canada telco's are credible in terms of service levels and technical sophistication, and can capitalize on lower costs, more agile start-up periods, and more appropriate scale to position themselves in local markets as facilitators of competitive capabilities.

Geomatics - Systems Integration

Perhaps the most important future market opportunity for Atlantic Canada's Geomatics cluster is developing integrated business platforms that include geomatics capability. An example of such a business platform would be a database system that indicated "just-in-time-delivery" solutions across international markets; the market would be substantial, especially for high-growth firms using a complex mix of air/surface transport. The market would involve current geomatic concepts of positioning within a large natural or built environment, but would also require dynamic capabilities that located, tracked and guided traffic units, personnel, cargoes, manifests, etc., in real time across both large-scale geographic areas (like oceans) and intensive built ones (like ports and warehouses).

Aquaculture - Diet Foods

Traditionally fish has been well-regarded as a useful calorie-reduced component of human diets. This characteristic could conceivably be further exploited through selective product development and forceful marketing campaigns. For example, aquaculture fish could be presented on a "lite" or "health" merchandising platform. The approach could involve both selective breeding of fishstocks (including capitalizing on unusual and/or non-traditional breeds) coupled with specialized recipes, cooking instructions, or prepared-meals auxiliaries, supportive of the health-food design.

Oceans Technology and Marine Communications - Coastal Zone Management

Newfoundland and Labrador, by virtue of its location, inevitably participates in the new, emerging activities relating to coastal zones. For example, parallel to weather forecasting and climatology is environmental control. Obvious candidates for the cluster include oil spill control and iceberg monitoring. Other such activities include:

- shipping lane management;
- resource demarcation;
- resource exploitation;
- safety and security;
- search and rescue;
- environmental response and control (e.g., fog, icebergs); and
- many others.

In this approach, the physical facilities development capabilities of the cluster could be enhanced by systems integration. If the Port of Halifax regained pre-eminence in freight traffic handling on Europe/North America great circle routes, then the Oceans Technology cluster in Newfoundland and Labrador could have a major coastal zone management role in terms of new traffic management and environmental security.

Oceans Technology and Marine Communication - Business Platforms

Perhaps the most important potential future market for this cluster would be business platforms that could incorporate oceans technologies and marine communications to enhance their operational capabilities. Examples might be fishing fleet management. Other illustrations could be tourism support in environmentally-sustainable context and "just-in-time" on-board mobile processing capability (e.g. fish), with alternative delivery points and product specifications (also in environmentally-sustainable contexts). It is important to note that these capabilities are not limited to North Atlantic environments, rather, the cluster should credibly seek out novel export potentials using its developed skills and capabilities as responses to the North Atlantic "most demanding customer". For example, the cluster may be able to position itself credibly as a business platform provider for oil exploration activities in unusual locations such as Falklands/Malvinas Islands.

Medical Devices and Services - Health Management Systems

In all of North America, health care expenditures are becoming a rising share of all costs. This phenomenon is putting a premium on health management systems that offer increased efficiencies and effectiveness both from a standpoint of costs as well as from the standpoint of patient well-being. Nova Scotia has an opportunity to capitalize on both its current capabilities and also its current customers to develop better systems. For example, flexible diagnostic and therapeutic health systems linked to a cost-containment regime either on a generalized basis or on a disease-specific (or other specific) basis could offer substantial insurance and medical care benefits.

Food Processing - Intensive Mass Production

Many modern agricultural producers resemble intensive manufacturing operations in terms of large scale, manipulated growth, and non-seasonal "harvesting". This opportunity may exist in PEI/NB based on existing technology and output (e.g. intensive hog or poultry production). The approach could involve coupling existing brand name products with more intense, large-scale production. For example, recent developments in the hog industry's production and processing, which involve vertically-integrated structures that link feed inputs with "industrial" farming and large-scale slaughter/packing/processing organizations offer rapid growth potential in locations as diverse as Denmark and North Carolina. Future potential in NB/PEI is not necessarily limited to either traditional products or hogs specifically, rather, it should be oriented toward optimizing cluster skills and integration capabilities.

5.2.1.1 Models

The Champlain Institute has as part of its mandate to identify and pursue opportunities in geomatics outside the region and to provide support necessary to export effectively. It is very close to the market and has organized international marketing missions. It has strong private sector support. Members pay $1500/year to belong and some funding is obtained from the Council of Maritime Premiers. It has a full time Executive Director who reports to a Board of Directors. While the Champlain Institute is currently mandated to serve the three Maritime provinces, discussions have been initiated to become an Atlantic Canada wide institution.

MEDIAfusion has, as part of its mandate, to support media related companies in Atlantic Canada through collective actions of its members (35 companies at present, mainly in Cape Breton). Their actions include carrying out market research and investigate export opportunities. It was formed with support from ACOA and Entreprise Cape Breton. It has an Executive Director (and two part time support staff) reporting to a Board of Directors.

5.2.2 Presence of an End-user Product or Service Integrator

There has to be an end-user supplier to the external market from within the cluster. However, sophisticated or unsophisticated the product may be from within the cluster, there has to be one identifiable local supplier who represents the seller of the most-highly-value-added product the cluster provides. There may be more than one, but the highest value-added layer of product has to be identified and his products have to be supported by other supply layers within the cluster. This may mean *either* simply identifying an existing supplier of integrated value-added product, who will be included in the structure *or* explicitly seeking to create such an organization where none currently exists. Nevertheless, a focal point for supply has to be identified explicitly (just as a focal point for demand - the external market - has also to be targetted).

This supplier has to be able to fulfill the functions of an integrated supplier and be able to demonstrate capabilities in external marketing, product integration, supply chain management, technological state-of-the-art and communications.

5.2.2.1 Models

Stratos (formerly NewEast Wireless Technologies) of Newfoundland is a long range mobile communications service provider offering customers a choice of wireless products and services for oceans, aeronautical and land-based markets. The firm is a system integrator providing end-user products for related wireless communication services.

NewTel Information Solutions (NIS) is subject to an Industrial Benefits Agreement (IBA) with the Government of Newfoundland over the life of its seven year out-sourcing contract to perform the Government's IT services. The IBA requires that NIS sub-contract a minimum of $21.2 million of IT professional services to local IT businesses over the IBA's life. Almost 60% of that is to come from work contracted by NIS with clients outside Government. This service integration role is bolstered by the commitment of NIS's shareholders (NewTel Enterprises, Andersen Consulting and Bell Sygma) to provide opportunities for Newfoundland companies to participate in projects across Canada, the United States and overseas.

5.2.3 Value-added Suppliers

Supporting the end-user supplier should be one or more layers of complementary and/or competing value-added suppliers who provide progressively greater value-added within the cluster. Their market is at least partially within the cluster. If there is only one end-user product supplier/integrator within the cluster then it is likely the supporting layers of value-added internal suppliers should be complementary (the competitiveness of the cluster will be tested and proven at the end-user product level, when the lone integrator tackles external markets). If however, there is more than one final product supplier, then it is likely there

should be competing capabilities at the supporting value-added supplier levels. The important benchmark is the vertical linkages explicitly identified in adding value within the cluster.

5.2.3.1 Models

The Applied Microelectronics Inc. model fits this category. AMI provides solutions. Established in 1981, it is a leader in the design and development of electronic based products. With a staff of 45, it provides turn-key products and services.

NovaLIS Technologies is an example of a value-added supplier to the Atlantic Canada Geomatics cluster. The company specializes in the Land Records domain. Its technology is the result of co-operative research through public-private partnering, and through close relationships with the academic community. Their products are designed to streamline land records management through integrating GIS, relational database systems and imaging technology.

5.2.4 Market-relevant Co-operative and Public R&D

The cluster needs an internal source of new technical knowledge *not* because it needs to generate all its own technology, but because it needs to be able to evaluate its own technical capabilities against competitors and/or adopt and adapt promising inventions from outside the cluster if need be. The key benchmark is market-relevance. This means that its output must be explicitly useable to the commercial units of the cluster. In turn this means its output of technical knowledge must be linked to targetted market objectives, and firm needs within the cluster. As described in Section 4.1.5, there are very weak links between R&D institutions and industry.

5.2.4.1 Models

The Canadian Centre for Marine Communications (CCMC) supports and assists the development of Canada's marine communications industry. Established in 1989 as a non-profit corporation, CCMC is strategically positioned between research institutions and private industry. Canadian companies and other relevant organizations drive CCMC's programs with industry led projects, annual membership, and board of directors representation. CCMC's mission is to facilitate the expansion of the Atlantic Canadian industrial base and enhance competitiveness of Canadian industry through a world class research and applied technology centre for marine communications, equipment, systems, and services to improve safety, security, and productivity of users on, above, and below the waters of the world.

Centre for Cold Ocean Resources Engineering (C-CORE) is an applied engineering research institute located at Memorial University. Funded by industry and government, the Centre undertakes research that contributes to the safe and economic development of Canada's resources. Building on twenty years of expertise and experience, the centre's fields of research have broadened to encompass new applications to a growing number of market

sectors. C-CORE educates and trains engineers and scientists to work offshore and in technology-based industries. C-CORE contributes to the economic development of Newfoundland and Labrador as a centre for ocean engineering. Projects are carried out in association with the private sector, particularly small and medium sized companies. The technology which is developed is transferred to the private sector.

The New Brunswick RPC (Research and Productivity Council) provides support for pre-market processing R&D. RPC also operates a "model" production facility accessible for new companies or firms interested in trialing new food processing techniques. This allows firms to experiment with the equipment and processing techniques prior to making, often large, capital expenditures on equipment. RPC also provides one on one food processing training.

Clinical Trial Atlantic Corporation has been successful in including regional clinicians within specific clinical trial projects.

5.2.5 Market-Relevant Related Business and Public Support

The business and public support networks must be relevant to both the targetted markets and the cluster firms. This can mean either horizontal or vertical communications links in that general capability (e.g. software) or cluster specific interests (e.g. oceans, medical devices) are being supported.

5.2.5.1 Models

Nova Knowledge has a mandate to increase the awareness and growth of information technology and growth of information technology in Nova Scotia. It has over 500 members (individuals and companies) who pay $50-60/year to belong. It is particularly financed through a federal-provincial sub-agreement. It has a full time Executive Director who reports to a small Executive Council (5-6 people). There is also an elected Council of 20-30 persons. It promotes information exchange, runs meetings and facilitates specific projects.

Software Industry Association of Nova Scotia has a mandate to promote the interests of software developers specifically and IT generally. It has about 150 members (mainly companies) who pay $200-300/year to belong. It is partially funded through a federal-provincial sub-agreement. It has a full time Executive Director who reports to a Board of Directors. It provides information and facilitates cooperative ventures between members.

The mission of the Newfoundland Ocean Industries Association (NOIA) is to assist, promote and facilitate participation of its members in ocean industries, with particular emphasis on oil and gas, to enhance their growth and development. The objectives of NOIA are:

- to create a forum for the exchange of ideas on ocean industry development;
- to promote the growth of ocean industry;
- to act as a focal point for representation to government bodies and agencies;

- to act as a source of information and education for members; and
- to identify and promote new business opportunities for members.

NOIA's membership is represented by companies involved in the development, manufacture and marketing of ocean technology, each company striving as part of a powerful team to optimize Canada's rich east coast marine resources. Members include industry from Newfoundland and Labrador, national partners and affiliates across the country.

Innovacorp's plans for pursuing further development in the medical services cluster also fits this model. Innovacorp works with multiple interests at various cluster levels (including private-public organizations such as the Greater Halifax Partnership) to pursue common investment strategies in the medical services field. They support firms as well assist in efforts to bring new firms to the province which have expertise, products or services which complement those of firms already in the province.

5.2.6 Recommendation

Clusters grow by strengthening the formal and informal linkages among the players. Criteria are presented above that indicate the functions that need to be provided to stimulate cluster development. In turn, these criteria indicate the type of mechanisms that should set in place to create the linkages needed within specific clusters. Some examples of such mechanisms are mentioned.

The main recommendation of this report is that all levels of government should stimulate the development of linkages among the key players in individual clusters. This means that their programs and activities should be aimed at the formation of alliances among firms and between firms and technical and business support institutions.

Major projects can be valuable focal points around which to get groups of firms and other organizations to develop specific activities. Identifying and structuring a few major projects that can create focal points for the development of consortia, partnerships and other joint activities should be a priority. Some such potential projects and project areas which were identified by interviewees during this study are shown in Exhibit 5-1.

Exhibit 5-1: Potential Projects

Cluster	Projects
Information Highway	• Vista phones • extension of TARA project • Ssart venture capital capability
Geomatics	• Placentia Bay Traffic management • Port of Halifax Traffic management
Aquaculture	• joint marketing • aquaculture link to bio-medicine • export of "growing systems" and brood stock • cost containment research
Oceans Technology (NFLD)	• oil and gas technology • environmental technology • seabed mining/exploration
Medical Devices and Services (N.S.)	• outsourcing solutions for hospitals • new health care management technologies
Food Processing (NB/PEI)	• marketing of vegetables • export of "wildbush" blackberries and other fruits • support of export clubs • increased efficiency of pesticides and machinery • increased use of computers • internship program • packaged meals

Three related elements of the strategy are presented in the following sections.

5.3 THREE OTHER ELEMENTS OF THE STRATEGY

5.3.1 Upgrading Management Skills

Weak management skills has emerged as a key issue. A number of approaches could be taken to bridge this management skills gap including the following:

- training entrepreneurs, managers and staff of existing firms. This can be done as specialized training courses and as part of university curricula. The management issue has been recognized and training programs are emerging. For example, there is the Certified Advanced Technology Manager program which is presented under the aegis of the Canadian Advanced Technology Association. Memorial University's Seabright Corporation established the GENESIS Centre which "will graduate companies with the business plans and management expertise required to attract venture capital";

- attracting seasoned managers and mentors to be retained by existing firms. These managers/mentors train firm personnel from within the firm through direct participation in the activities of the firm (e.g. sitting on management committees, preparing business plans and marketing strategies);

- developing an MBA program in technology transfer; and

- providing management services on a contractual basis. There exist professional services firms that specialize in providing management services to small and medium sized firms.

These approaches could be supported financially by government.

5.3.2 Bridging the Skilled People Gap

Skilled people are very much in demand in all high-technology sectors. This is especially so in the rapid growing information technology/information highway sector. This skilled people gap, especially that in information technology specialists, was identified by most people interviewed in this study. This is not surprising since the situation exists in all regions of Canada. It is a problem of much concern everywhere because it can be a bottleneck on the development of firms and by implication on the growth of clusters.

The problem was recognized at the Atlantic Technology Forum and a recommendation was made to have "an initiative to clearly identify the human resource needs of each sector in order to put into motion those programs necessary to catch up and meet the human resource needs of each".[14]

The universities and colleges as well as private training institutions have a prime responsibility to educate and train people that meet industry requirements. However, other venues are also being followed. Firms, for example, are aggressively recruiting specialists from the ex-Soviet Union (e.g. Newbridge) as well as contracting-out work around the world (e.g. software development to Bangalore, India). As well, attracting Atlantic Canadians working elsewhere should also be an element of the strategy.

Strategic alliances between firms have also emerged as a mechanism to augment human resources[15] as well as sharing risk.

[14] Proceedings of the Atlantic Technology Forum

[15] Kelly M.J. and Schaan J-L; The Management and Implementation of Strategic Alliances in the Canadian High Technology Industry; Department of Foreign Affairs and International Trade (1996)

5.3.3 Attracting External Investment

Atlantic Canada has assets that can make the region attractive to outside investors interested in knowledge-based/high technology industries. These assets include:

- a well developed technical infrastructure (e.g. universities, government laboratories);
- a well developed communications infrastructure;
- a lower cost business environment than many other locations in North America[16]
- a well developed social and cultural infrastructure and good quality of life.

The federal government has recently established a new agency, Investment Partnerships Canada (IPC) to spearhead a foreign investment strategy in knowledge-based/high-technology sectors. Three priority sectors selected by IPC that relate to this study are the information technology, life sciences and agri-food sectors. Federal, provincial and municipal authorities in Atlantic Canada should work closely with IPC to develop approaches and activities to attracting investment to the region. As well, the international network of Foreign Affairs and International Trade Canada should be used to the fullest extent possible.

In developing approaches that support cluster development the focus should be on attracting investment that brings marketing, design, product development, systems integration as well as production functions to the region to avoid the cluster truncation phenomenon that has occurred in Scotland and elsewhere, where foreign investment in low-level assembly functions with limited spill-over potential dominated.

5.4 SUMMING-UP

Acting on the proposed strategy would stimulate cluster development. It is a strategy that strikes a balance between growing firms and capabilities from within and attracting investment and capabilities from outside the region.

[16] KPMG; A Comparison of Location-Sensitive Operating Costs in Canada and the United States; Prepared for Foreign Affairs and International Trade Canada, August 1994